Linguistic and Conceptual Structure in Verb Learning

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Infants exploit relations between linguistic and conceptual structure to infer the types of events that a new verb can label [1-3]. What are these structures, and how do infants map between them?

Linguistic Structure

When and how do infants perceive sentences as transitive?

Can infants use verb knowledge to predict a direct object?

19-month-olds and some 16-month-olds interpret ***the tig*** as the patient of wiping in (1-2), but as the instrument of wiping in (3-4) [4]:

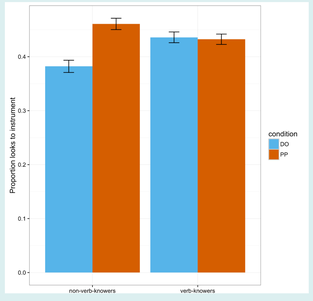
(1) **DO**: She's wiping **the tig!**
(2) **PP**: She's wiping with **the tig!**
(3) DO & PP: She's wiping that thing with **the tig**!
(4) Novel verb: She's meeking with **the tig**!

- **Hypothesis**: infants predict an upcoming direct object (DO) for known transitive verbs, and can't revise this prediction
  → Prediction: performance at 16 months depends on experience with these verbs

- **Results**:
  → 16-month-olds with no verb vocabulary look more to the instrument when they hear PP sentences
  → Verb-producing 16-month-olds prefer the patient for both DO and PP sentences

- **Further questions**:
  → Will infants' prediction for a DO be satisfied by an object WH-question? Currently testing *What is she wiping _ with the tig?*
  → How do high-vocabulary infants parse PP sentences? Upcoming

Fig. 1 Prop. looks to instrument (*n* = 42)



Do infants recognize transitivity in non-basic clauses?

Clauses with non-canonical word orders may be difficult to recognize as transitive:

(5) Passive: The monkey was fed.
(6) WH: **Which monkey** is the frog feeding __?
(7) RC: Find **the monkey** that the frog is feeding __.

15-month-olds behave as if they comprehend WH-questions (5) and relative clauses (6) [5,6]. But do they understand the **filler** as an object in these sentences?

- **Hypothesis**: **no**, they notice that a predicted object for the verb is missing, and search for referent [6]
  → Prediction: performance depends on verb knowledge, and therefore vocabulary

- **Results**: vocabulary, but not age, predicts looks to target (WH: $p<0.0057$; RC: $p<0.0498$)

- **Further questions:**
  → When do infants understand a WH-phrase as an object? Underway
  → Can infants learn that a novel verb in a WH-object question is transitive? Upcoming

Fig. 2 WH looking timecourse (*n* = 28)

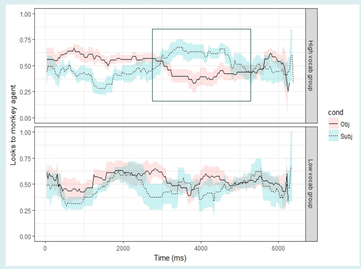
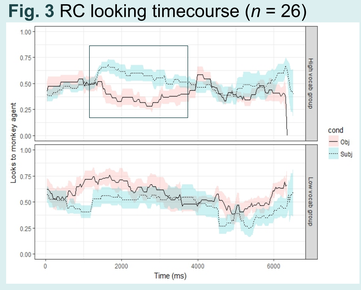


Fig. 3 RC looking timecourse (*n* = 26)



Can infants filter non-basic clauses to learn verb transitivity?

Infants who do not perceive object WH-questions as transitive might infer that ***fix***, like ***eat***, can be intransitive. Infants may need to "filter" non-basic clauses [1,7,8]:

(8) What did Amy **eat**? What did Amy **fix**?
(9) Amy **ate**. *Amy **fixed**.

Problem: infants may need to know verb transitivity to identify non-basic clauses [6], so how can they filter them for verb learning?

- **New solution**: filter sentences that may have been mis-parsed, without knowing whether they are non-basic clauses

- **Our model**: uses distribution of direct objects within and across verbs as its only signal, jointly infers transitivity of each verb and frequency of parsing errors

- **Results**: model learns accurate parameters for its input filter and correctly infers transitivity for majority of verbs

Work with Naomi H. Feldman (University of Maryland)

Fig. 4 Verb learning model

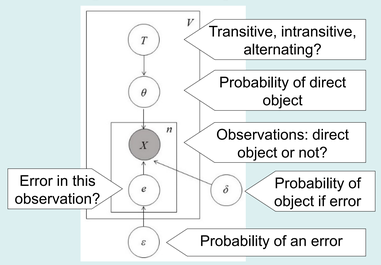


Fig. 5 Proportions of verbs categorized correctly

Model	Transitive	Intransitive	Alternating	Total
Our Model	0.67	0.83	0.63	0.66
Known Filter	0.77	0.83	0.54	0.62
No Filter	0.00	0.00	1.00	0.70

Conceptual Structure

When viewing particular scenes, what participant relations do infants readily perceive?

What events do infants view as having 3 participants?

Adults perceive the following events as having 3 participants [9], even though they admit transitive descriptions. What about pre-linguistic infants (9-12 months)?

(10) JIMMYINGBYOF(e,x,y) or JIMMYINGBYOFWITH(e,x,y,z)? (Anne **jimmied** the box.)
(11) STEALINGBYOF(e,x,y) or STEALINGBYOFFROM(e,x,y,z)? (Anne **stole** a toy.)

- **Habituation method**: habituate to an event, then measure dishabituation to a change in participant number (critical contrast) or direction/manner (perceptual contrast)

- **JIMMY**: infants dishabituate to addition or subtraction of the instrument but not to change in direction
  → they view the scene under a 3-place event concept with the instrument as a participant

- **STEAL**: will infants dishabituate to addition or subtraction of victim, but not change in manner? Underway

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Fig. 6 Looking time (s): subtracting instrument (*n=32)*

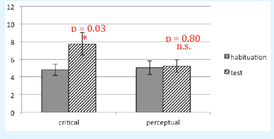
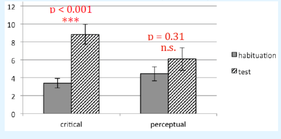


Fig. 7 Looking time (s): adding instrument (*n*=32)



Mapping between Linguistic and Conceptual Structure

How do infants draw inferences about verb meanings on the basis of linguistic structure?

Do infants expect arguments to match participants one-to-one?

One bootstrapping hypothesis proposes that infants expect one-to-one participant-to-argument matching **(PAM)** [2,3,10], but previous results [10,11] are consistent with other possibilities:

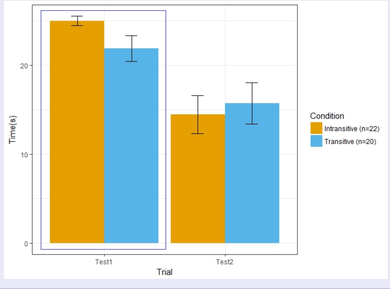
(12) **ANP**: Arguments Name Participants, but need not match one-to-one [12]
(13) **Thematic role sensitivity**: objects name patients, clauses with patients often label changes of state [13-18]

- **"Violation of Fit" method**: familiarize to an event, then measure infants' surprise upon hearing a particular clause type describing it

- **PAM vs. ANP**: infants look longer when hearing an intransitive than a transitive description of a KNOCKING-OVER
  → surprise at hearing an intransitive label this 2-participant event: a stronger strategy than ANP

- **Further questions: PAM vs. thematic roles**
  → Is this effect driven by argument number (PAM) or argument role? Currently testing intransitives with inanimate subjects *(It just blicked)*
  → What meaning will infants infer for a novel transitive verb labelling a 3-participant STEALING event? Upcoming

Fig. 8 PAM vs. ANP: Looking time at test



References: [1] Gleitman 1990. The structural sources of verb meanings. *Lang Acq* 1. [2] Naigles 1990. Children use syntax to learn verb meanings. *J Child Lang* 17. [3] Fisher et al. 2010. Syntactic bootstrapping. *WIRES Cog Sci* 1. [4] Lidz, White, & Baier. The role of incremental parsing in syntactically conditioned word learning. Under review. [5] Seidl, Hollich, & Jusczyk 2003. Early understanding of subject and object wh-questions. *Infancy* 4. [6] Gagliardi, Mease, & Lidz 2016. Discontinuous development in the acquisition of filler-gap dependencies. *Lang Acq* 23. [7] Pinker 1984. *Language Learnability and Language Development*. [8] Lidz & Gleitman 2004. Yes, we still need Universal Grammar. *Cognition* 94. [9] Wellwood, He, Lidz, & Williams 2014. Participant structure in event perception. *PLC 21.1*. [10] Yuan, Fisher, & Snedeker 2012. Counting the nouns. *Child Dev* 83. [11] Noble, Rowland, & Pine 2011. Comprehension of argument structure and semantic roles. *Cog Sci* 35. [12] Williams 2015. *Arguments in Syntax and Semantics*. [13] Fillmore 1968. The case for case. *Universals in linguistic theory*. [14] Dowty 1991. Thematic proto-roles and argument selection. *Lang* 67. [15] Jackendoff 1972. *Semantic interpretation in generative grammar*. [16] Baker 1988. *Incorporation: A theory of grammatical function changing*. [17] Fillmore 1970. The grammar of *hitting* and *breaking*. *Readings in English Transformational Grammar*. [18] Levin & Rappoport Hovav 2005. *Argument realization*.

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