

# Matching Number vs. Linking Roles: Using 3-Participant Scene Percepts to Understand Infants' Bootstrapping Laurel Perkins, Tyler Knowlton, Alexander Williams, and Jeffrey Lidz

### How do Infants Acquire Verb Meanings?

Infants exploit relations between linguistic and conceptual structure to infer the kinds of events a new verb can label [e.g. 1-3]

But do they exploit relations between the number of arguments and participants [2-6], or between grammatical relations and thematic **roles** [8-15]?



#### **Counting Arguments**

Children expect the **number** of clause arguments to match one-to-one the number of perceived event participants [2-6]

- Transitive clause describes 2-participant event
- Intransitive clause describes 1-participant event
- Requires only the ability to count the number of NP arguments in a clause, but does not generalize widely within or across languages
  - (1) The girl stole the truck.
  - (2) Sťáťimcets:
    - kwskwimçxen Qámt hit.with.projectile det.NAME 'Kwimçxen got beaned.' [7]



**Prior Work** 

Preferential looking/pointing studies find different patterns of behavior for different clause types [2, 4, 5, 10]

Children prefer 2-participant events for transitive clauses Children do not reliably prefer 1-participant events for intransitive clauses

Can be explained under both **Counting** and **Thematic Linking**:

- Counting: children may perceive 1-participant events in intended 2-participant scenes (e.g. PLAYING), making them compatible with intransitive descriptions [4, 11]
- Thematic Linking: transitive clauses describe events with both agents and patients; intransitive subjects can name either agents or patients, so no preference predicted
- Prior work does not differentiate bootstrapping hypotheses

### **Current Goals**

Differentiating number-based from role-based bootstrapping hypotheses by evaluating how infants represent scenes as events (Study 1) and how they map sentences onto those representations (Study 2) Case study: events that are plausibly viewed with 3 participants, yet are readily described with transitive clauses

References: [1] Gleitman 1990. The structural sources of verb meanings. [2] Naigles 1990. Children use syntax to learn verb meanings. [3] Fisher et al. 2010. Syntactic bootstrapping. [4] Yuan, Fisher, & Snedeker 2012. Counting the nouns. [5] Arunachalam & Waxman 2010. Meaning from syntax. [6] Lidz, Gleitman, & Gleitman 2003. Understanding how input matters. [7] Davis 2010. Teaching grammar of St'át'incets. [8] Williams 2015. Arguments in Syntax and Semantics. [9] Pinker 1984. Language Learnability and Language Development. [10] Noble, Rowland, & Pine 2011. Comprehension of argument structure and semantic roles. [11] Pozzan, Gleitman, & Trueswell 2015. Semantic Ambiguity and Syntactic Bootstrapping. [12] Gordon 2003. The origin of argument structure in infant event representations. [13] Wellwood et al. 2015. Participant structure in event perception. [14] Waxman et al. 2009. Twenty four-month-old infants' interpretations of novel verbs and nouns in dynamic scenes. Big thanks to: Angela Xiaoxue He, Mina Hirzel, Tara Mease, Abigail Kameny, and the Project on Children's Language Learning. Funding: NSF BCS-1551629, NSF NRT-DESE-1449815. Contact: perkinsl@umd.edu, tzknowlt@umd.edu

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#### **Conceptual representation** TAKING(e) Moving(e) & AGENT(e, girl) & AGENT(e, girl) $\mathbf{O}$ & PATIENT(e, truck) & PATIENT(e, truck)

**Thematic Linking** 

& SOURCE(e, boy)

Children expect particular grammatical relations to link to particular participant roles [8-9]

- Transitive subjects name agents and objects name patients
- Clauses describing a change realize the thing being changed
- Clauses describing an action realize the agent of that action
- More robust generalization within and across languages, but requires richer clause structure representations

#### Arunachalam & Waxman (2010)

- (3) The boy is going to moop the girl.
- (4) The boy and the girl are going to moop.



Yuan, Fisher, & Snedeker (2012)

(5) He's gorping him. (6) He's gorping.









## **Study 1: Diagnosing Event Representations**

An event concept entails many relations. Only some of these are psychologically privileged, explicit in the structure of the representation. Call these participant relations [8]:

Entailments of TAKING

	Agent	nt Patient	Source	Location
Manner Duration	Ma	Manner D	uration	

FAKING(e) & AGENT(e,x) & PATIENT(e,y) & SOURCE(e,z) TAKING(e) & AGENT(e,x) & PATIENT(e,y) TAKING(e) & AGENT(e,x)

► For a given stimulus scene, which relations are privileged in the concept that infants view it under?

#### Habituation-Switch Task [12-13]

32 infants aged 9;21-12;15 (mean=10;23) habituated to a scene of a girl picking up a truck, with a boy sitting idly

• **Participant change**: girl starts taking truck from boy's grip Manner change: girl starts sliding truck instead of picking it up

Phase Habituation Test

Mean Looking Time



### Results

Infants dishabituate more when the boy is added as a participant than when manner of motion is changed, even though the manner change is more perceptually salient (*F*(4,30)=5.42, *p*<.03)

Infants, like adults, view our taking scene under a concept with the boy filling a psychologically privileged role: TAKING(e) & AGENT(e, girl) & PATIENT(e, truck) & SOURCE(e, boy)

## Study 2 (Ongoing): Evaluating Mapping Strategy

► If infants readily view our taking scene under a 3-participant concept, how will they map a transitive clause to that representation?

#### Verb Extension Task [14]

Infants aged 19;0-21;0 are familiarized to taking scene paired with a transitive clause containing a novel verb (*pim*)

**Counting** leads learner to conclude that *pim* must describe a 2-participant event involving only the girl and the truck, e.g. MOVE

**Thematic Linking** allows learner to pair *pim* with the 3-participant concept under which they readily view this scene, predicting that they will think *pim* means TAKE

At test, infants are asked to find *pimming* in context of taking video and moving video

**Counting** predicts no preference: both videos show girl moving the truck Thematic Linking predicts preference for taking video

#### **Preliminary Results**

Partial sample of 15 subjects (target *n*=24) suggests preference for TAKING

• Marginally significant increase in looks to TAKING compared to baseline preferences before test prompt (Wilcoxon signed rank test p < 0.08) • Control comparisons (ongoing): She pimmed the truck from him should describe TAKING, The truck pimmed should describe MOVING under both hypotheses

Full results will diagnose whether infants use **number-based** or **role-based** mapping when two strategies would lead to different inferences about verb meaning

#### **Future Directions**

▶ Will infants use the same strategy to map sentences to other 3-participant event concepts, e.g. opening with an instrument [13]? Can infants bootstrap from "non-basic" clauses, e.g. wh-object questions?





Structure of Representation



