Clean Mapping:

A sketchy story about how conceptual structure could shape language acquisition and some evidence suggesting that it just might be true

Jesse Snedeker
Harvard University
Sally hit the ball.
The storm trooper kicked the man.
The horse *pilked* the bear.

(Baker, 1988; Marantz, 1982; Jackendoff, 1990)
Systematic, abstract mapping rules

Levin & Rappaport-Hovav, 2005; Jackendoff, 1990; Pinker, 1988; Baker, 1988; etc
Defining my terms

Semantics:
- Combinatorial conceptual system that encodes the meaning of thoughts and utterances
- Has hierarchical structure but no linear order
- Captures the syntactically relevant similarities in meaning btw predicates
- Universal and prior to acq.

Syntax:
- Combinatorial system that interfaces btw semantics and externalization
- Has linear order and hierarchical structure
- Encodes morpho-syntactic features

Folks who use these words in the same way:
Pinker, Jackendoff, Levin, most psycholinguists
A rose by any other name…

<table>
<thead>
<tr>
<th>Language of Thought</th>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>
A rose by any other name…

D-Syntax, Early Phase
• Combinatorial system that *reflects* the content of thoughts and utterances
• Has hierarchical structure but no linear order
• Captures the syntactically relevant similarities in meaning btw predicates
• Universal and prior to acq.

S-Syntax, Late Phase
• Interfaces between D-Syntax and externalization
• Has hierarchical structure and linear order (at some point)
• Encodes morpho-syntactic features
Folks who flat out disagree...

Pre-linguistic Thought

- Conceptual combination but solely within a domain
- *Does it have hierarchical structure?*
- *Does it capture syntactically relevant similarities in meaning btw predicates?*
- Universal and prior to acq.

Language & Linguistic Thought

- Semantic and syntactic reps acquired via language module
- Acquisition of mapping to form needed for use
- Presumably has hierarchical structure and linear order
- Encodes morpho-syntactic features
How do children acquire this system?

Two proposals:

1. Semantic Bootstrapping (Pinker, 1984; 1988)
2. Verb Island Hypothesis (Tomasello, 1992; 2002)
Semantic Structure

Syntactic Structure

?
**Infant’s Starting State**

**Semantic Structure**

**Syntactic Structure**

**Primitives**

- S
- N
- V
- D
- etc...

**Phrase Structure Rules** (underspecified)

- S → [NP VP or VP NP]
- VP → [V NP or NP V]
- NP → [D N or N D]
- etc...
Infant’s Starting State

Semantic Structure

- cause
  - thing
    - have
      - thing
        - property
    - thing
      - mental
        - state
- act
  - thing
    - activity
- go
  - thing
    - path
      - place
- place

Syntactic Structure

Primitives

- S
- N
- V
- D

Phrase Structure Rules

- (underspecified)
- \[ S \rightarrow [NP \; VP \text{ or } VP \; NP] \]
- \[ VP \rightarrow [V \; NP \text{ or } NP \; V] \]
- \[ NP \rightarrow [D \; N \text{ or } N \; D] \]
Infant’s Starting State

Semantic Structure

- cause
  - thing
  - have
    - thing
    - property
- go
  - thing
  - path
    - place
    - place
- have
  - thing
  - mental state
- act
  - thing
  - activity

Linking Rules

- thing
  - noun
- activity
  - verb

Syntactic Structure

Primitives
- S
- N
- V
- D

Phrase Structure Rules (underspecified)

- S → [NP VP or VP NP]
- VP → [V NP or NP V]
- NP → [D N or N D]

etc...
Infant’s Starting State

Semantic Structure

- **cause**
  - thing
  - have
  - thing
  - property
- **go**
  - thing
  - path
  - place
- **have**
  - thing
  - mental
  - state
- **act**
  - thing
  - activity

Linking Rules

- **thing** → **noun**
- **activity** → **verb**

Syntactic Structure

Primitives

- S
- N
- V
- D

Phrase Structure Rules

(underspecified)

- \( S \rightarrow [NP \ VP \ or \ VP \ NP] \)
- \( VP \rightarrow [V \ NP \ or \ NP \ V] \)
- \( NP \rightarrow [D \ N \ or \ N \ D] \)

etc...
**Semantic Structure**

- cause
  - thing
  - have
    - thing
    - property

- go
  - thing
  - path
    - place
    - place

- have
  - thing
  - mental
    - state

- act
  - thing
  - activity

**Syntactic Structure**

**Primitives**

- S
- N
- V
- D

**Phrase Structure Rules**

- S → NP VP
- VP → V NP
- NP → D N

**Linking Rules**

- thing → noun
- activity → verb

**Adult State**

- etc...

etc...
Problems for semantic bootstrapping

- Requires simultaneous evolution of syntactic categories, under-specified rules and mapping rules to specify them.
- Proposed innate rules are too constraining to account for all languages? (Evans & Levinson, 2009; Baker, 2003; Pye, 1990; Siegal, 2000)
- Assumes that the message is unambiguous (Gleitman, 1990)
- Made few falsifiable predictions about development
Verb island hypothesis
(Tomasello, 1992; 2002)

• Starting state: no broad syntactic or semantic relations
• Learner treats each lexical item as separate entity
  – Verb island stage (24-48 m)
  – Push: NP 1= pusher, NP 2= pushee
Verb island hypothesis
(Tomasello, 1992; 2002)

• Child gradually forms generalizations on the basis of experience
  – By “noticing” similarities
  – Contact-verb: NP = contacter, NP2 = contactee

• Constructions become more abstract with age
Do young children have abstract categories?

- Can’t tell from spontaneous production
- Test: do children generalize their knowledge to novel verbs?

During comprehension children generalize knowledge to novel verbs

The bunny is gorping the duck!

The duck is gorping the bunny!

Gertner, Fisher & Eisengart, 2006
Did that settle the issue?

• Of course not....
  – weak schemas may affect looking time but not language use (Abbott-Smith, Lieven & Tomasello, 2004)
  – transitive or use of word order exceptional
  – are children treating the words as novel?

• Solution priming studies....

Malathi Thothathiri
George Washington University
Structural Priming

- Datives: Verbs of transfer *(give, show).*
- 3 participants: Agent, Recipient, Theme
- Dative alternation
  - Double-Object Dative *(DO)*
    
    *He gave the boy the truck*
  
  - Prepositional Dative *(PO)*
    
    *He gave the truck to the boy*
Structural Priming

Producing or hearing a sentence facilitate using new sentences with the same *structure*

John gave Mary the book  John gave the book to Mary

Kim gave Bob the picture  Kim gave the picture to Bob

Within-Verb Priming

Bock, 1986; Pickering & Branigan, 1998
Structural Priming

Even when the different *words* are used.....

John gave Mary the book

John gave the book to Mary

Kim *showed* Bob the picture

Kim showed the picture to Bob

Across-Verb Priming

Bock, 1986; Pickering & Branigan, 1998
Priming and Representation

- Verb Island (lexical) \(\rightarrow\)
  Within-verb priming only

- Pure Abstraction \(\rightarrow\)
  Within-verb = Across-verb priming

- Priming at both levels \(\rightarrow\)
  Within-verb > Across-verb priming
Design

Prime: *Pass the lion the ball* or *Pass the ball to the lion*

Target: *Show the horse the book* or *Show the horn to the dog*
Comprehension priming at 3;0 is entirely abstract
Production priming at 3-4 is entirely abstract

Lexical boost emerges later

Rowland, Chang, Ambridge, Pine & Lieven (2012)
Overwhelming evidence for early abstraction

- Novel Verb Generalization
- Priming
- Categories present in child-built languages (Homesign and NSL)

Overwhelming evidence for early abstraction

- Novel Verb Generalization
- Priming
- Categories present in child-built languages (Homesign and NSL)

Is this evidence for innate **syntax**?
  - No, it doesn’t tell us what the relevant domain is or developmental history

Desiderata for a theory of acquisition

• Must account for early abstraction

• Can exploit the statistical learning abilities of infants

  Chemla, Mintz, Bernal & Christophe, 2009; Gomez & Gerken, 2000; Gweon, Tenenbaum, & Schulz, 2010; Marcus, Vijayan, Rao, & Vishton, 1999; Marquis & Shi, 2012; Mintz, 2012; Saffran, Aslin & Newport, 1996; Saffran & Wilson, 2003; Shi & Melancon, 2010; Swingley, 2005; van Heughten & Shi, 2010

• Can exploit rich conceptual system of pre-linguistic infants (semantics)


• Cannot depend on extensive innate syntax

  Chomsky, 1995; Dryer, 1997; Evans & Levinson, 2009; Haspelmath, 2007, 2009; Lazard, 1992
Clean Mapping

• Our description of an emerging consensus
• Drawing on semantic bootstrapping, syntactic bootstrapping, statistical learning
• With particular debt to Cindy Fisher

Joshua Hartshorne
Boston College
Proposed Starting State

Semantic Structure

- cause
  - thing
    - have
      - thing
        - property
  - thing
    - go
      - thing
        - path
          - place
          - place
- have
  - thing
    - mental
      - state
- act
  - thing
    - activity

Clean Mapping Principle

syntactic structure reflects semantic structure

Syntactic Structure

- Categories
  - Cluster 1
  - Cluster 2
  - Cluster 3
  - Cluster 4
  - Cluster 5
  - Cluster 6
  - etc...

- Structure
  - [Cluster 1 + Cluster 2]
  - [Cluster 3 + Cluster 4]
  - etc...
Infant’s Starting State

Semantic Structure

- cause
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etc...

Pre-linguistic Conceptual Structures

Compositional Hierarchical Event Representations

Outputs of Core Knowledge
Infant’s Starting State

Pattern Finding Algorithms

Distribution over lexical types:
Find candidate categories

Distributional over categories:
Find candidate rules

Domain-General

Syntactic Structure

Categories

Cluster 1  Cluster 2
Cluster 3  Cluster 4
Cluster 5  Cluster 6

etc...

Structure

[Cluster 1 + Cluster 2]
[Cluster 3 + Cluster 4]

etc...
Infant’s Starting State

Evidence

Corpus Analyses & Modelling:
Cartwright & Brent, 1997; Redington, Chater & Finch, 1998; Mintz, 2003; Swingley, 2005; Chemla, Mintz, Bernal & Christophe, 2009; Connor, Fisher & Roth, 2014

Infant Studies:
Gómez & Gerken, 1999; Gómez, 2002; Saffran & Wilson, 2003; Gómez and Maye, 2005; Mintz, 2006; Shi & Melancon, 2010; van Heughten & Shi, 2010; Cyr & Shi, 2012; Mintz, 2012
Infant’s Starting State

Clean Mapping Principle
Assume syntactic structure reflects semantic structure

An idea with a long history:

Structural Isomorphism:
Bouchard, 1995; Jackendoff, 1992; Levin & Rappaport Hovav, 2005; Wechsler, 1995; Williams, 2003
Infant’s Starting State

Clean Mapping Principle

- **Domain-specific expectation**
  - patterned intentional signals reflect conceptual structure

- **Domain-general mapping algorithm**
  - Category-to-category mapping
  - Structure-to-structure mapping (preserve dominance)
Infant’s Starting State

Semantic Structure

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Clean Mapping Principle

syntactic structure reflects semantic structure

Syntactic Structure

Categories

- Cluster 1
- Cluster 2
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- Cluster 4
- Cluster 5
- Cluster 6

Structure

- [Cluster 1 + Cluster 2]
- [Cluster 3 + Cluster 4]

etc...
The cat broke the vase
The cat broke the vase

The cat knocked over the vase
The cat broke the vase

The cat knocked over the vase

The vase fell
The cat broke the vase.

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Mapping Rules (tentative)

thing \rightarrow C 2
The cat broke the vase.

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etc...

Clean Mapping Principle

syntactic structure reflects semantic structure

Syntactic Structure

Categories

- Cluster 1
- Cluster 2
- Cluster 3
- Cluster 4
- Cluster 5
- Cluster 6
etc...

Structure

- [Cluster 1 + Cluster 2]
- [Cluster 3 + Cluster 4]

cr...
Predictions of clean mapping

• Early syntax-semantics mappings will be abstract
  – Acquisition of case marking (Duygu Ozge)
  – Structural priming across constructions (Jayden Ziegler)

• Path of acquisition reflects decoding not conceptual change
  – International adoption as natural experiment

• Mappings are clean (even when they look messy)
  – Psych verbs (Josh Hartshorne) and Light Verbs (Eva Wittenberg)

• Abstract semantic structures are accessible to learners
  – Manner and results (Amy Geojo, Carissa Shafto, Melissa Kline)

• Child-built languages should reflect semantic structure
  – Nicaraguan Sign Language (Annemarie Kocab)
Predictions of clean mapping

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- Child-built languages should reflect semantic structure
  - Nicaraguan Sign Language (Annemarie Kocab)
This should predict consistent syntax-semantics mappings

But they can look pretty messy....
emotion verbs

liked, adored, hated, despised, loved, dreaded, admired....

experiencer-subject

S
Albert
VP
feared
Beatrice

experiencer-object

S
Albert
VP
frightened
Beatrice

pleased, surprised, calmed, angered, impressed, annoyed....
emotion verbs

experiencer-subject

experiencer-object

[Diagram showing syntactic structures with nodes labeled as 'have', 'emotion', 'about', 'THING', 'Albert', 'VP', 'feared', 'Beatrice', 'S', 'frightened', 'Beatrice']
emotion verbs

experiencer-subject

experiencer-object
emotion verbs

experiencer-subject

experiencer-object

Albert VP

feared Beatrice

THING cause

thing have

THING emotion

Albert VP

frightened Beatrice
emotion verbs

experiencer-subject

experiencer-object

Albert VP feared Beatrice

cause

THING have

THING emotion

cause

THING have

THING emotion
emotion verbs

experiencer-subject

experiencer-object

S

Albert

VP

feared

Beatrice

S

Albert

VP

frightened

Beatrice

have

THING

emotion

about

THING

have

THING

emotion

about

THING

inspired by Pestesky, 1995
emotion verbs

experiencer-subject

S
Albert VP feared Beatrice

experiencer-object

S
Albert VP frightened Beatrice

cause
THING have
THING emotion

have
THING emotion
about THING

inspired by Pestesky, 1995
Evidence for two conceptual structures

Joshua Hartshorne
Boston College

Hartshorne, O'Donnell, Sudo, Uruwashi, Lee & Snedeker
Causal differences in real verbs

Mary frightened Sally.
Who is guilty of causing this emotion?

- Mary
- Sally
- Nobody (these things just happen)

Predicted Results

Experiencer
- Subject (frighten)
- Object (frighten)
Causal differences in real verbs

Mary frightened Sally.
Who is guilty of causing this emotion?

- Mary
- Sally
- Nobody (these things just happen)

Observed Results

<table>
<thead>
<tr>
<th></th>
<th>% sent to jail</th>
</tr>
</thead>
<tbody>
<tr>
<td>subject</td>
<td>40</td>
</tr>
<tr>
<td>object</td>
<td>20</td>
</tr>
<tr>
<td>neither</td>
<td>20</td>
</tr>
<tr>
<td>subject</td>
<td>60</td>
</tr>
<tr>
<td>object</td>
<td>0</td>
</tr>
<tr>
<td>neither</td>
<td>0</td>
</tr>
</tbody>
</table>

Experiencer-Subject (fear)
Experiencer-Object (frighten)
When does this knowledge develop?

• Bottom up learning?
  – First verbs learned by trial and error
  – Semantic generalization arises after mastering many instances of each kind

• Clean mapping?
  – As soon as the relevant conceptual structures are available
  – Children will use the asymmetry between the arguments to correctly map both kinds of verbs
Who does Monkey frighten?

Argument realization for known verbs

See Monkey? Monkey is walking along. Then he sees Lion. Monkey screams and runs away. Monkey hides from Lion.

See Elephant? Elephant is playing outside. Then he sees Monkey. Elephant screams. Then he runs away and hides.

Who does Monkey frighten?
5 year olds have mastered verbs of both kinds

Hartshorne, Pogue & Snedeker (in press)
Can children generalize these patterns to novel verbs?

Non-causal emotion (envy):

*Who does Bear wixter?*
Can children generalize these patterns to novel verbs?

Causal emotion (disgust):

Who does Bird gorphin?
Kids use different mappings for causal and non-causal psych verbs

**Graph:**
- **Y-axis:** % of “fear verb” choices
- **X-axis:** Age groups (4-5 yo and 6-7 yo)
- **Bars:**
  - Blue: non-causal
  - Red: causal

**Legend:**
- Blue: non-causal
- Red: causal
2. Evidence for the psychological reality of event primitives

Shafto, Havasi & Snedeker (2014); Geojo & Snedeker (in prep)
The psychological reality of semantic structures

Semantic structures consist of
- primitive predicates: cause, become, be, act
- categories of arguments: path, result-state
- categories of modifiers: manner-of-motion, manner-of-speaking

Evidence for the existence of these categories is thin
- They make for better linguistic theory
- Experiments show that instances of the category are available ("walk" or "run") but fail to show that the higher-level category is represented

Clean Mapping requires learners to access these structures and primitives
Solution: look for generalization
Learning Motion Verbs

- Moving object: woman
- Manner of motion: hopping
- Reference Object: sidewalk
- Path of motion: across

Talmy (1985)
Systematic Cross-Linguistic Variation in Conflation Patterns

Manner Languages (English)
- Conflate motion + manner in verb
- Path in preposition

*She is jumping across the sidewalk*

Path Languages (Spanish)
- Conflate motion + path in verb
- Manner in optional gerund

*Ella está cruzando la acera* (She is crossing the sidewalk)

Talmy (1985)
Typological Bootstrapping

- Child considers all event components as possible meanings
- Learns few verbs by trial and error
- Discovers correct conflation patterns
- Develops lexicalization bias
- Verb learning accelerates

Slobin, 1997; Naigles, et al., 1998; Gentner & Boroditsky, 2001; Goksun, Golinkoff & Hirsh Pasek, 2010; Papafragou & Selmis, 2010
Unanswered Questions

- How stable are these biases?
  - Rigid reorganization (as in speech perception)?
  - Or a flexible inference?

- Can we use bias learning to demonstrate that manner-of-motion and path are psychologically-relevant categories?
  - Need evidence of generalization across category
Trial Structure

1. Ambiguous Initial Video
2. Bias Test
3. Training Phase
4. Verb-Learning Test

Repeat for each verb (6-16)
1. Initial Ambiguous Scene

“She’s glipping down the hill”

Manner: stoop-walk
Path: down
2. Bias Test

“Is this glipping?”
Path Match
Manner: crawl
Path: down

“Is this glipping?”
Manner Match
Manner: stoop-walk
Path: around
3. Training
(5 videos)

either

Path-Training
Manner: varies
Path: down

Manner-Training
Manner: stoop-walk
Path: varies
4. Verb Learning Test

"Is this glipping?"
Path Match
Manner: hop
Path: down

"Is this glipping?"
Manner Match
Manner: stoop-walk
Path: out
Trial Structure

1. Ambiguous Initial Video

2. Bias Test

OR

3. Training Phase

4. Verb-Learning Test

5 Videos with Same Manner

5 Videos with Same Path

Two Questions

Two Questions

Repeat for each verb (6-16)
Shafto, Havasi & Snedeker (2012)

Adult English speakers

Conditions

- 0% of verbs are path verbs (all manner)
- 25% path verbs
- 50% path verbs
- 75% path verbs
- 100% path verbs
Adult Lexicalization Biases Shaped by Verb Learning

![Graph showing the relationship between percentage of path verbs in input and final path bias. The x-axis represents the percentage of path verbs in input (0% to 100%), and the y-axis represents the final path bias. The graph indicates a positive correlation between the percentage of path verbs and the final path bias.]
Children’s Bias Shaped by Verb Learning

Proportion of Path Choices

Path

Proportion of Path Choices

Manner

All Manner

All Path

5 year olds

Adults
Bias Learning affects attention during initial encoding

Geojo & Snedeker, submitted

The man is **krading** into the garage
Experience rapidly shapes attention to new events

Geojo & Snedeker, submitted
Conclusions:

• Conceptual dimensions (path, manner) highly salient in categorization of events

• Experience rapidly influences attention to these dimensions

• Highly malleable system, not rigid constraints
  – Unlike speech perception

But are manner & path of motion the relevant categories?
manners as modifiers, results as arguments

(7) \[ \text{manner} \rightarrow [\ x\ \text{ACT}_{\text{MANNER}}\ ]\]
    (e.g., jog, run, creak, whistle, …)

(8) \[ \text{instrument} \rightarrow [\ x\ \text{ACT}_{\text{INSTRUMENT}}\ ]\]
    (e.g., brush, hammer, saw, shovel, …)

(9) \[ \text{container} \rightarrow [\ x\ \text{CAUSE}\ [\ y\ \text{BECOME\ AT}\ \text{CONTAINER}]\ ]\]
    (e.g., bag, box, cage, crate, garage, pocket, …)

(10) \[ \text{internally caused state} \rightarrow [\ x\ \text{STATE}\ ]\]
    (e.g., bloom, blossom, decay, flower, rot, rust, sprout, …)

(11) \[ \text{externally caused, i.e. result, state} \rightarrow [ [\ x\ \text{ACT}\ ]\ \text{CAUSE}\ [\ y\ \text{BECOME}\ \text{RESULT-STATE}]\ ]\]
    (e.g., break, dry, harden, melt, open, …)\(^4\)

Rappaport Hovav & Levin, 2010
Complementarity Hypothesis  
(Rappaport Hovav & Levin, 2010)

Verbs encode either manner or result (not both) other feature often implied but can be cancelled

I scrubbed the table, but it was still dirty
I cleaned the table, but it was still dirty ???

The distinction cuts across semantic fields

<table>
<thead>
<tr>
<th>Semantic Field</th>
<th>Manner Verb</th>
<th>Result Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbs of Damaging</td>
<td>hit</td>
<td>break</td>
</tr>
<tr>
<td>Verbs of Putting</td>
<td>pour</td>
<td>fill</td>
</tr>
<tr>
<td>Verbs of Removal</td>
<td>shovel</td>
<td>empty</td>
</tr>
<tr>
<td>Verbs of Combining</td>
<td>shake</td>
<td>combine</td>
</tr>
<tr>
<td>Verbs of Killing</td>
<td>stab</td>
<td>kill</td>
</tr>
</tbody>
</table>
Is the manner / result distinction psychologically salient?

Is it available to individual word learners or is it emergent property of language use and transmission?
What is the scope of lexicalization biases?

- if manner vs. result is the salient cognitive distinction
- then lexicalization biases should extend across semantic fields

Geojo & Snedeker (in prep)
Two Phases

Trials 1-8: Novel verb learning and bias induction

<table>
<thead>
<tr>
<th>Event category</th>
<th>Motion verb</th>
<th>CoS verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANNER</td>
<td>Manner-of-motion</td>
<td>Means</td>
</tr>
<tr>
<td>RESULT</td>
<td>Path</td>
<td>Effect</td>
</tr>
</tbody>
</table>

Trials 9-16: Novel Verb extension

CoS verbs
- Means
- Effect

Motion verbs
- Manner-of-motion
- Path

Geojo & Snedeker (in prep)
Biases formed within each semantic field

Motion Verbs

Change of State Verbs
Biases readily extend across semantic fields

From Motion to COS

From COS to Motion
3. Grounding semantic structures in infant cognition

Melissa Kline
MIT/Harvard

Kline, Snedeker & Schultz (2015)
Pre-linguistic concepts and language development

Infants know a lot about events
  • Agency and animacy
  • Causes vs effects
  • Relationship btw agents' goals, constraints and the actions they take to reach them

What conceptual structures underlie these abilities?
How do they shape language acquisition?
Pre-linguistic concepts and language development

Hypothesis: same representation underlies prelinguistic conceptual structure, guides syntax acquisition, and provides semantic content in mature state.

Predictions:
- Features relevant for syntax of verbs should guide infant event cognition
- Early mapping of syntactic distinctions to properties of event structure (e.g., manner/result)
- Early integration of syntax into reasoning about the goals of intentional events (and imitation)
Head-touch studies
(Gergely, Bekkering & Kiraly 2002)
Manners and Results as Goals

- If the unusual action can be ‘explained away’, focus on result only
- If it can’t, assume unusual action (manner) is important, and imitate it
- Does syntax change expectations about whether the manner is the goal?

I’m daxing my toy (result-bias frame)

I’m daxing to my toy (manner-bias frame)
Methods

• N=24 (ages 1;7-2;11, mean age 2;2)

• Two syntax conditions
  • I’m blicking my toy vs. I’m blicking to my toy

• Action demonstrated with Hands-Occupied
  • Baseline: few head-touches
Children’s actions

- Dax to my toy
- Dax my toy

- Head imitation
- Imitation without head
Head Touch Summary

- Children who hear ‘dax to my toy’ believe the manner is being labeled (and thus is the goal)
  - Syntax guides interpretation of goal-directed action
- A missing piece - complementarity?
  - Do children expect a verb to label either means or result?
  - Persistence measures (turn off box)
- What about the first mappings? 14-16m in progress!
Infant’s Starting State

Semantic Structure

- cause
  - thing
  - have
    - thing
    - property
- go
  - thing
  - path
    - place
    - place
- have
  - thing
  - mental
    - state
- act
  - thing
  - activity

etc...

Clean Mapping Principle

syntactic structure reflects semantic structure

Syntactic Structure

Categories

- Cluster 1
- Cluster 2
- Cluster 3
- Cluster 4
- Cluster 5
- Cluster 6

etc...

Structure

- [Cluster 1 + Cluster 2]
- [Cluster 3 + Cluster 4]

etc...
Infant’s Starting State

**Semantic Structure**
- cause
  - thing
    - have
        - thing
        - property
- go
  - thing
    - path
    - place
  - place
- have
  - thing
    - mental
    - state
- act
  - thing
    - activity
  - etc...

**Syntactic Structure**
- Clusters
  - Cluster 1
  - Cluster 2
  - Cluster 3
  - Cluster 4
  - Cluster 5
  - Cluster 6
  - etc...

**Clean Mapping Principle**
- syntactic structure reflects semantic structure
- Mappings are cleaner than they appear
- Children know this fairly early

**Structure**
- [Cluster 1 + Cluster 2]
- [Cluster 3 + Cluster 4]

etc...
Infant’s Starting State

Semantic Structure

cause
  thing have
  thing property

- go
  thing path
  place place

- have
  thing mental state

- act
  thing activity

etc...

Clean Mapping Principle

syntactic structure reflects semantic structure

Syntactic Structure

Categories

- Cluster 1
- Cluster 2
- Cluster 3
- Cluster 4
- Cluster 5
- Cluster 6
- [Cluster 1 + Cluster 2]
- [Cluster 3 + Cluster 4]

- Adults readily access the concepts with the right scope
  - Children do too
- Similar concepts guide toddlers action understanding
Thank you