Normativity, Meaning Plasticity, and the Significance of Vector Space Semantics

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Language as Mechanisms for Interaction

Conventional referential views of semantics confront endemic context-sensitivity of NL resources. Instead, with a dynamic and non-representational view of meaning, words can be modelled as cues triggering affordances of interaction with vector space semantics (VSS) modelling memory mechanisms of episodes of use as in exemplar models of conceptualisation (Nosofsky, 2011). This framework (DS-VSS) then provides the requisite basis for assuming that multidimensional and subsymbolic conceptual mechanisms explain the nondeterminism that grounds continuous learning and adaptation, which are necessary to establish the cognitive and evolutionary niches in which NLs can be seen as complex systems for group interactivity.

Dynamic Syntax

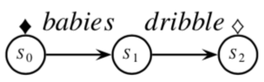
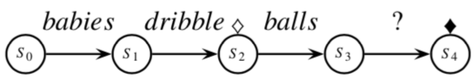
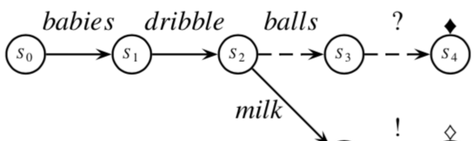
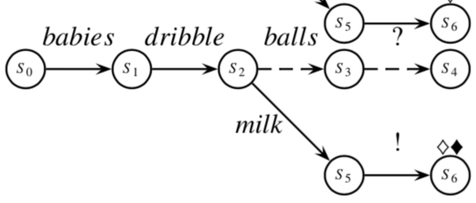
- **Domain-general** processing mechanisms
- **Incremental, predictive, bidirectional** grammar
- **Words = stimuli as cues for affordances**
- **Syntax = procedures for ad hoc online conceptualisation**
- Goal-directed **grammar operations probabilistically weighted** with multiple simultaneous paths of development
- Broad cross-language applications
- Suited to Dialogue Modelling

Lexical actions as affordances

dribbled

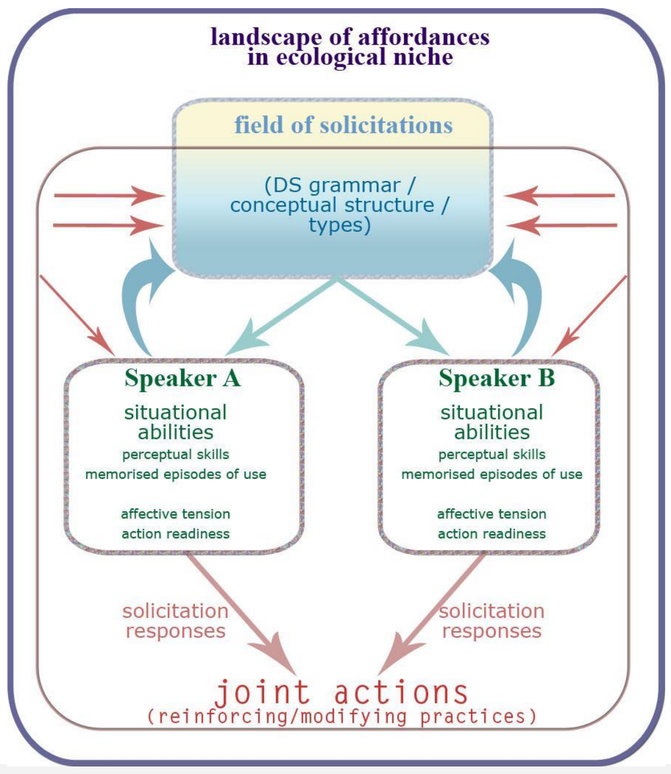
IF	$Tn(a), ?Ty(t)$	
THEN	IF	$\langle\downarrow_*\rangle\top$
	THEN	go($\langle\downarrow_*\rangle$); put($?\langle\uparrow_0\rangle\langle\uparrow_1\rangle Tn(0)$)
		go($\langle\uparrow^*\rangle Tn(a)$)
		make($\langle\downarrow_0\rangle$) : go($\langle\downarrow_0\rangle$);
		put($Ty(e_s), Fo(s_{PAST}), ?\exists x Fo(x)$); go($\langle\uparrow_0\rangle$)
		make($\langle\downarrow_1\rangle$); go($\langle\downarrow_1\rangle$); put($?Ty(e_s \rightarrow t)$);
		make($\langle\downarrow_0\rangle$); go$\langle\downarrow_0\rangle$; put($?Ty(e)$); go($\langle\uparrow_0\rangle$);
		make($\langle\downarrow_1\rangle$); go($\langle\downarrow_1\rangle$); put($?Ty(e \rightarrow (e_s \rightarrow t))$);
		make($\langle\downarrow_0\rangle$); go($\langle\downarrow_0\rangle$); put($?Ty(e)$); go($\langle\uparrow_0\rangle$)
		make($\langle\downarrow_1\rangle$); go($\langle\downarrow_1\rangle$);
		put(Fo(Lose'), $Ty(e \rightarrow (e \rightarrow ((e_s \rightarrow t)))))$
		go($\langle\uparrow_1\rangle$); make($\langle\downarrow_0\rangle$); go($\langle\downarrow_0\rangle$);
	ELSE	Abort
ELSE	Abort	

Interaction Control States

Utterance	B's Context After Utterance
A: Babies dribble ⟨*pause*⟩	
B: balls?	
A: no milk!	
B: okay	

Skilled Intentionality Framework

(Rietveld et al., 2018)



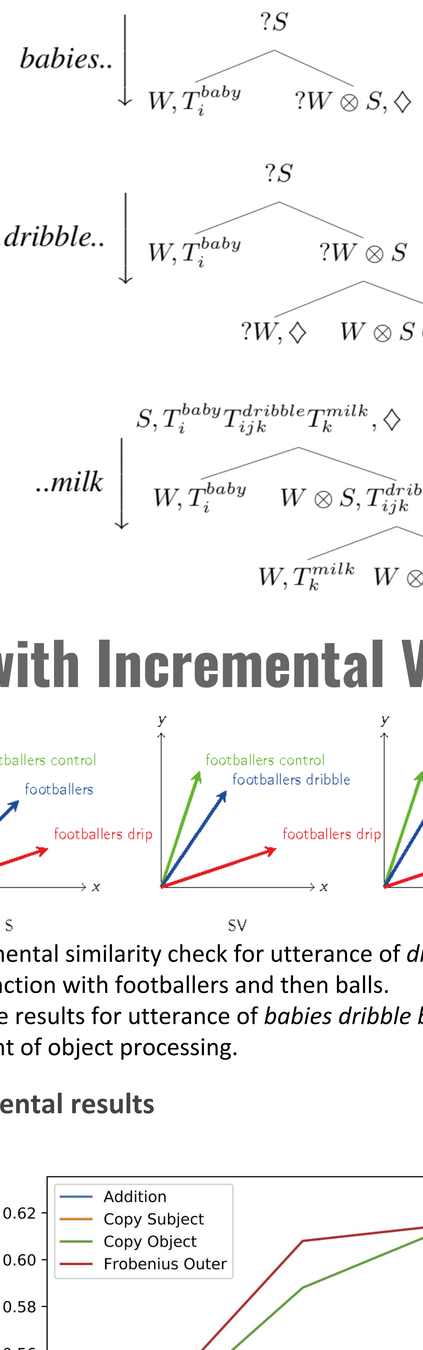
Affordances

Agent-relative opportunities for action available in the ecosocial niche:

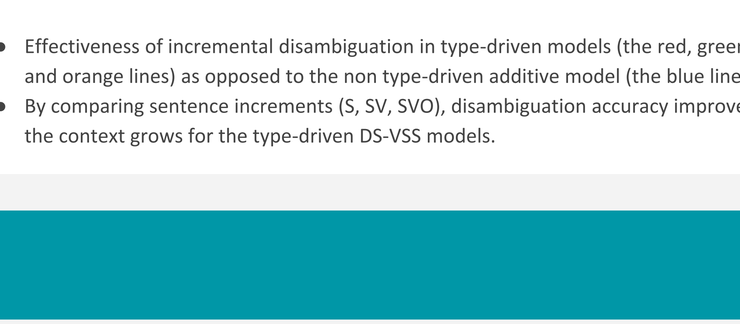
- reinforcement learning (e.g., Eshghi & Lemon, 2014)
  - routinised group-consolidated actions
  - need for coordination in socio-material settings enable emergence of norms
- vast landscape of affordances for humans necessitates probabilistically weighted anticipations of rewards/penalties
- in dialogue, interlocutors as cues for past episodes of interaction
  - appearance of "audience-design", "mind-reading", common ground calculation

DS with Vector Space Semantics

- Non-determinism of meaning ensuing from context-relative vectors and tensors (modelling memorised episodes of use)
- Incremental context-aware prediction
- Incremental disambiguation/enrichment/narrowing

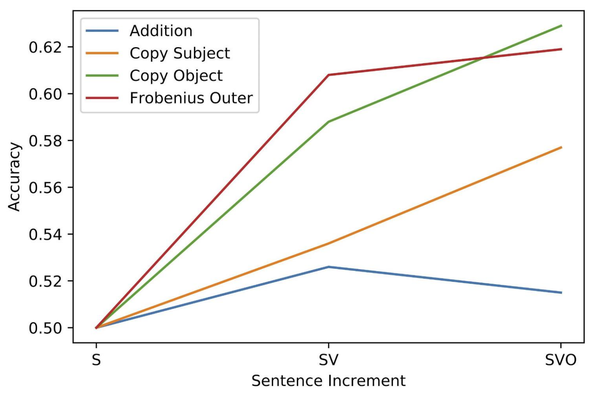


DS with Incremental VSS



- Incremental similarity check for utterance of *dribble* uttered in conjunction with footballers and then balls.
- Inverse results for utterance of *babies dribble balls*, with sharper effect at point of object processing.

Experimental results



- Effectiveness of incremental disambiguation in type-driven models (the red, green, and orange lines) as opposed to the non type-driven additive model (the blue line).
- By comparing sentence increments (S, SV, SVO), disambiguation accuracy improves as the context grows for the type-driven DS-VSS models.

Response to Lücking et al (2019)

- the **Distributional Hypothesis**: DH interpretable, beyond current operationalisations, as the fact that words are pieces of behaviour deployed/interpreted within particular contexts of use (language games), learned in particular such games, so interdependent with other participating elements.
- **Vector Space Semantics**: a geometrical perspective on the interdependence of multi-dimensional language games and their elements; models succinctly the richly-detailed non-symbolic memory of episodes of use (*exemplar* storage) and appropriate selection of cues for behaviour potential (*affordances*) during recall.
- phenomena such as underspecification, polysemy, audience-design, mind-reading, common ground, presuppositions etc are due to memory organisation induced by these non-representational memory mechanisms.
- representations of meaning (eg TTR) may be needed on top of non-representational subsymbolic layer (Gregoromichelaki et al. 2019) for metalinguistic/reflective linguistic/conceptual uses, but
- such representational levels of knowledge are "bootstrapped" from the fundamental VSS substratum through dimensionality-reducing mechanisms summarising significant patterns.

Language as group-level adaptive unit

VSS modelling of conceptual structure essential for capturing nondeterminism evident in:

* differences across agents with distinct experiences,
* variable uses for single agent across contexts,
* cross-individual interaction success despite possible misalignment, via continuous learning/adaptation,
* evolving language change while sustaining group stability,
* language success as a complex adaptive system (Wilson 2019).

DS+TTR+VSS+Multi-level selection

Language actions yield interactions stabilising as affordances, all traits individual and group adaptive, group-level adaptivity dominant

- **Phonetic properties** of signal
  - content-structure edges and
  - variation (dialect, etc)
- **Morphosyntactic properties** of signal
  - content,
  - phrasal boundaries
  - social boundaries (e.g. politeness)
- **Semantics**
  - flexible content essential
  - no requirement of matching denotational content/context
  - uncertainty enables communicative success without mind-reading, and
  - ensures stability across time/agents
- **Acquisition/evolution** parallel
  - grounded in emerging group-level adaptivity of interactivity
  - transition from individual- to group-directed dominance
  - emergence of normativity through routinised group actions

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