Synergies in learning words and their referents

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- Input: unsegmented utterances tagged with contextual objects
- Output: word segmentation and word to object mapping

$$PIG|DOG \quad I \quad Z \quad \delta \quad a \quad t \quad \delta \quad a \quad \underbrace{p \quad I \quad g}_{PIG}$$

Word to object "topic models" as PCFGs

- Objects in non-linguistic context \approx sentence topics
- Such topic models can be expressed as *Probabilistic* **Context-Free Grammars**
- PCFG rules choose a topic from possible topic marker and propagate it through sentence
- Each word is either generated by sentence topic or a special null topic





- Requiring at most one topic per sentence:
 - improves accuracy
 - can be expressed by PCFG

Adaptor grammars for word segmentation

- Adaptor grammars (AGs) Words generalise PCFGs by learning probability of entire subtrees Words Word • Prob. of adapted subtree \propto Phons Word number of times tree was previously generated $+ \alpha \times$ Phon Phons Phons PCFG prob. of subtree AGs are hierarchical Dirichlet ð Phon Phon Phons or Pitman-Yor Processes Phon Phons • AG for unigram word segmentation: Words \rightarrow Word | Word Words Phon Word \rightarrow Phons $Phons \rightarrow Phon \mid Phon Phons$
- Segmentation accuracy improves if AG *learns collocations*



Joint segmentation and object-mapping

- Combine word-object "topic PCFGs" with word segmentation AGs
- Synergies in learning:
 - improving topic detection improves word segmentation 70% → 75% f-score
 - improving word segmentation Topic_{pig} improves topic detection 50% → 74% f-score Topic_{pig} Wc



- Joint (rather than staged) learners can exploit these synergies
- Are there similiar synergies in other aspects of language acquisition?
- Do human learners exploit such synergies?

