Acquisition of Desires before Beliefs - A Computational Investigation

Libby Barak, Afsaneh Fazly, and Suzanne Stevenson
Department of Computer Science, University of Toronto

{libbyb,afsaneh,suzanne}@cs.toronto.edu

Earlier Acquisition of Desire vs. Belief Verbs

Psycholinguistic theories:

- The acquisition of mental verbs requires the development of cognitive and linguistic skills, e.g., identifying mental content and facility with Sentential Complements (SCs)
- Desire verbs are conceptually simpler
- Desire verbs are pragmatically and communicatively more salient

Our Proposal – focus on the syntactic patterns across verb classes:

- Desire verbs occur mostly with infinitival SC ➡ *I **want** to eat ice-cream*
- Belief verbs occur mostly with finite SC ➡ *I **think** she is eating ice-cream*
- Other verbs occur with SCs ➡ *I **see** she is eating ice-cream*

Our goal:

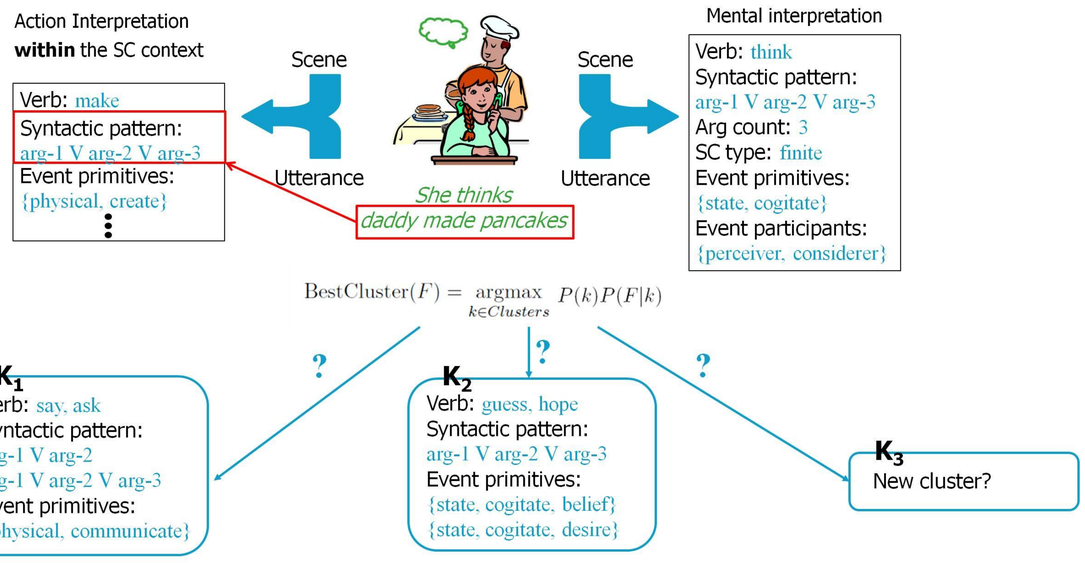
Use a computational model to investigate how the distribution of semantic and syntactic properties over constructions may facilitate the acquisition of these verbs

Methodology:

- Simulate the psycholinguistic tasks to evaluate the strength of a `learned' construction
  - E.g., Belief – finite SC construction
- Analyze the contribution of distributional patterns of syntax to the observed pattern by manipulating the input of the simulation

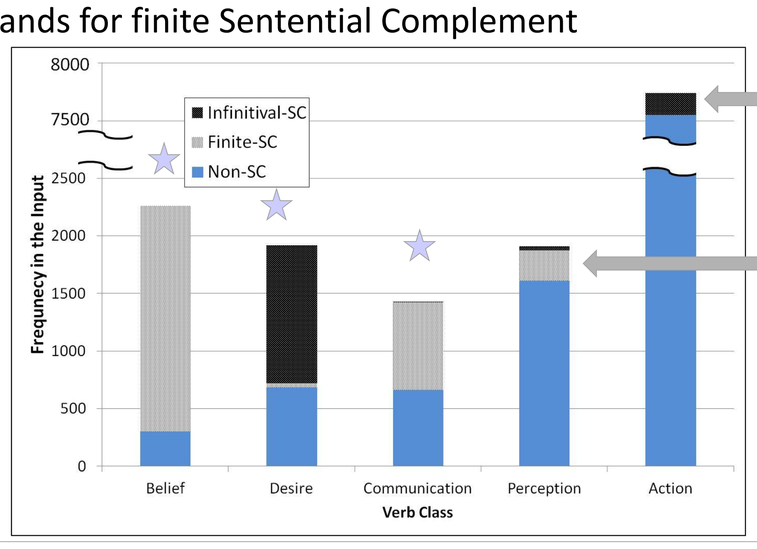
Modeling Construction Learning

- Input: a sequence of frames that are collections of syntactic and semantic features that correspond to a usage of a verb
  - Including mental meaning & SC syntax
- Learn constructions as probabilistic associations of form (syntactic features) and meaning (semantic features)
- Constructions emerge by grouping usages (represented as frames) on the basis of their syntactic and semantic similarity



Frequency with SC in the Input

SC – stands for finite Sentential Complement



Low SC frequency

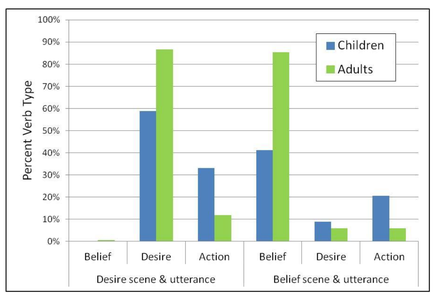
Occur with finite SC & some infinitival SC

Occur mostly with one SC type

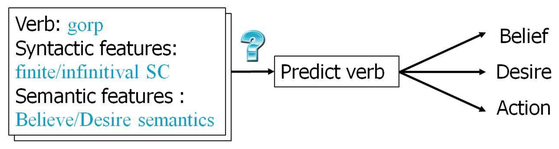
Simulation 1: The Verb Prediction Task

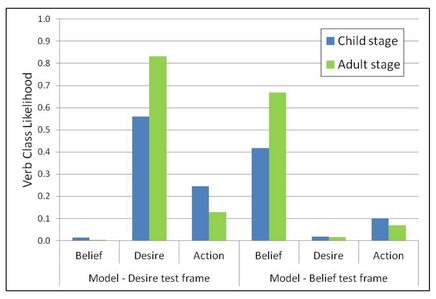
Psycholinguistic task – Guess the meaning of a novel verb in a silent scene and given utterance (Papafragou et al., 2007)

- Children produced more Desire than Belief verbs
- Children produced more Action verbs given Desire vs. Belief cues



Computational task – Predict the verb given Desire & Belief test frames

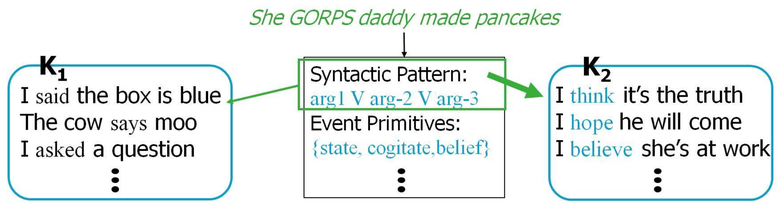




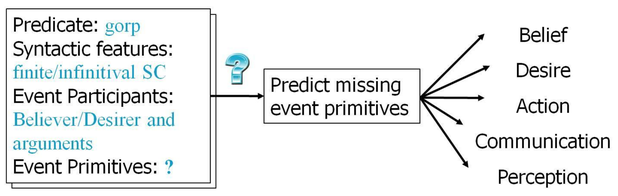
- Replicates the **delayed association of Beliefs to finite SC**
- Model does not encode difference in conceptual/pragmatic/syntactic requirements of Desire vs. Belief verbs
- Input specifies **distribution of semantic classes with SC types**

Simulation 2: Predict the Event Properties

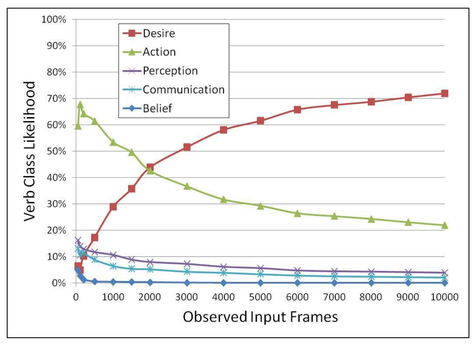
Our hypothesis – the distribution of syntactic features in the input enables the replication of the acquisition pattern

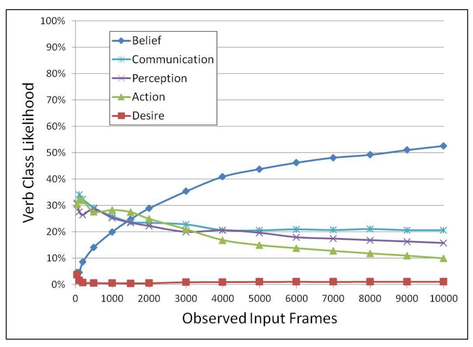


Computational task – Predict the semantic properties of the event while focusing on the syntax



- Initial high likelihood of **Action event** given its frequency with infinitival SC
- **Desire event** becomes most likely from an early stage (around 2K input frames)





- More event types have high likelihood given finite SC vs. infinitival SC
- **Perception and Communication events** gain likelihood given their frequency with finite SC
- **Belief event** becomes most likely later in the training

Conclusions

- We replicate the higher rate of prediction of Desire verbs vs. Belief verbs in early stages
  - **without encoding a difference in the conceptual, pragmatic, or syntactic requirements**
- The distribution of SC syntax across the semantic verb classes may be an important determinant of the patterns observed in children

References

Alishahi, A., & Stevenson, S. (2008). A computational model of early argument structure acquisition.
Barak, L., Fazly, A., & Stevenson, S. (2012). Modeling the acquisition of mental state verbs.
Papafragou, A., Cassidy, K., & Gleitman., L. (2007). When we think about thinking: The acquisition of belief verbs.