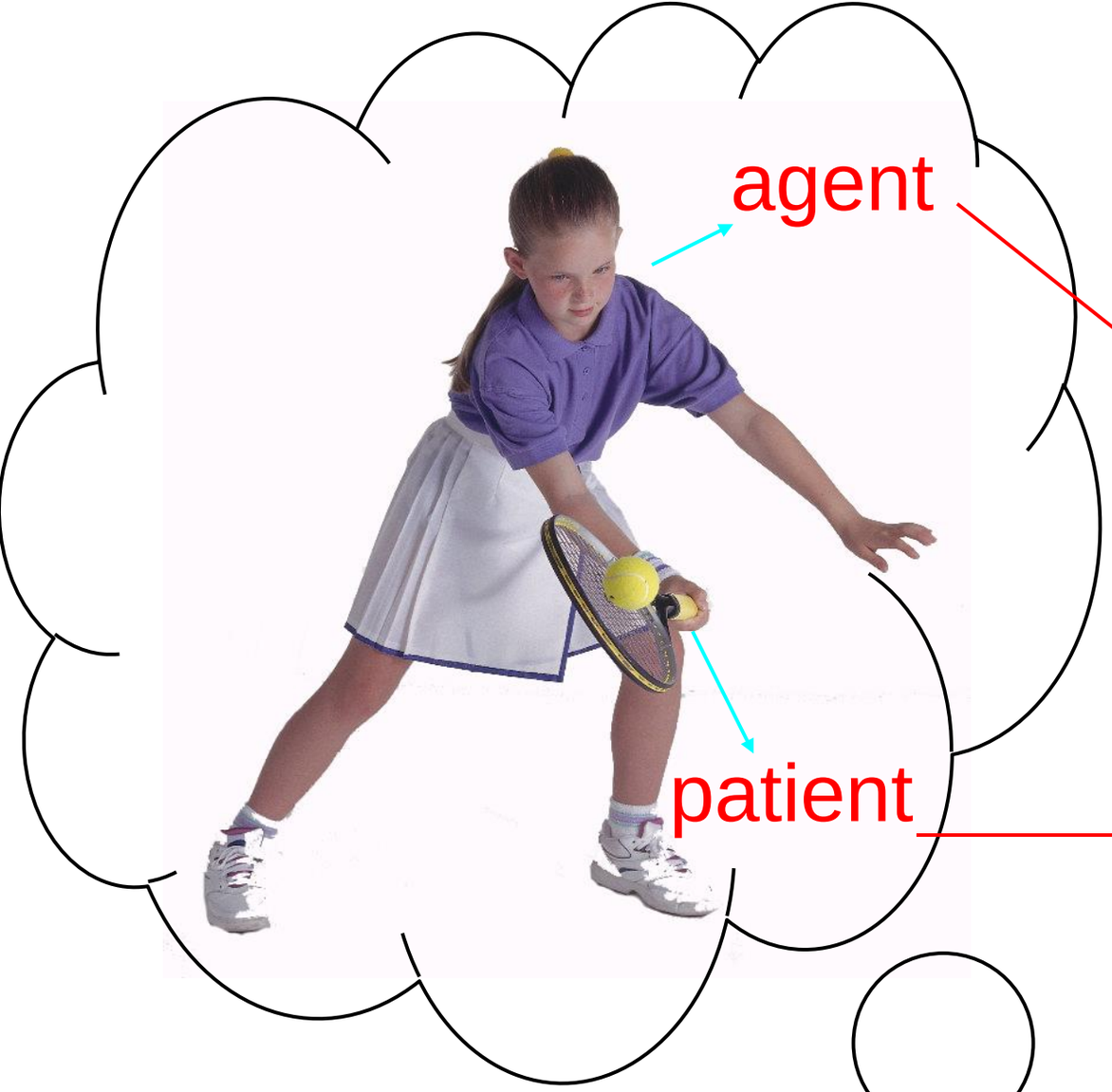
Clean Mapping:

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

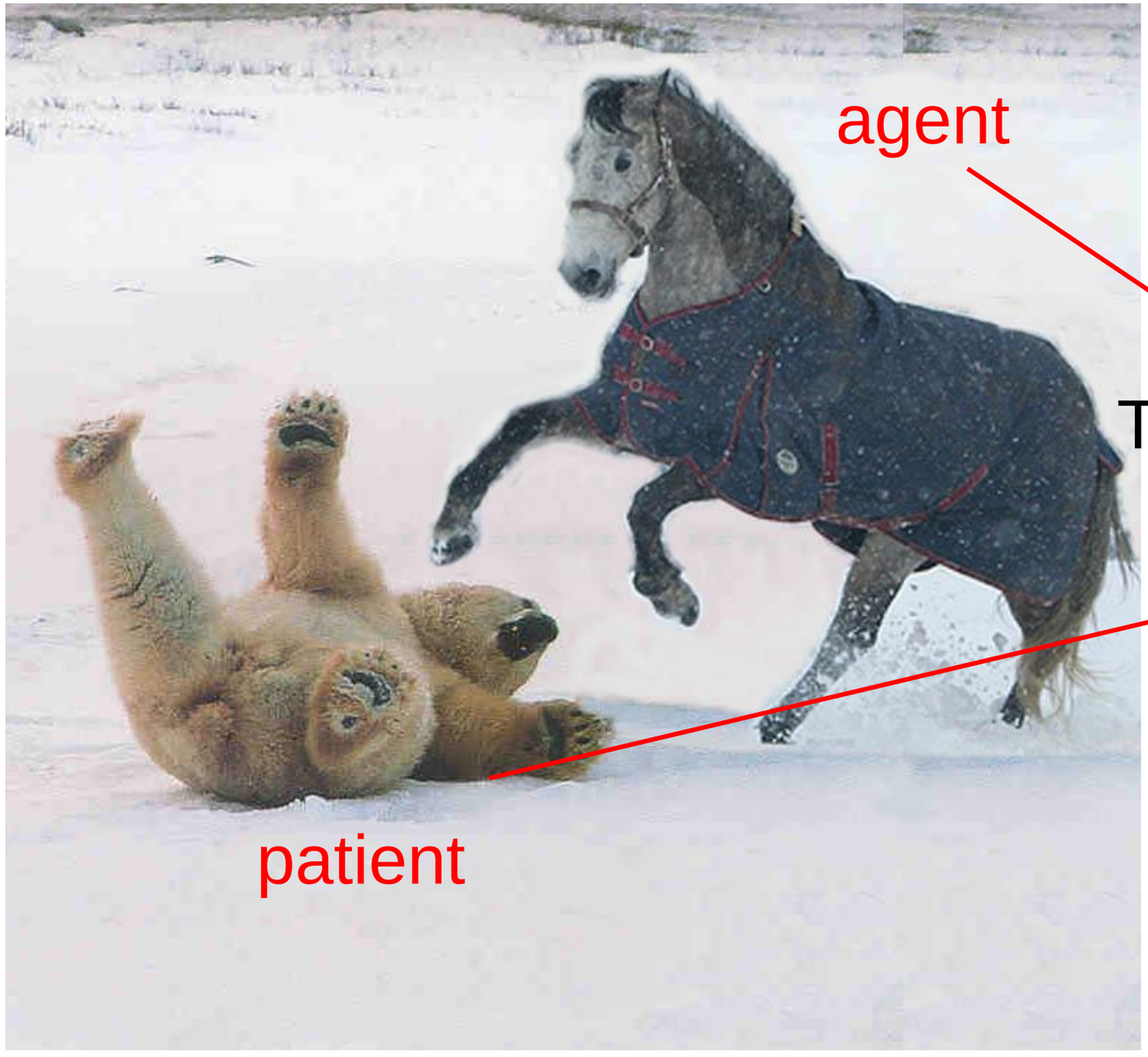


Sally hit the ball.

agent

The storm trooper kicked the man

patient

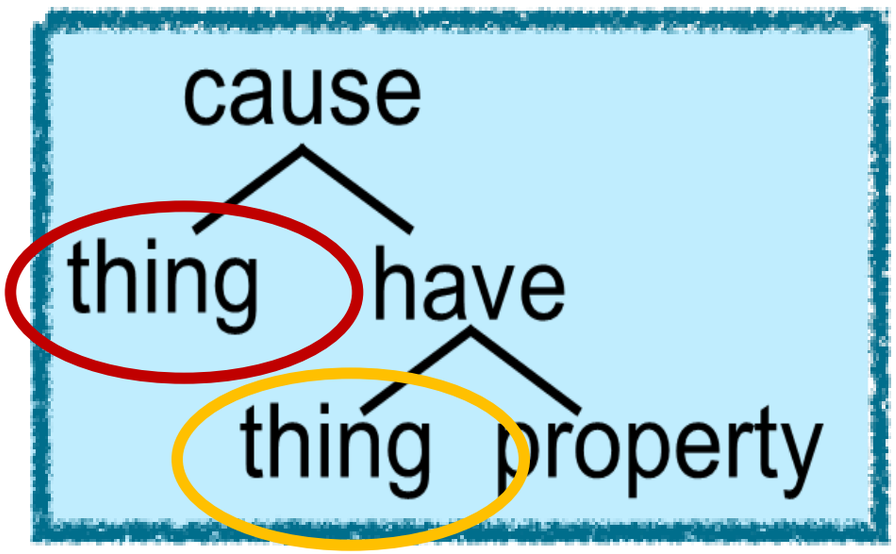


The horse *pilked* the bear.

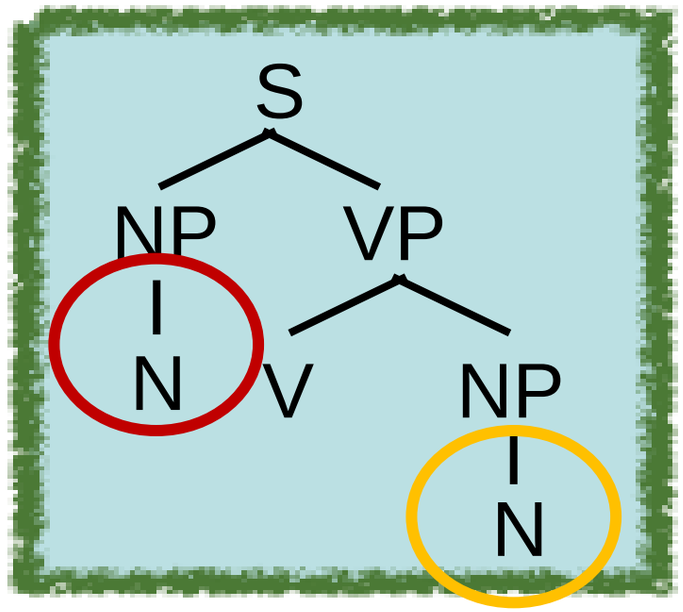
(Baker, 1988; Marantz, 1982; Jackendoff, 1990)

Systematic, abstract mapping rules

Semantics



Syntax



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…

Language of Thought

- 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.

Language

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

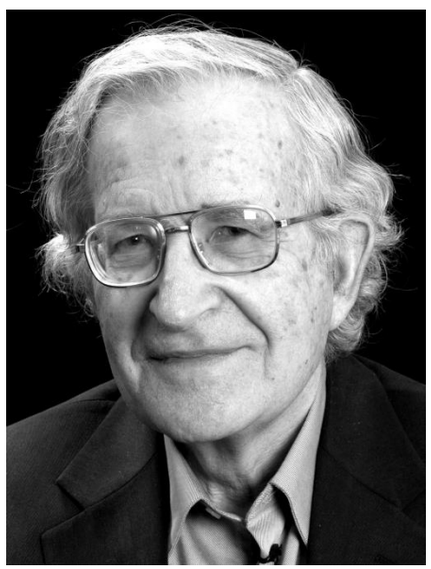
A rose by any other name…

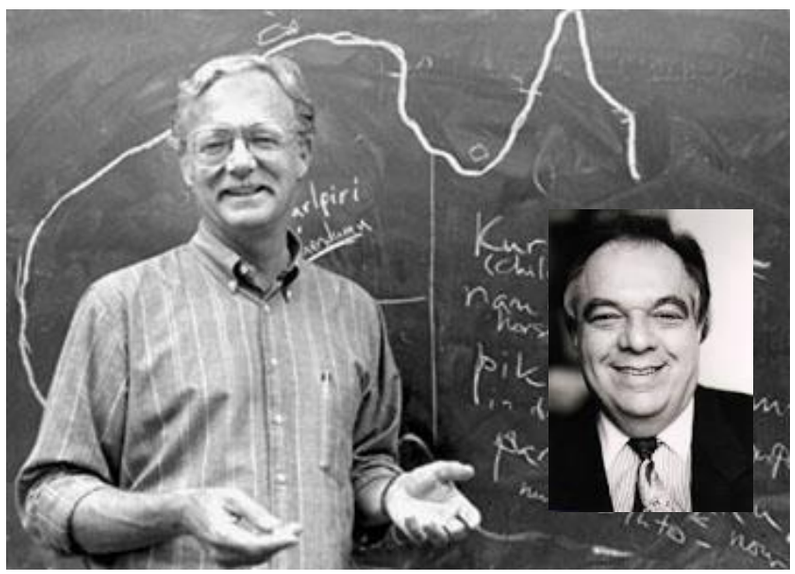
D-Syntax, Early Phase

- 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

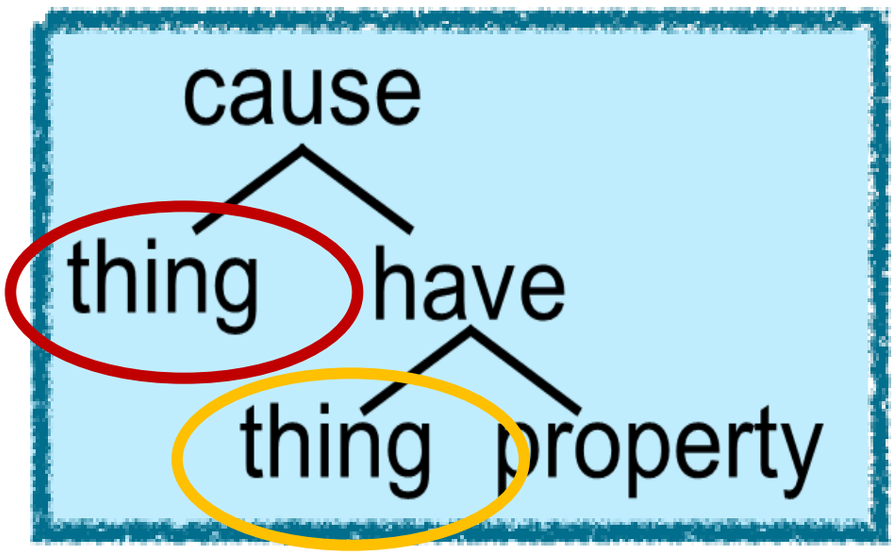
- Conceptual combination but solely within a domain
- *Does it have hierarchical structure?*
- *Does it capture syntactically relevant similarities in meaning btw predicates?*
- Universal and prior to acq.

Language & Linguistic Thought

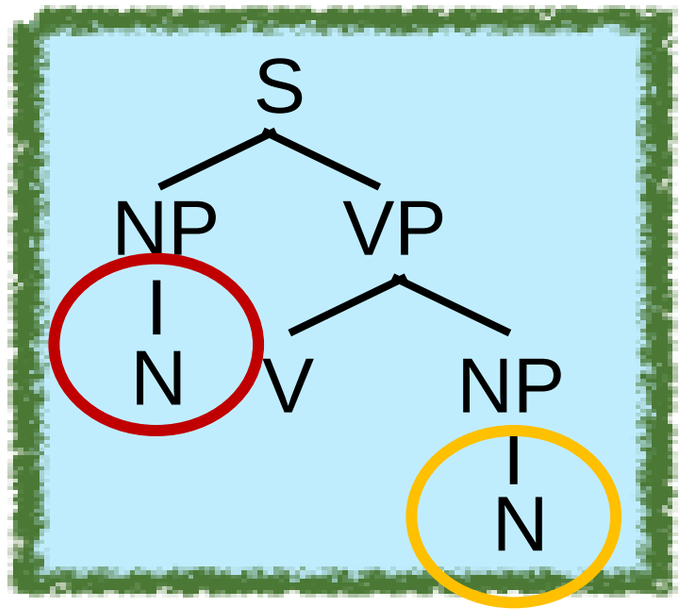
- Semantic and syntactic reps acquired via language module
- Acquisition of mapping to form needed for use
- Presumably has hierarchical structure and linear order
- Encodes morpho-syntactic features

How do children acquire this system?

Semantics

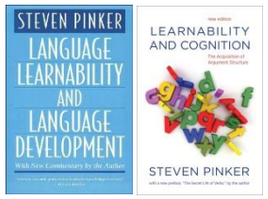


Syntax



Two proposals:

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



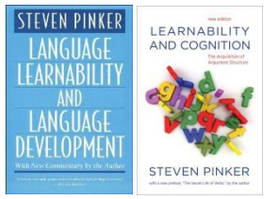
Semantic Structure

?

?

Syntactic Structure

?



Infant's Starting State

Semantic Structure

Syntactic Structure

Primitives

S N V D

etc...

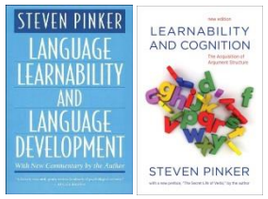
Phrase Structure Rules (underspecified)

S → [NP VP or VP NP]

VP → [V NP or NP V]

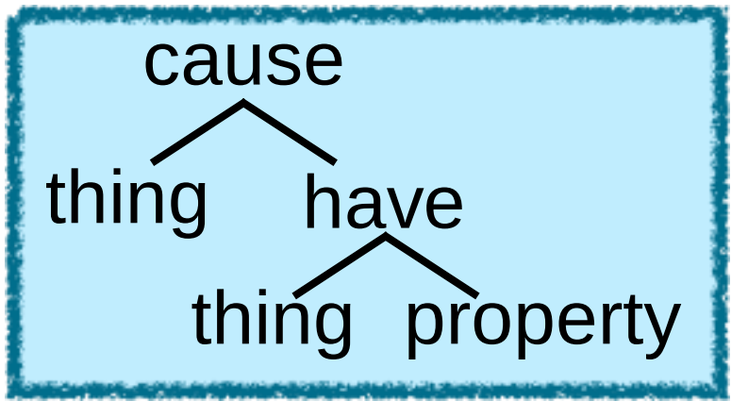
NP → [D N or N D]

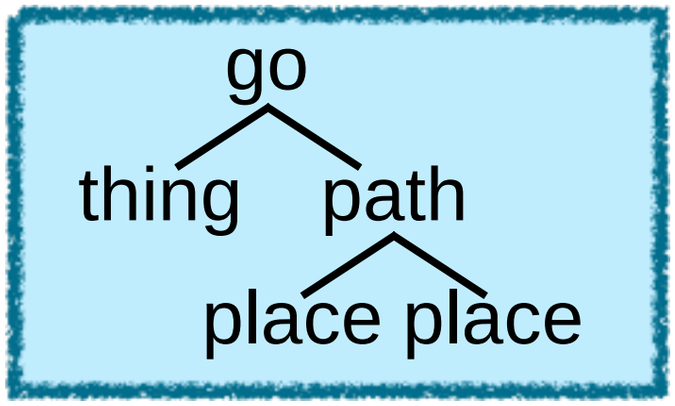
etc...

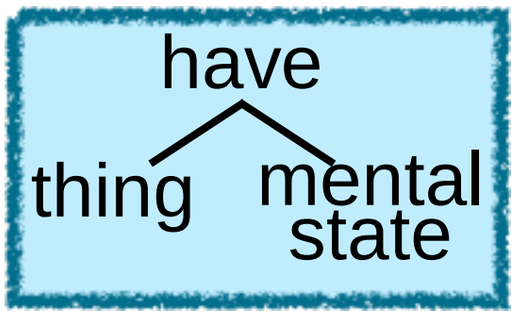


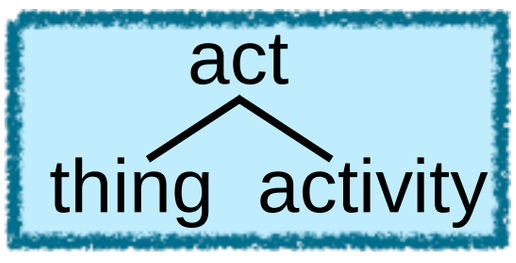
Infant's Starting State

Semantic Structure









etc...

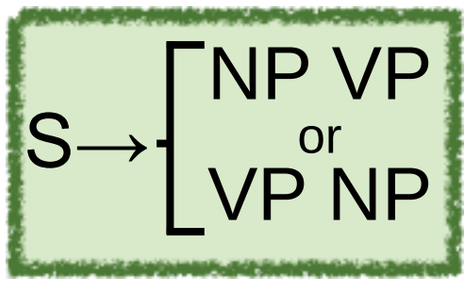
Syntactic Structure

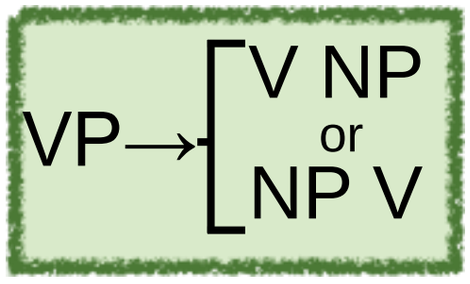
Primitives

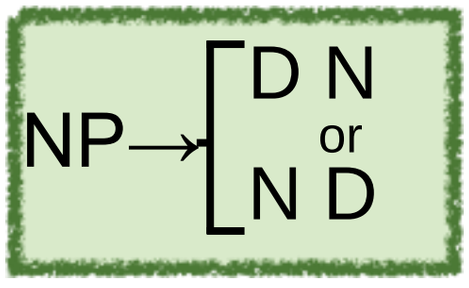
S N V D

etc...

Phrase Structure Rules (underspecified)







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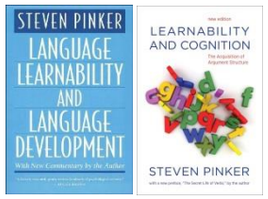
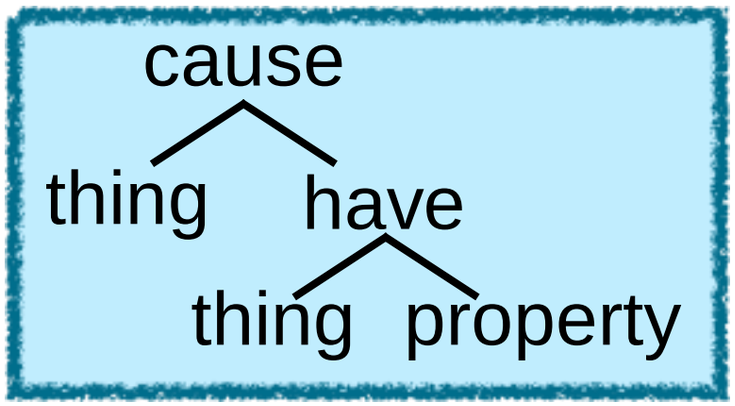
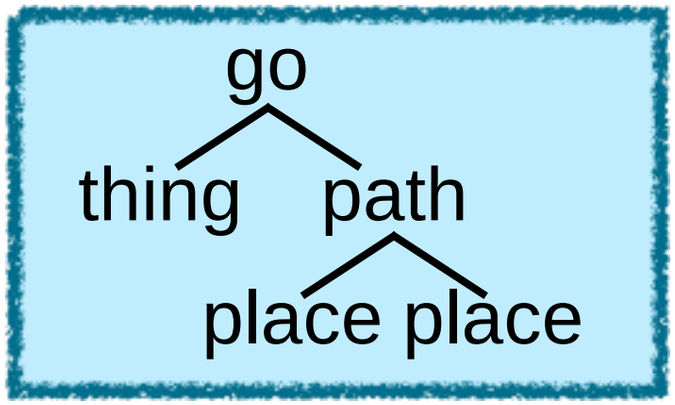
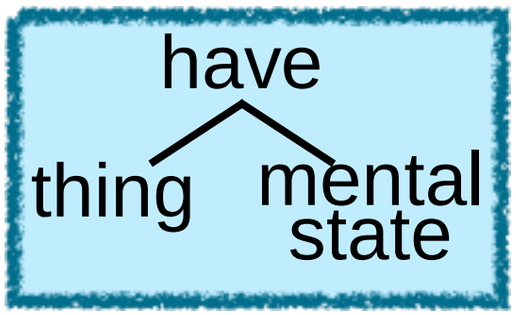


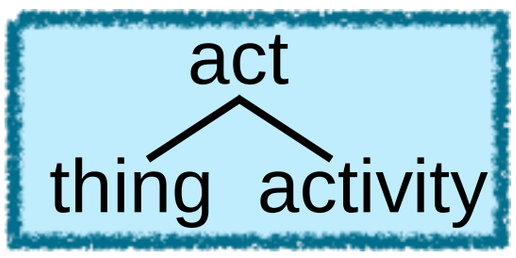
Infant's Starting State

Semantic Structure









etc...

Linking Rules

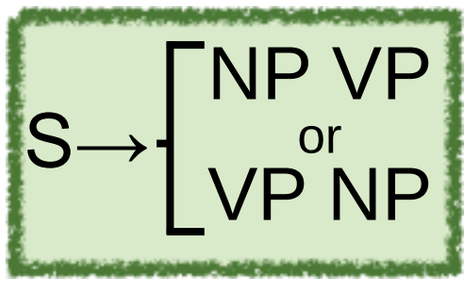
etc...

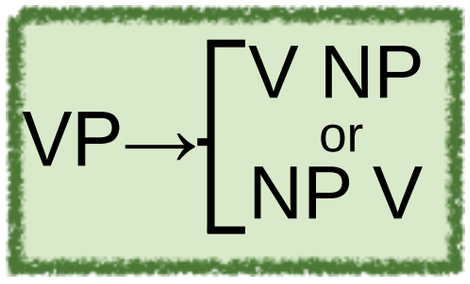
Syntactic Structure

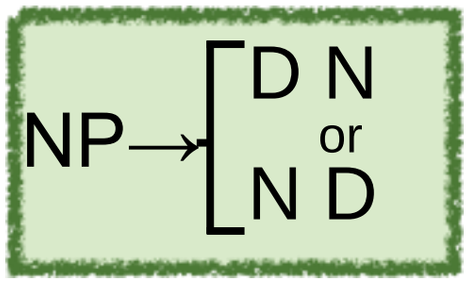
Primitives

etc...

Phrase Structure Rules (underspecified)







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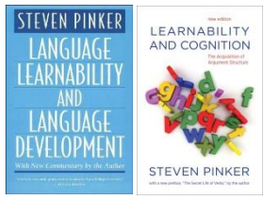
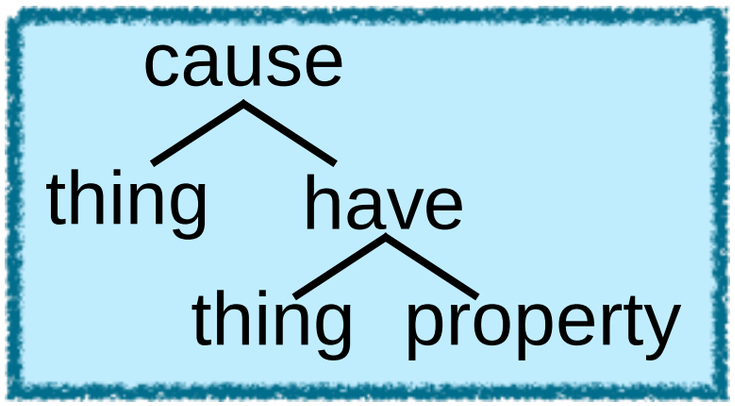
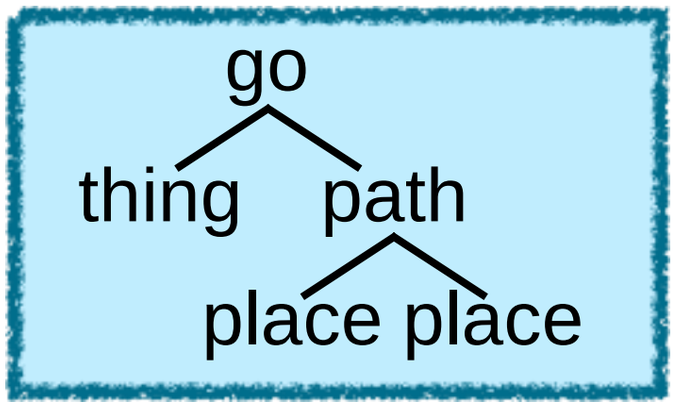
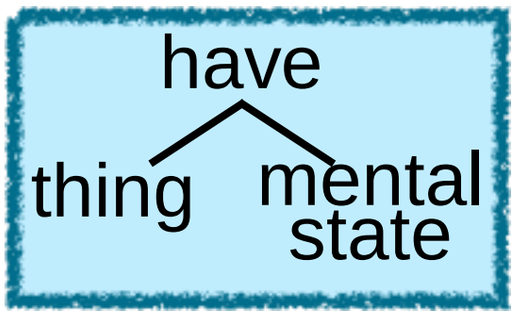


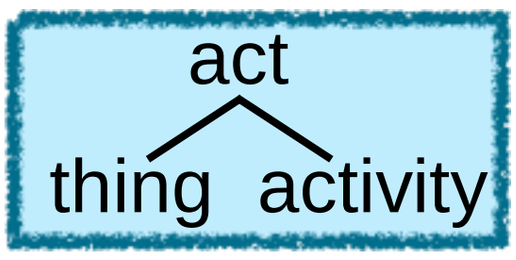
Infant's Starting State

Semantic Structure



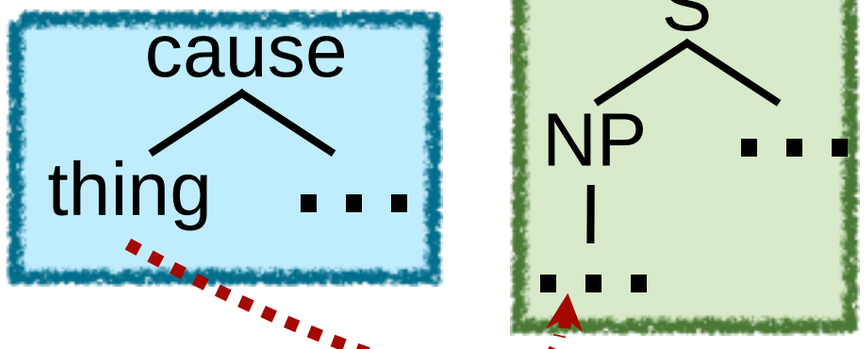






etc...

Linking Rules



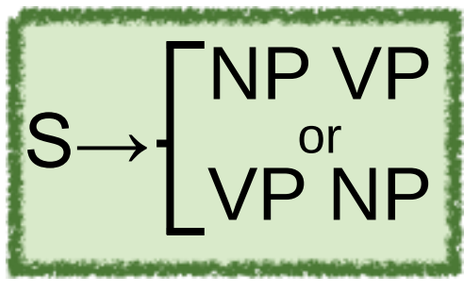
etc...

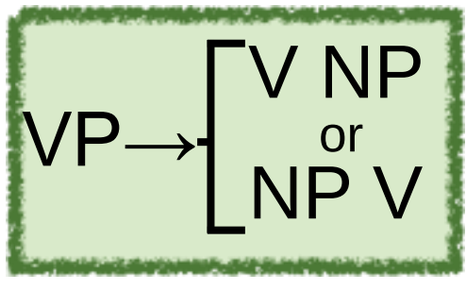
Syntactic Structure

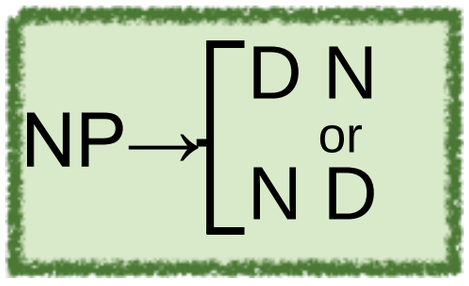
Primitives

etc...

Phrase Structure Rules (underspecified)







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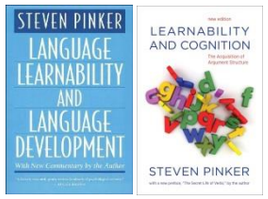
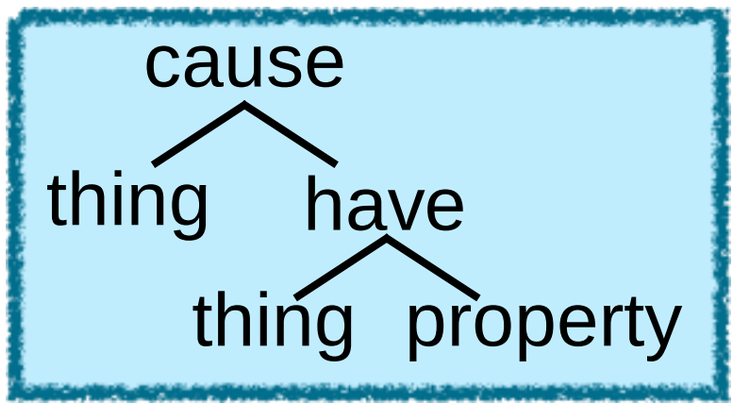
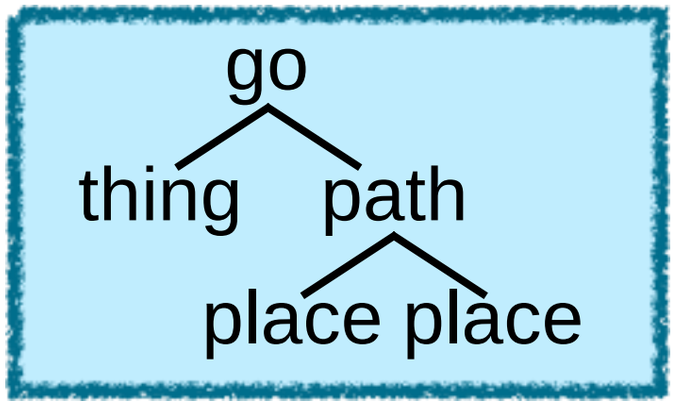
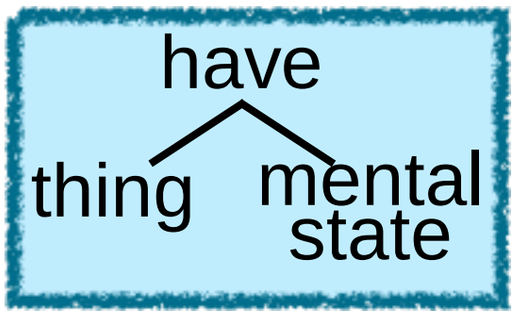


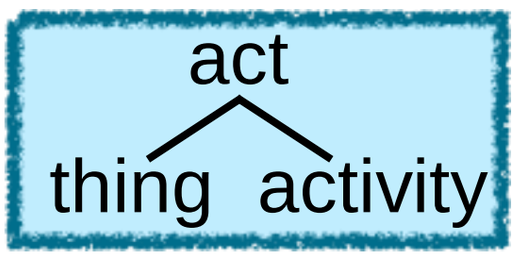
Adult State

Semantic Structure



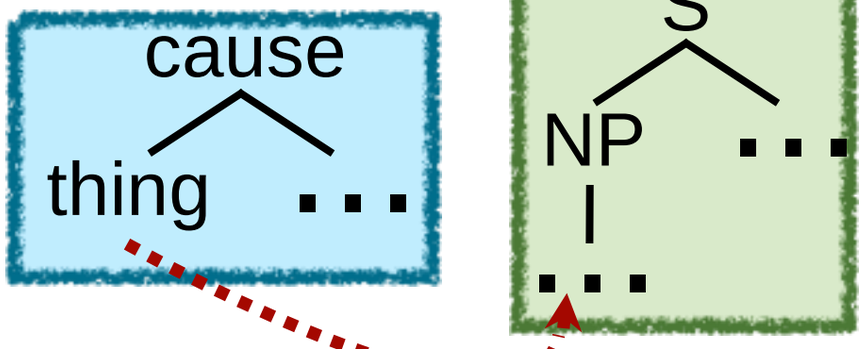






etc...

Linking Rules



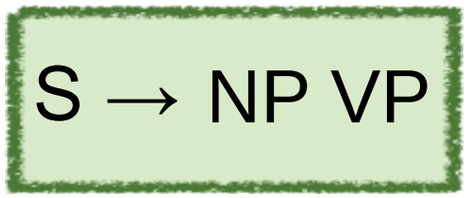
etc...

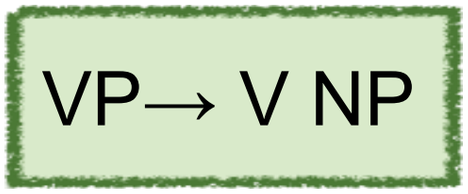
Syntactic Structure

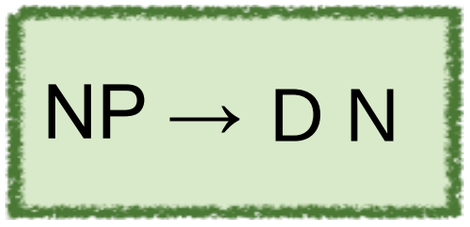
Primitives

etc...

Phrase Structure Rules (fully specified)







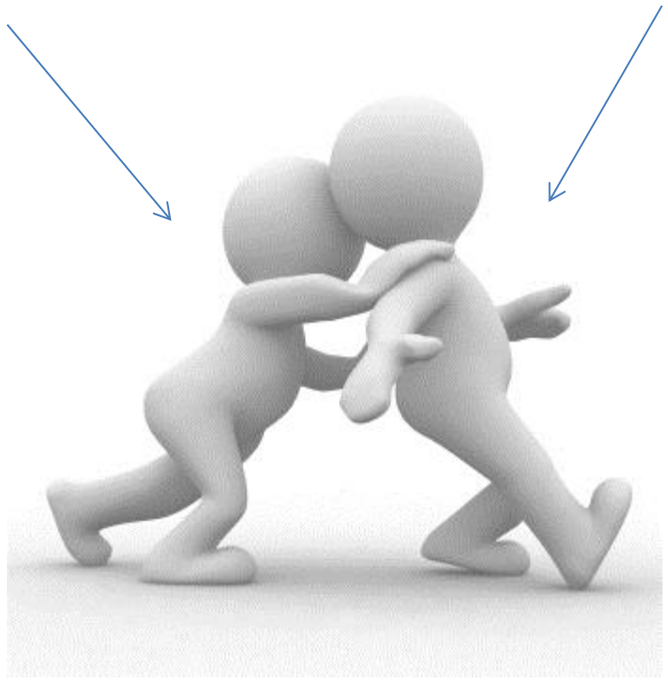
etc...

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)

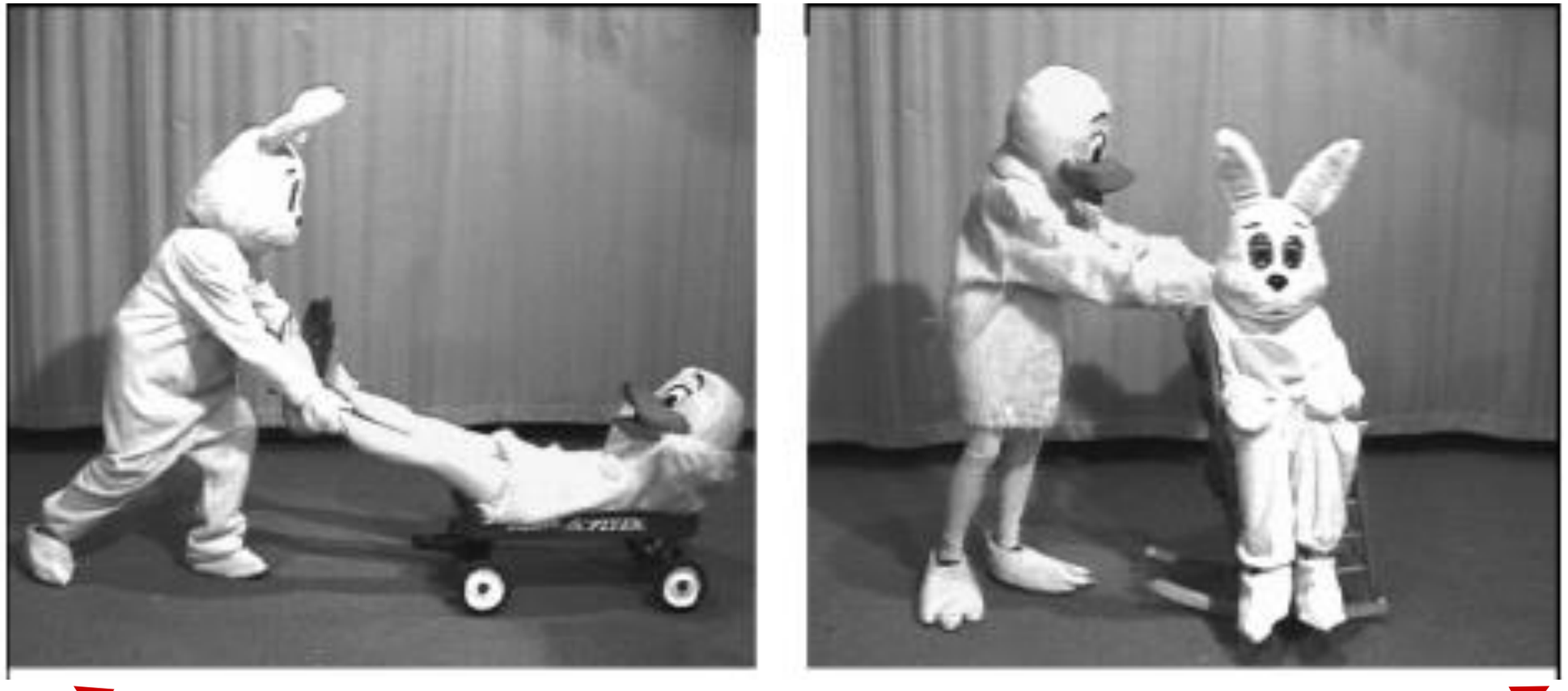
- Child gradually forms generalizations on the basis of experience
  - By “noticing” similarities
  - Contact-verb: NP = contacter, NP2 = contactee
- Constructions become more abstract with age

Do young children have abstract categories?

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

Naigles, 1990, 1996; Naigles & Kako, 1993; Fisher, 1996, 2000, 2002; Gertner, Fisher & Eisengart, 2006; Yuan, Fisher & Snedeker, 2012; Jin & Fisher, 2013; Fernandes, Marcus, Di Nubila, & Vouloumanos, 2006; Bunger & Lidz, 2008; Aruchalan & Waxman, 2010; Arunchalam, Escovar, Hansen & Waxman, 2012; Kline & Demuth, 2013; Conwell & Demuth, 2007

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

Within-Verb Priming

Kim gave Bob the picture

Kim gave the picture to Bob

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

Across-Verb Priming

Kim showed Bob the picture

Kim showed the picture to Bob

Bock, 1986; Pickering & Branigan, 1998

Priming and Representation

- Verb Island (lexical) →

  Within-verb priming only

- Pure Abstraction →

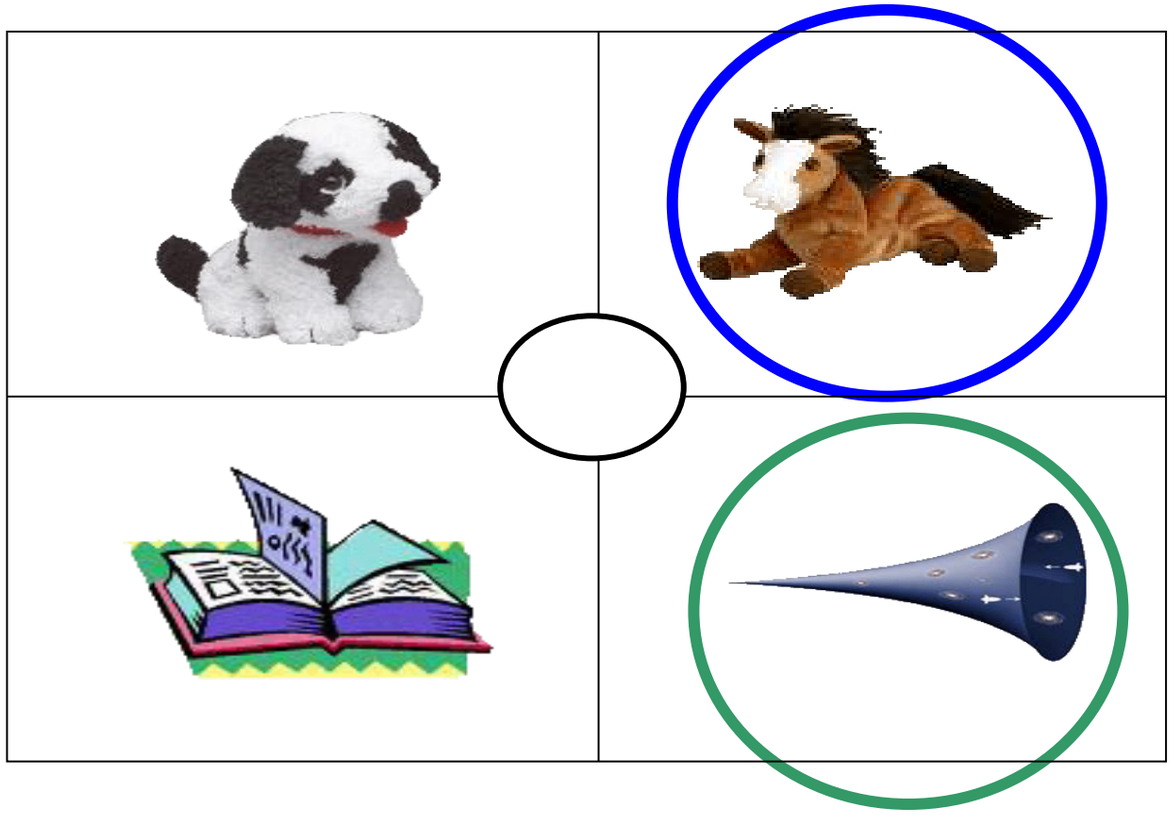
  Within-verb = Across-verb priming

- Priming at both levels→

  Within-verb > Across-verb priming

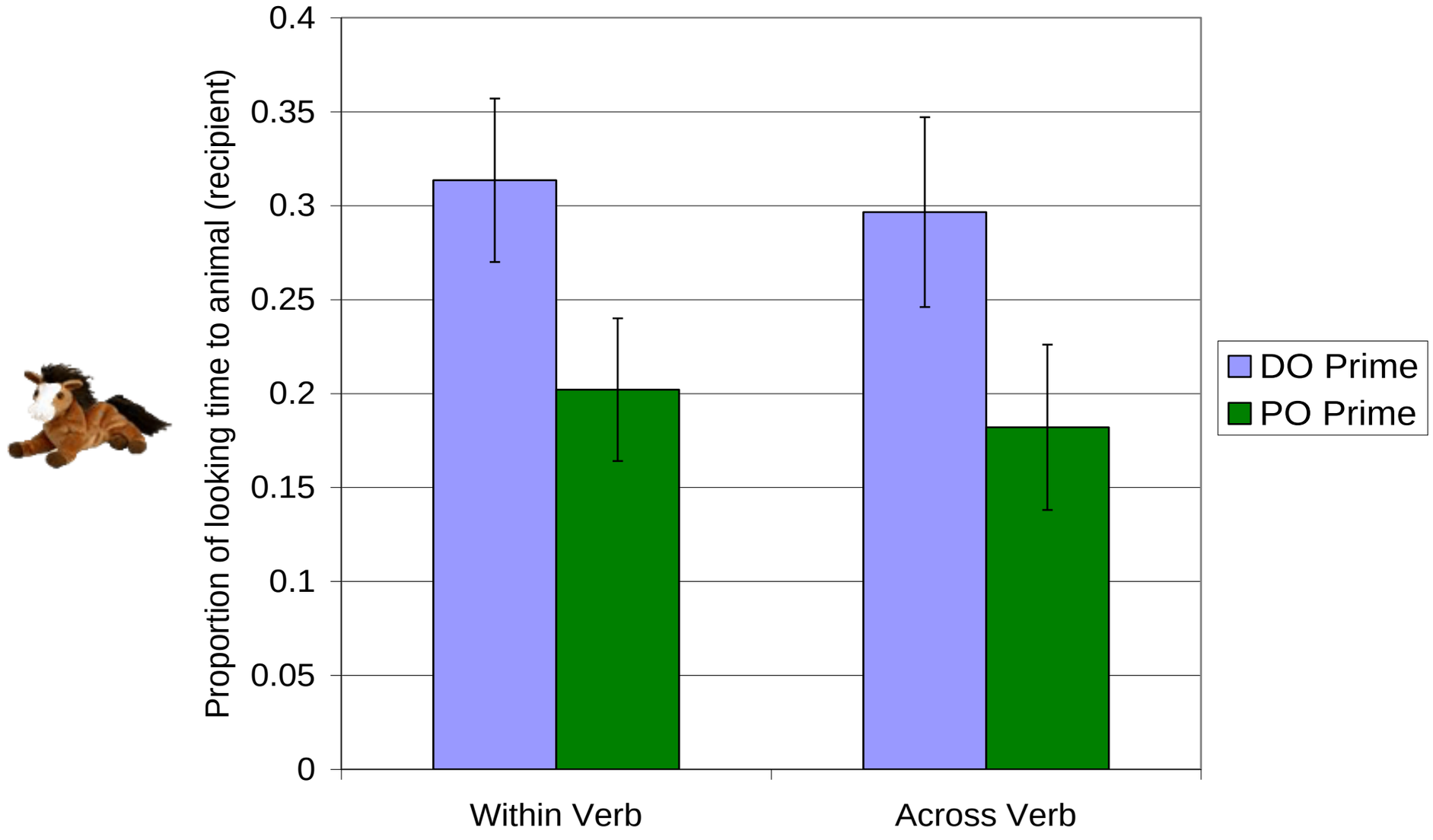
Design

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



Target: *Show the **hor**se the book* or
*Show the **hor**n to the dog*

Comprehension priming at 3;0 is entirely abstract



Thothathiri & Snedeker, 2008a

Production priming at 3-4 is entirely abstract

Lexical boost emerges later

Rowland, Chang, Ambridge, Pine & Lieven (2012)

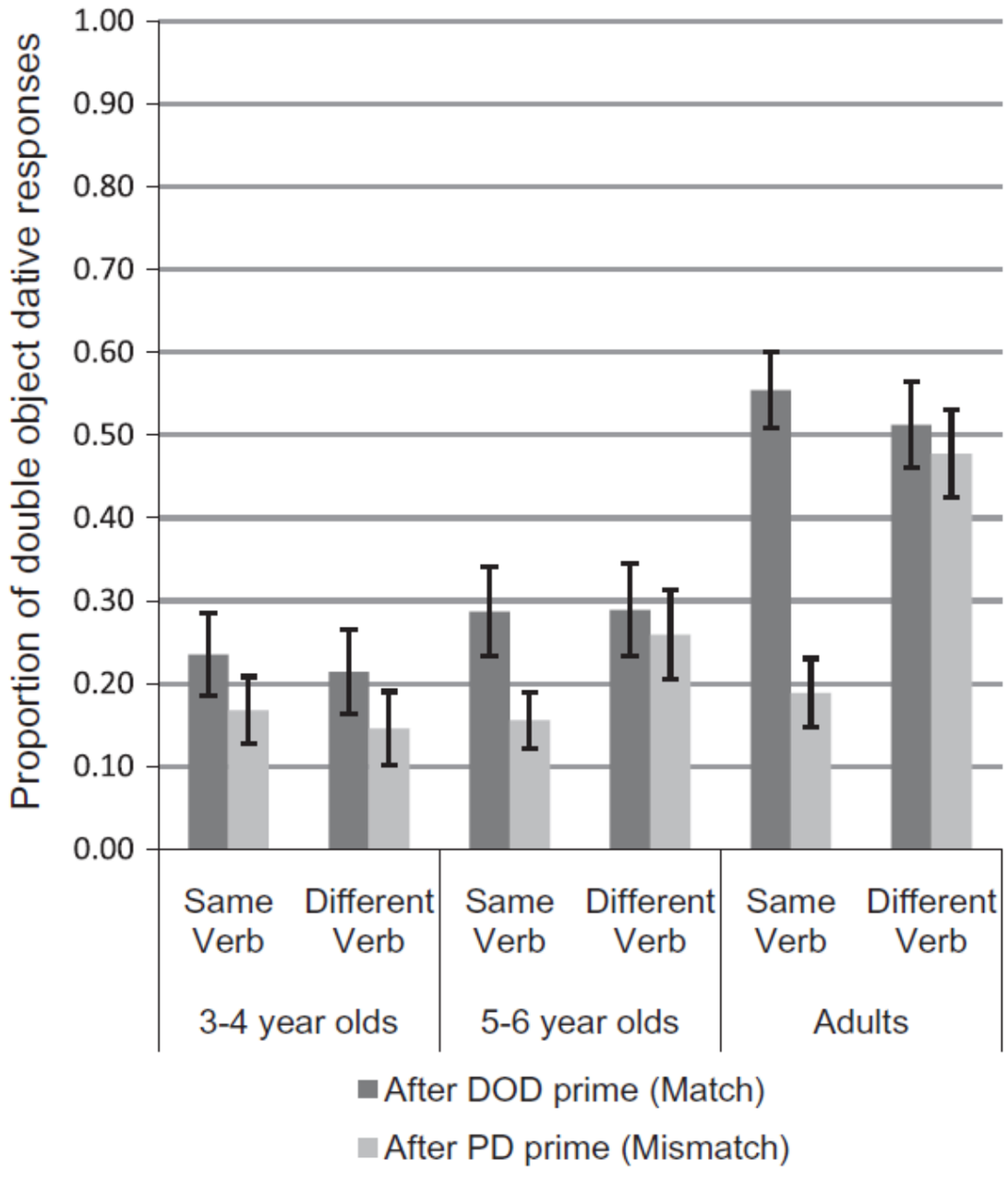


Fig. 1. Mean proportion of datives that were double object datives after DOD and PD primes (SE in error bars).

Overwhelming evidence for early abstraction

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

Aruchalan & Waxman, 2010; Arunchalam, Escovar, Hansen & Waxman, 2012Bencini & Valian, 2008; Bunger & Lidz, 2008; Coppola & Newport, 2005; Ditmar, Abbot-Smith, Lieven & Tomasello, 2011; Fernandes, Marcus, Di Nubila, & Vouloumanos, 2006; Fisher, 1996, 2000, 2002; Fisher & Song, 2006; Jin & Fisher, 2013; Kline & Demuth, 2014; Messenger, Branigan & McLean, 2011; Naigles, 1990, 1996; Naigles & Kako, 1993; Peter, Blything, Rowland & Chang, 2012; Thothathiri & Snedeker, 2008; Rowland, Chang, Ambridge, Pine & Lieven, 2012; Yuan, Fisher & Snedeker, 2012

Overwhelming evidence for early abstraction

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

Is this evidence for innate <u>syntax</u>?

- No, it doesn't tell us what the relevant domain is or developmental history

Aruchalan & Waxman, 2010; Arunchalam, Escovar, Hansen & Waxman, 2012; Bencini & Valian, 2008; Bunger & Lidz, 2008; Coppola & Newport, 2005; Ditmar, Abbot-Smith, Lieven & Tomasello, 2011; Fernandes, Marcus, Di Nubila, & Vouloumanos, 2006; Fisher, 1996, 2000, 2002; Fisher & Song, 2006; Jin & Fisher, 2013; Kline & Demuth, 2014; Messenger, Branigan & McLean, 2011; Naigles, 1990, 1996; Naigles & Kako, 1993; Peter, Blything, Rowland & Chang, 2012; Thothathiri & Snedeker, 2008; Rowland, Chang, Ambridge, Pine & Lieven, 2012; Yuan, Fisher & Snedeker, 2012

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)

Carey, 2009; Gergely & Csibra, 2003; Huntley-Fenner, Carey, & Solimando, 2002; Johnson, Slaughter, & Carey, 1998; Muenener & Carey, 2010; Hamlin, Wynn, & Bloom, 2010; Kuhlmeier, Bloom, & Wynn, 2004; Spelke, 1990; Spelke & Kinzler, 2007; Spelke, Phillips, & Woodward, 1995; Woodward, 1999; Leslie & Keeble,1987.

- Cannot depend on extensive innate syntax

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

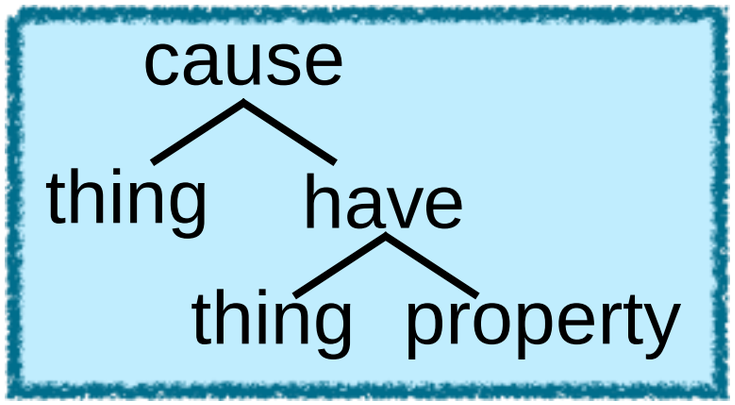
Clean Mapping

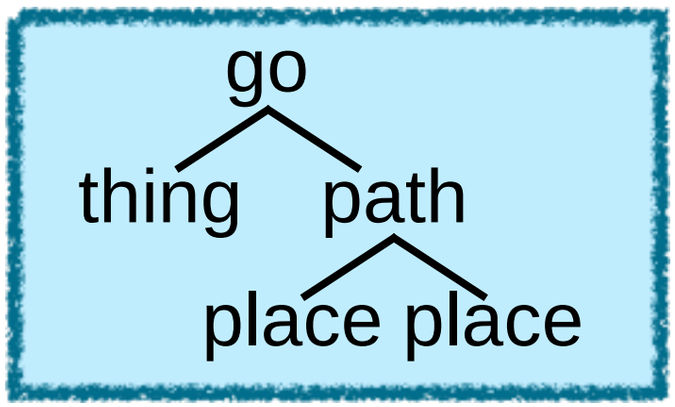
- Our description of an emerging consensus
  - Drawing on semantic bootstrapping, syntactic bootstrapping, statistical learning
- With particular debt to Cindy Fisher

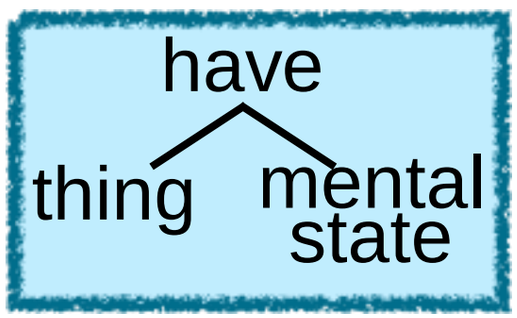
Joshua Hartshorne
Boston College

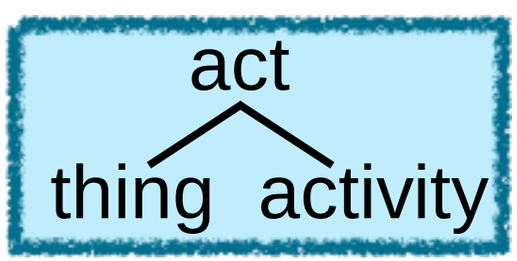
Proposed Starting State

Semantic Structure









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...

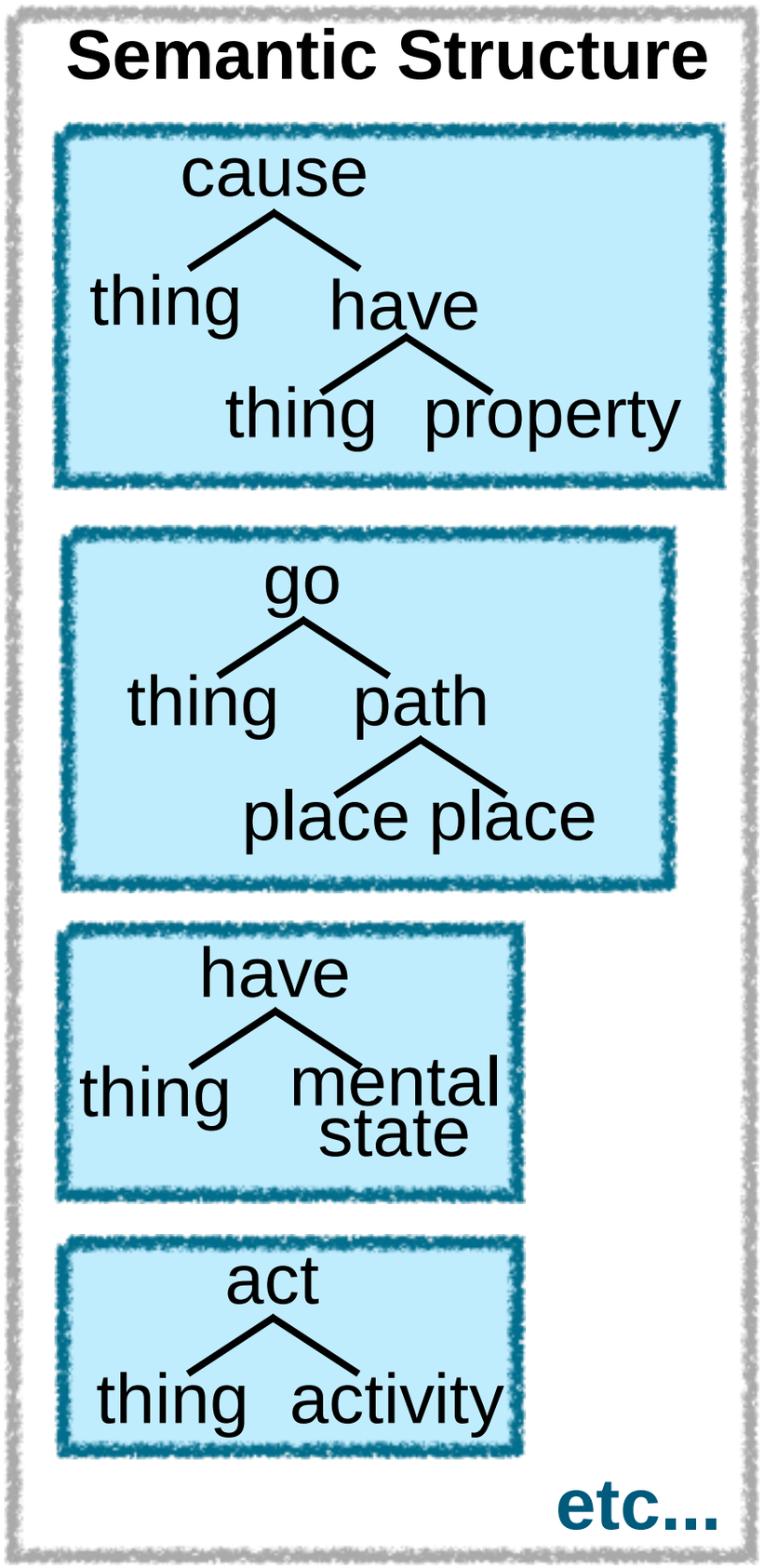
Structure

[Cluster 1 + Cluster 2]

[Cluster 3 + Cluster 4]

etc...

Infant's Starting State



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

Syntactic Structure

Categories

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

etc...

Structure

- [Cluster 1 + Cluster 2]
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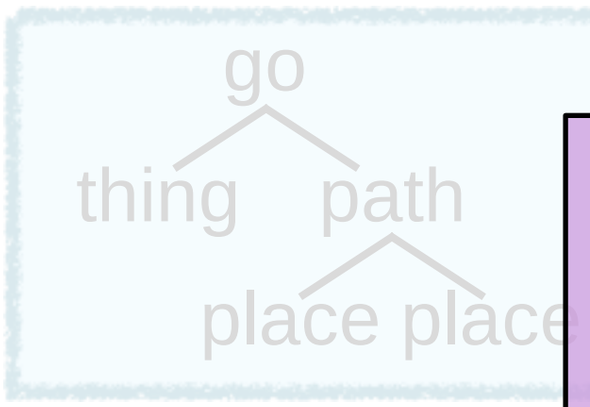
etc...

Infant's Starting State

Semantic Structure



etc...

Clean Mapping Principle

Assume
syntactic structure reflects
semantic structure

An idea with a long history:

Montague, 1970; Baker, 1988; Pinker, 1984; 1988; Gleitman, 1990; Fisher, Hall, Rakowitz & Gleitman, 1994; Macnamara, 1982 inter alia

Structural Isomorphism:

Bouchard, 1995; Jackendoff, 1992; Levin & Rappaport Hovav, 2005; Wechsler, 1995; Williams, 2003

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

thi

thi state

act

thing activity

etc...

Syntactic Structure

Categories

2

4

6

...

]

[Cluster 3 + Cluster 4]

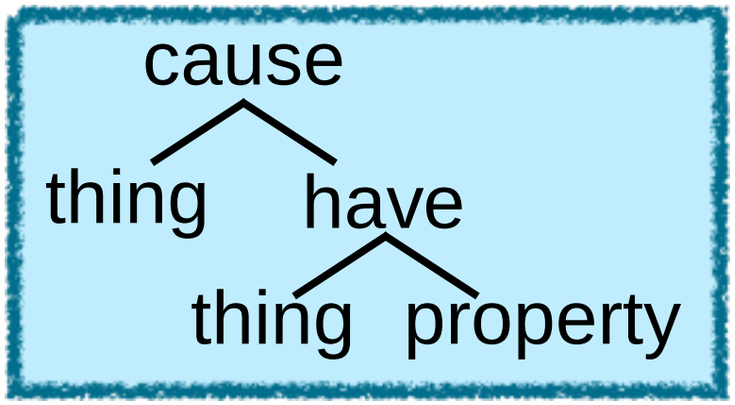
etc...

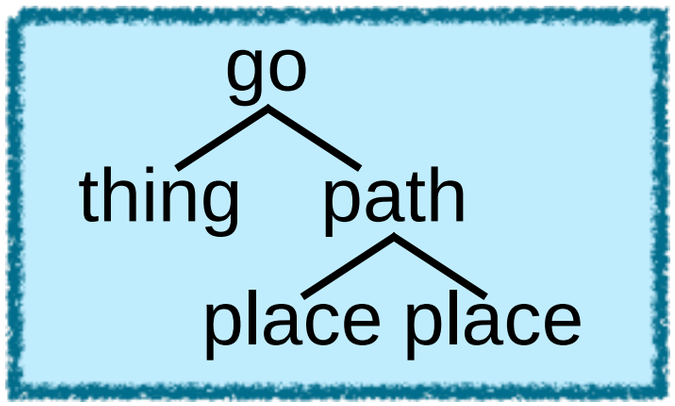
Clean Mapping Principle

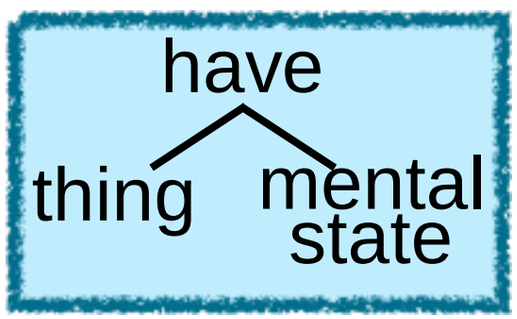
- ***Domain-specific expectation***
  - patterned intentional signals reflect conceptual structure
- ***Domain-general mapping algorithm***
  - Category-to-category mapping
  - Structure-to-structure mapping (preserve dominance)

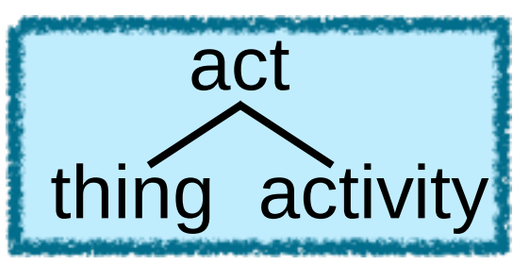
Infant's Starting State

Semantic Structure









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Clean Mapping Principle

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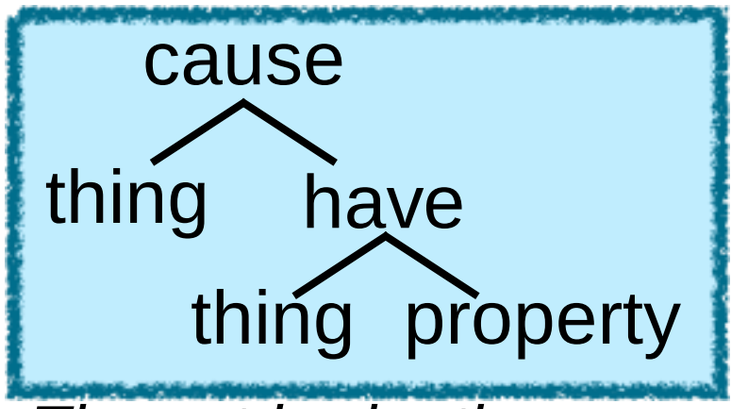
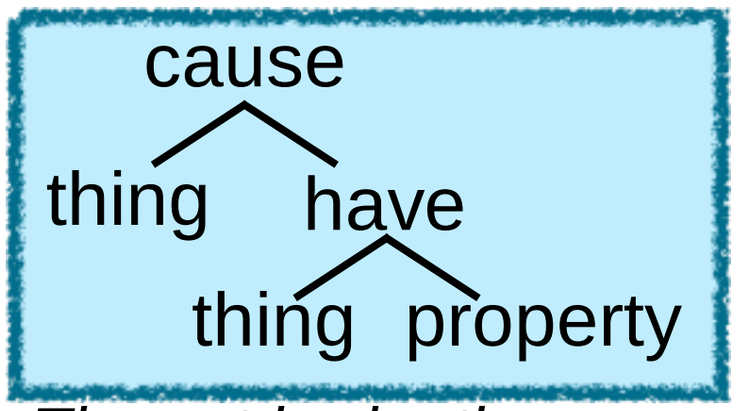


The cat broke the vase



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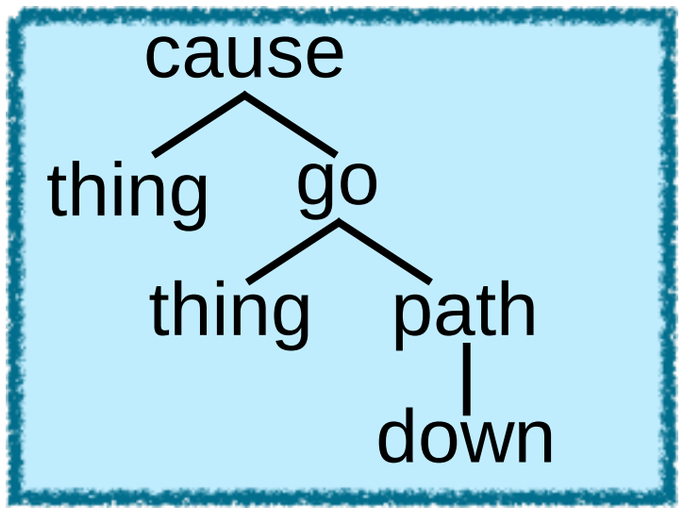
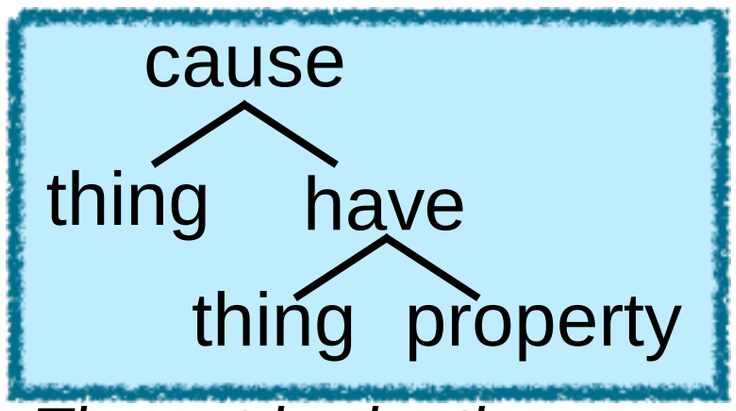


The cat knocked over the vase



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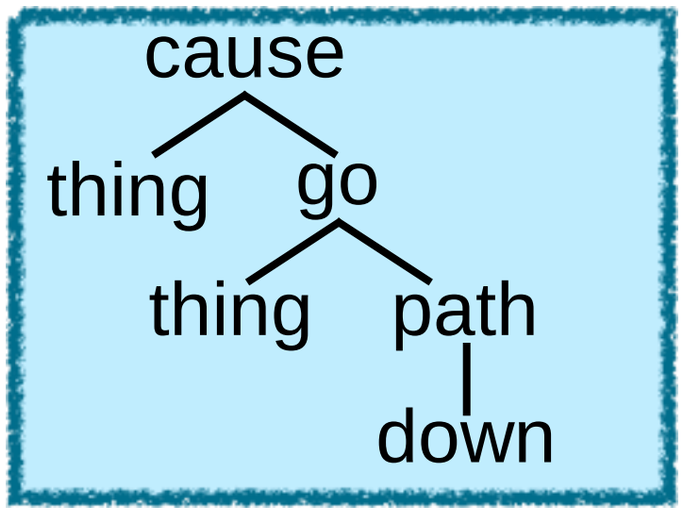

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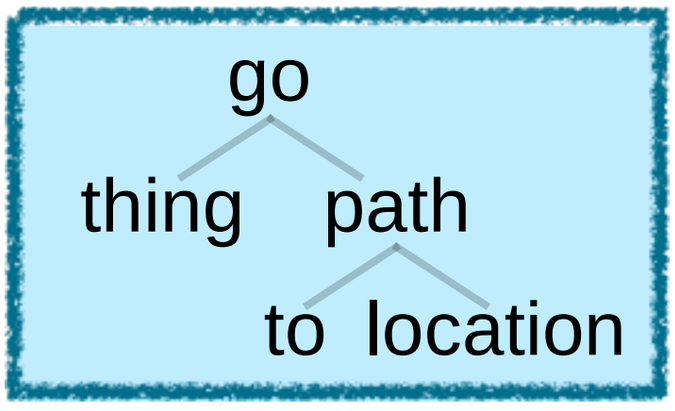
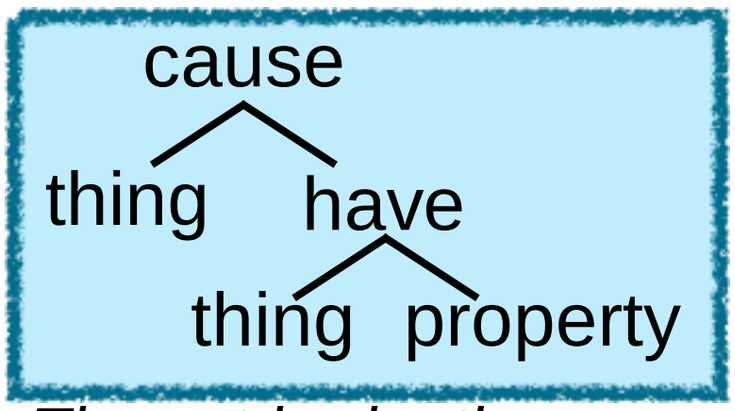


The vase fell



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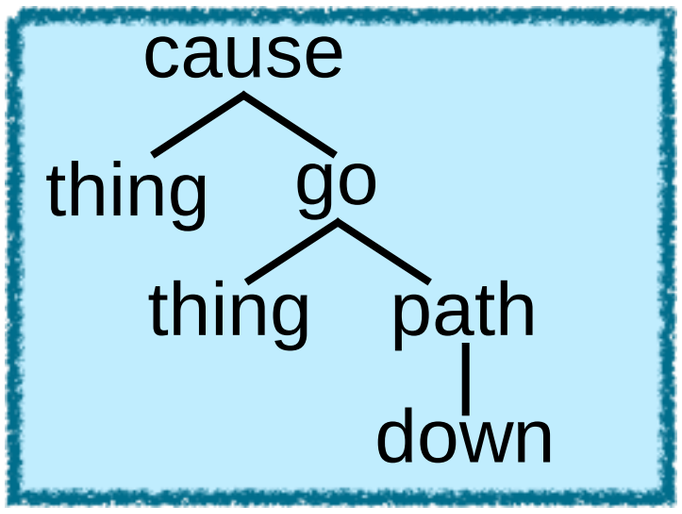

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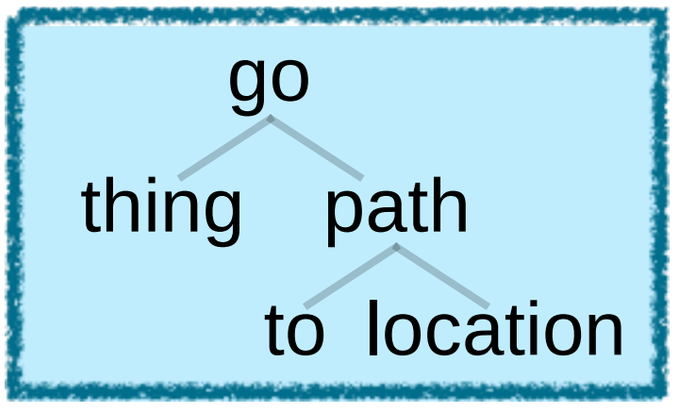

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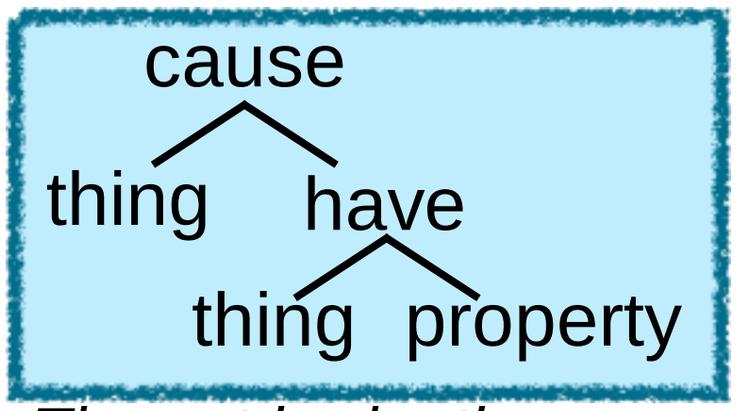

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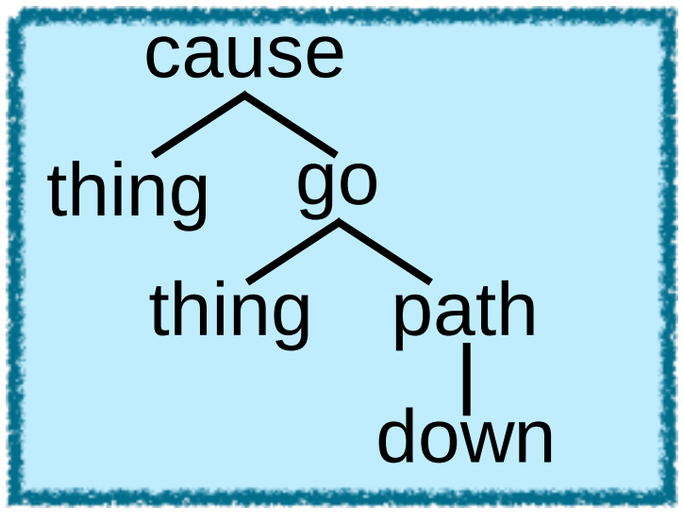

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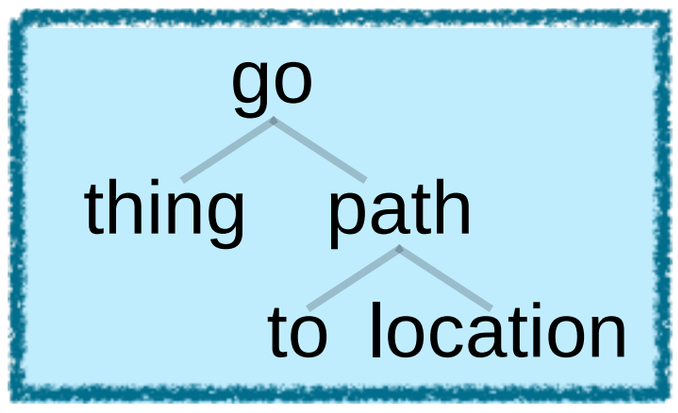

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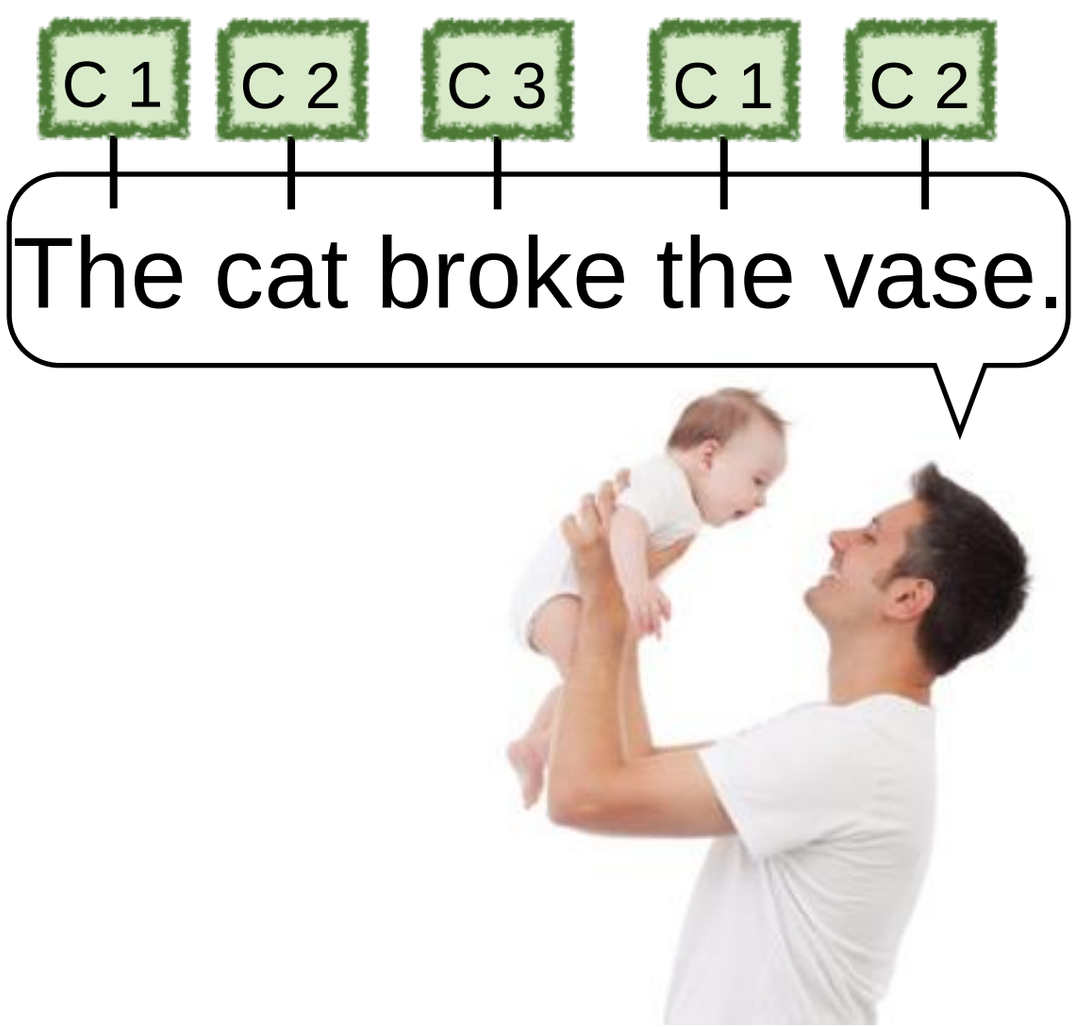

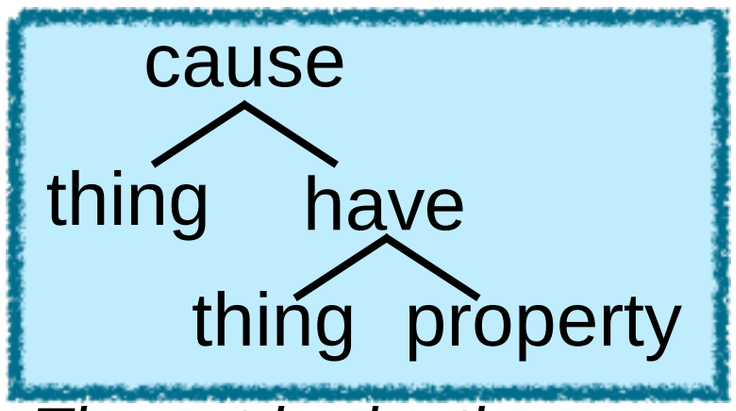

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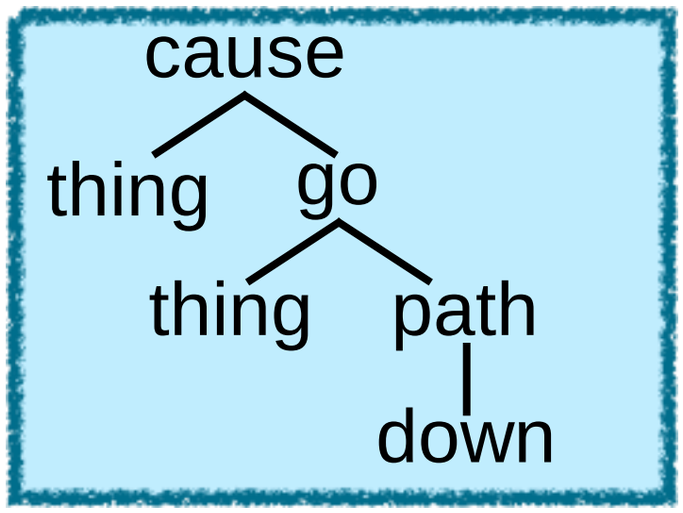

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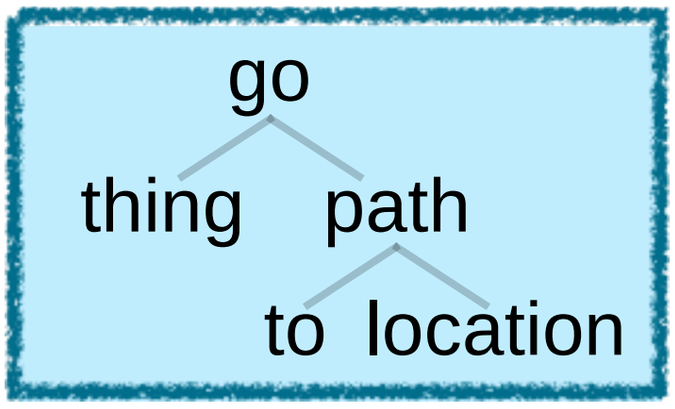

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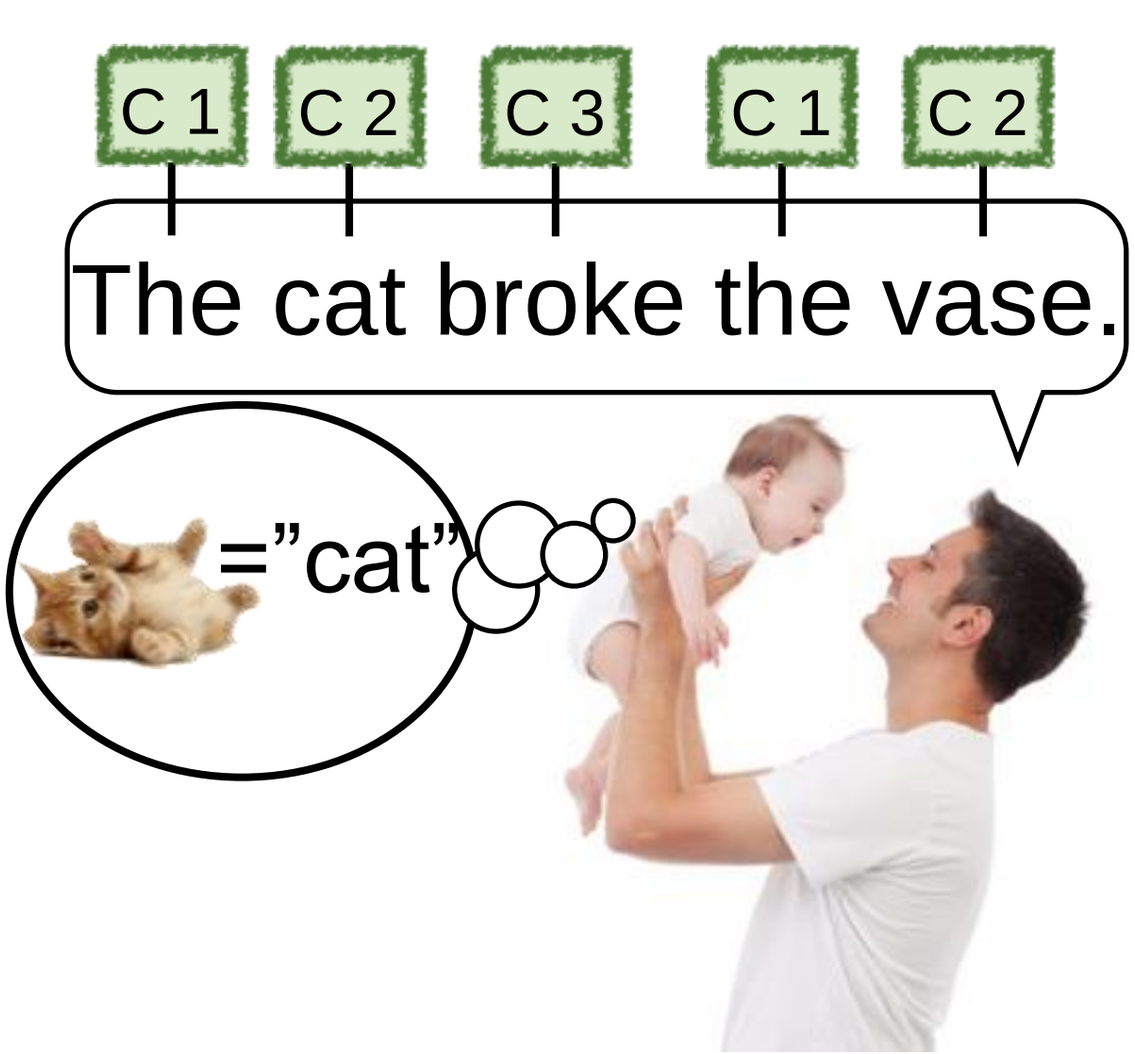


Mapping Rules
(tentative)

thing ⇢ C 2

cause
- thing
- have
  - thing
  - property

The cat broke the vase

cause
- thing
- go
  - thing
  - path
    - down

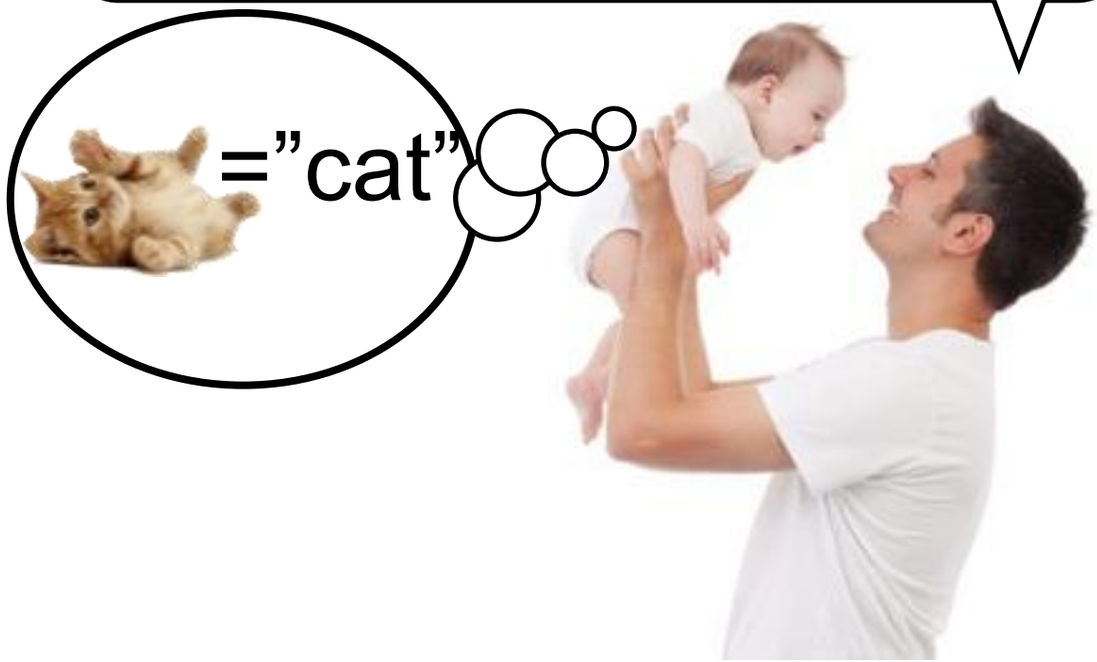
The cat knocked over the vase

go
- thing
- path
  - to
  - location

The vase fell

C 1 C 2 C 3 C 1 C 2

The cat broke the vase.



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go
- thing
- path
  - to
  - location

The vase fell

???

C 1 C 2 C 3 C 1 C 2

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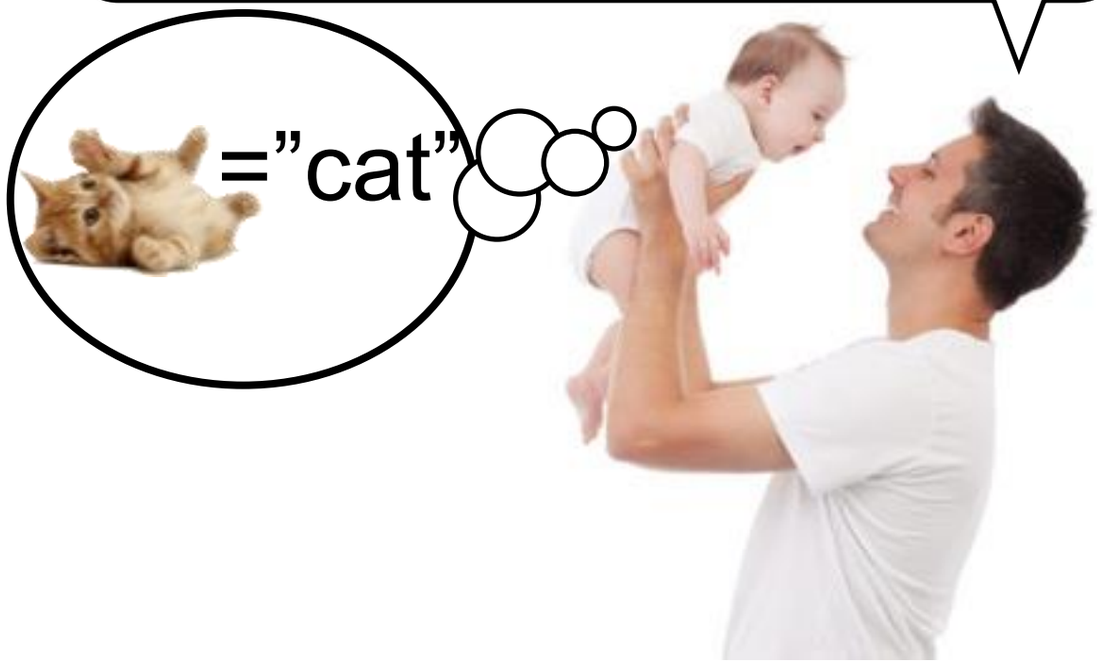

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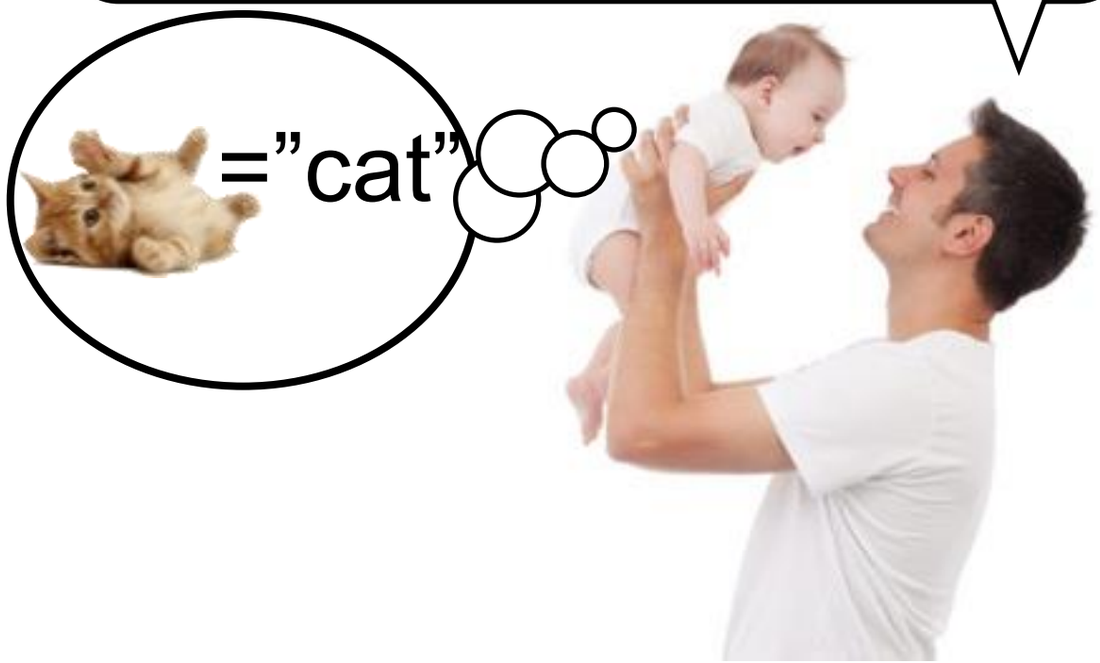
- thing
- path
  - to
  - location

The vase fell

???

C 1 | C 2 | C 3 | C 1 | C 2

The cat broke the vase.



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go
- thing
- path
  - to
  - location

The vase fell

C 1 | C 2 | C 3 | C 1 | C 2

The cat broke the vase.

No

Mapping Rules
(tentative)

thing ⇢ C 2

cause
thing have
thing property

The cat broke the vase

cause
thing go
thing path
down

The cat knocked over the vase

go
thing path
to location

The vase fell

C 1 C 2 C 3 C 1 C 2

The cat broke the vase.

Mapping Rules
(tentative)

thing ⇢ C 2

cause
- thing
- have
  - thing
  - property

The cat broke the vase

cause
- thing
- go
  - thing
  - path
    - down

The cat knocked over the vase

go
- thing
- path
  - to
  - location

The vase fell

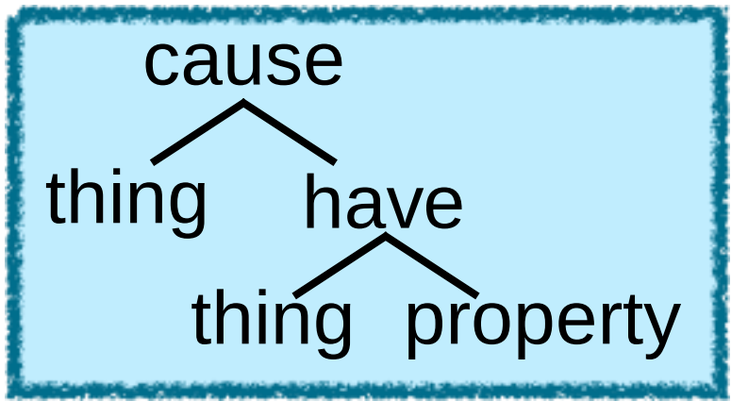
C 1 | C 2 | C 3 | C 1 | C 2

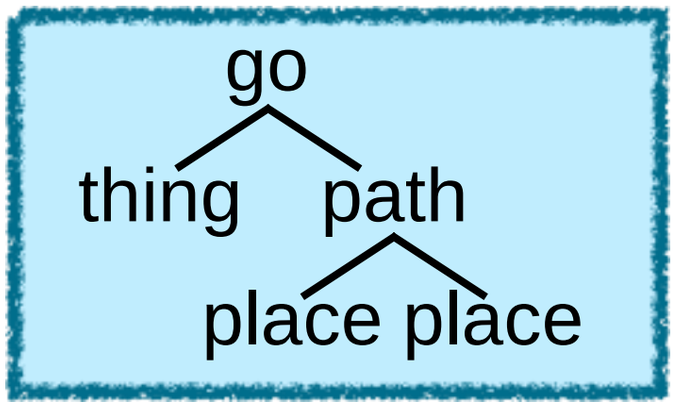
The cat broke the vase.

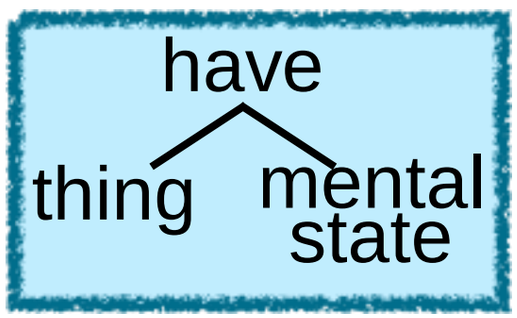
Bingo!

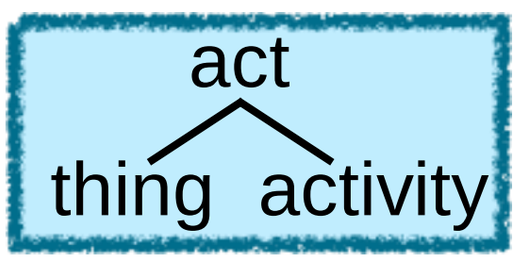
Infant's Starting State

Semantic Structure









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...

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)

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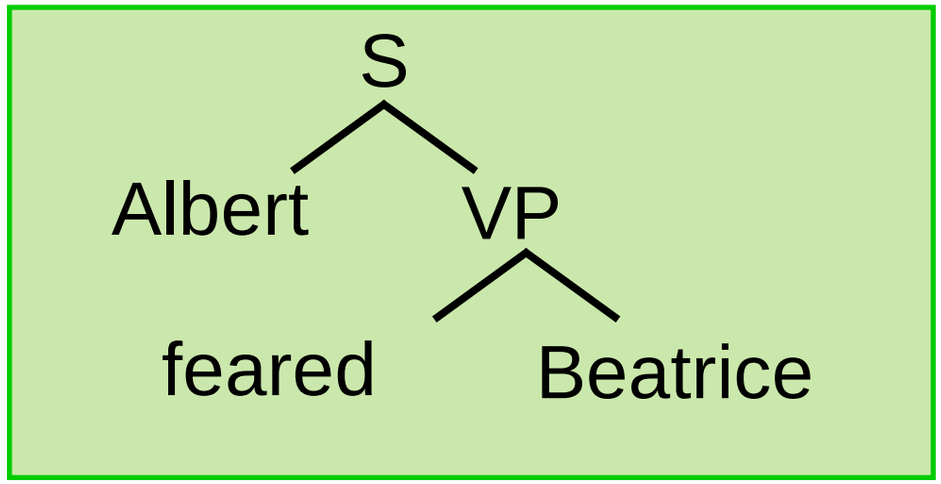
This should predict consistent syntax-semantics mappings

But they can look pretty messy….

emotion verbs

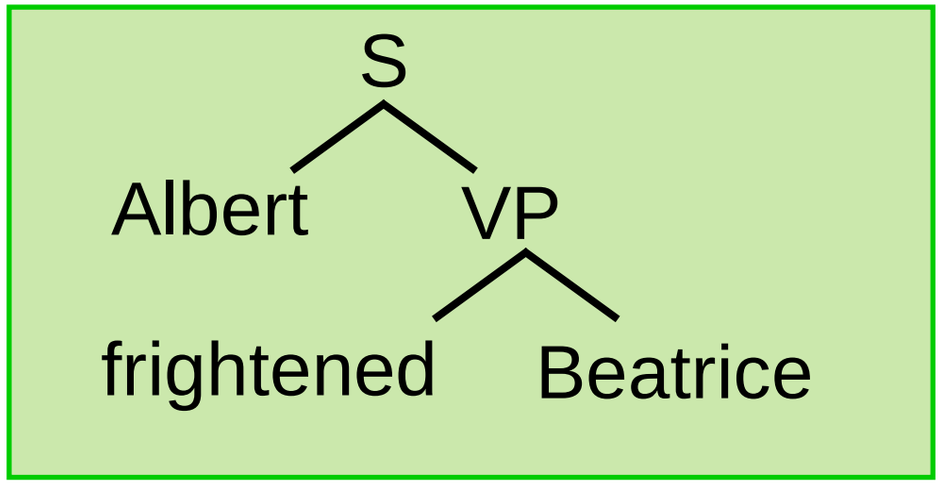
liked, adored, hated,
despised, loved,
dreaded, admired….

experiencer-subject

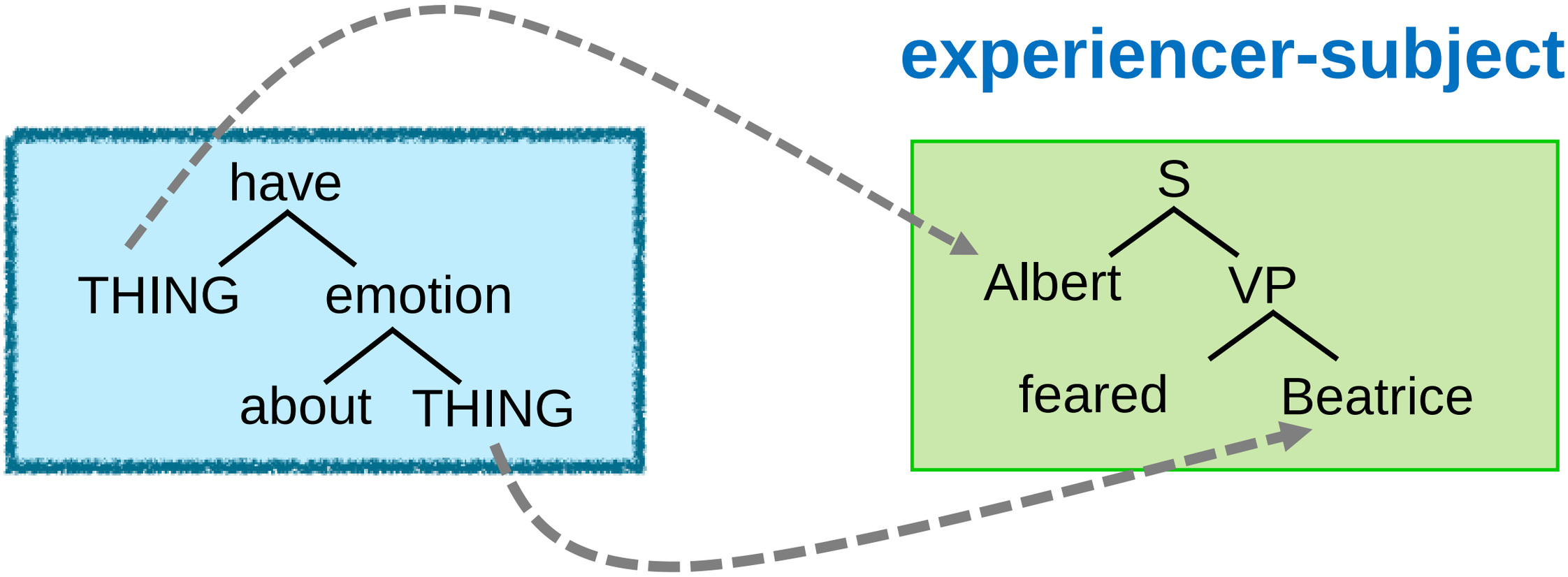


pleased, surprised,
calmed, angered,
impressed, annoyed….

experiencer-object

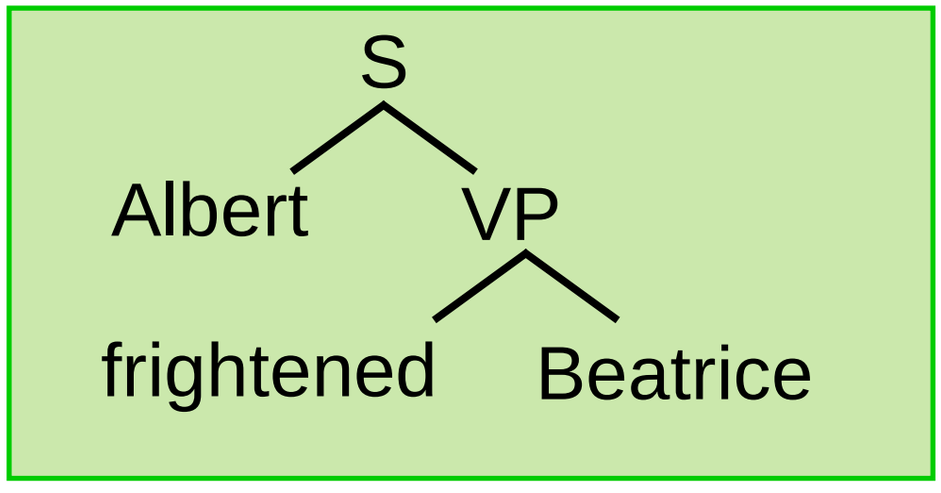


emotion verbs



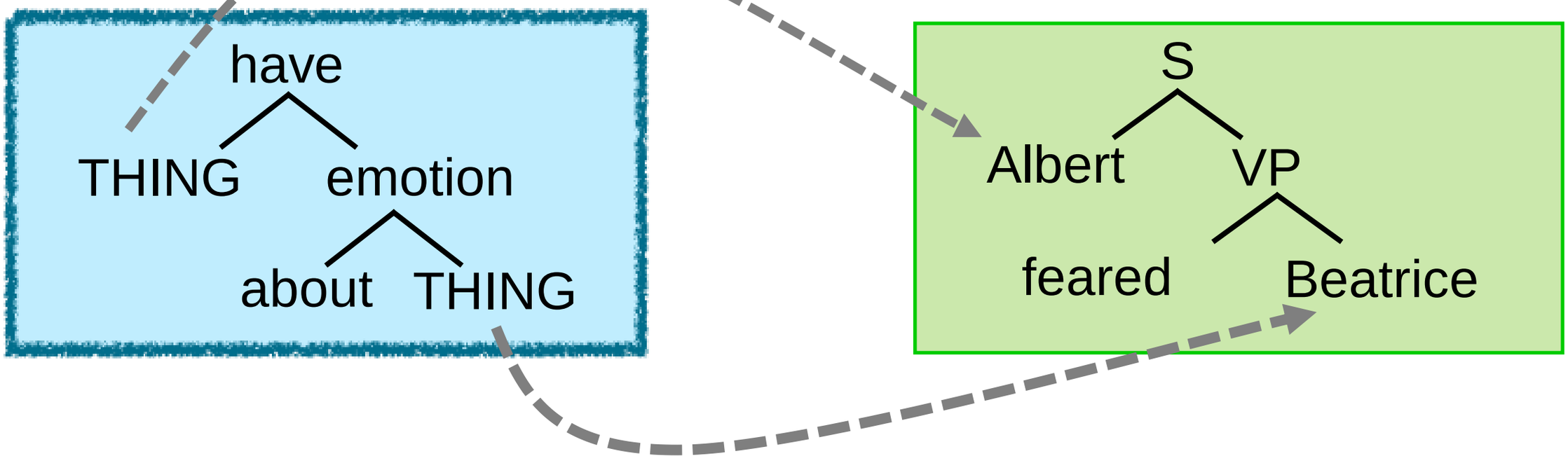
experiencer-subject

experiencer-object

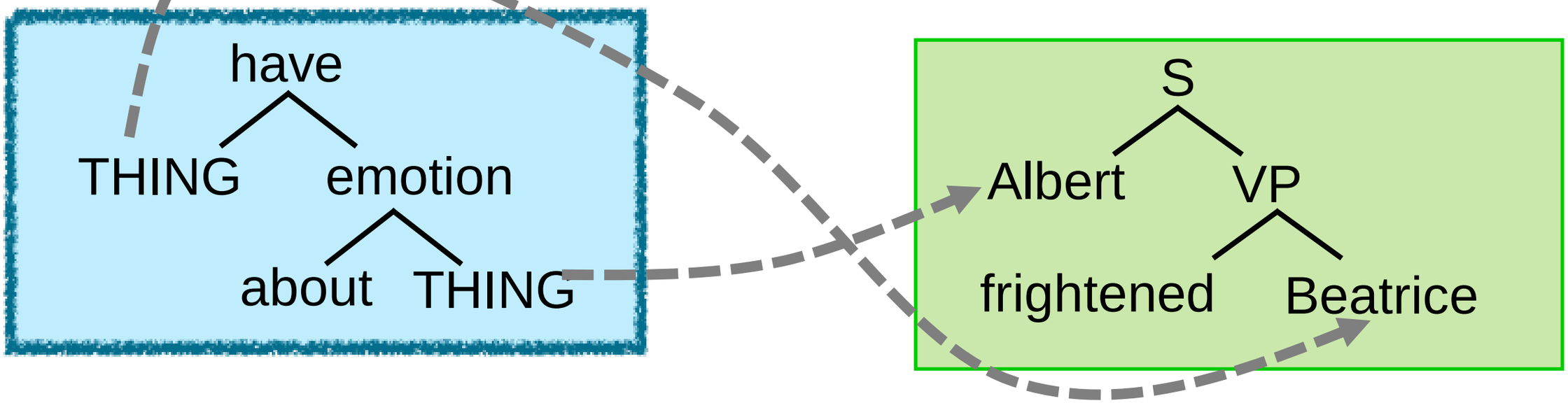


emotion verbs

experiencer-subject

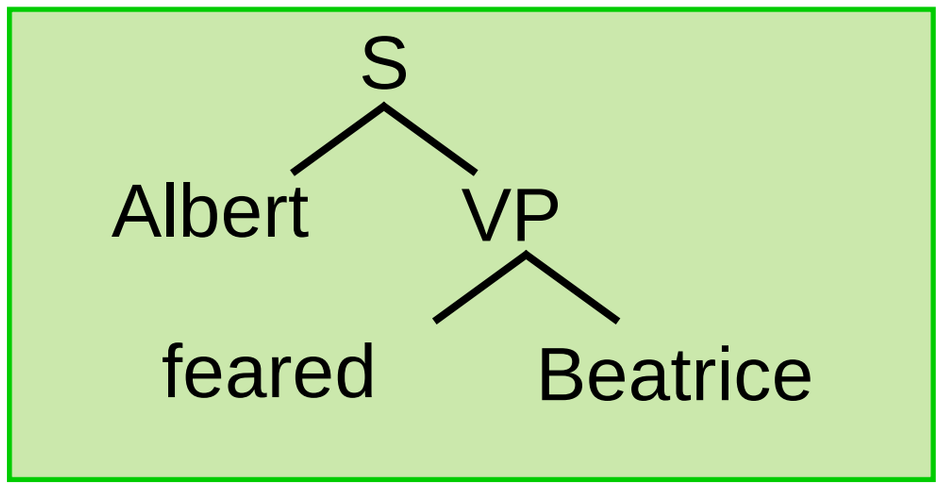


experiencer-object

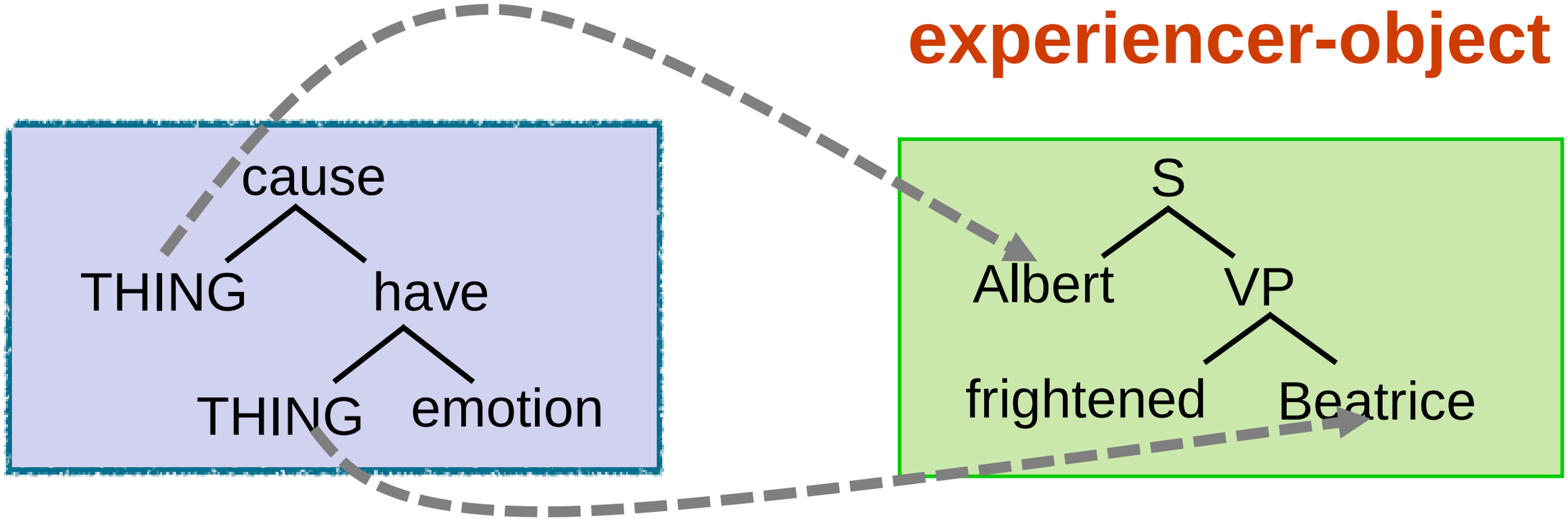


emotion verbs

experiencer-subject

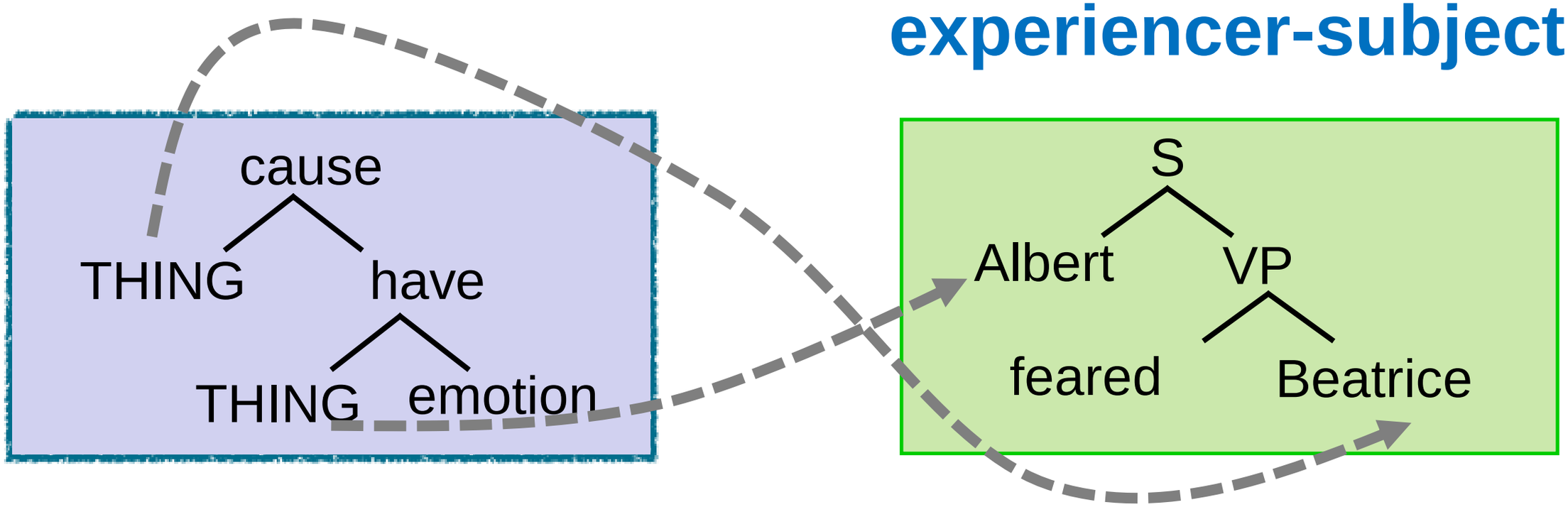


experiencer-object

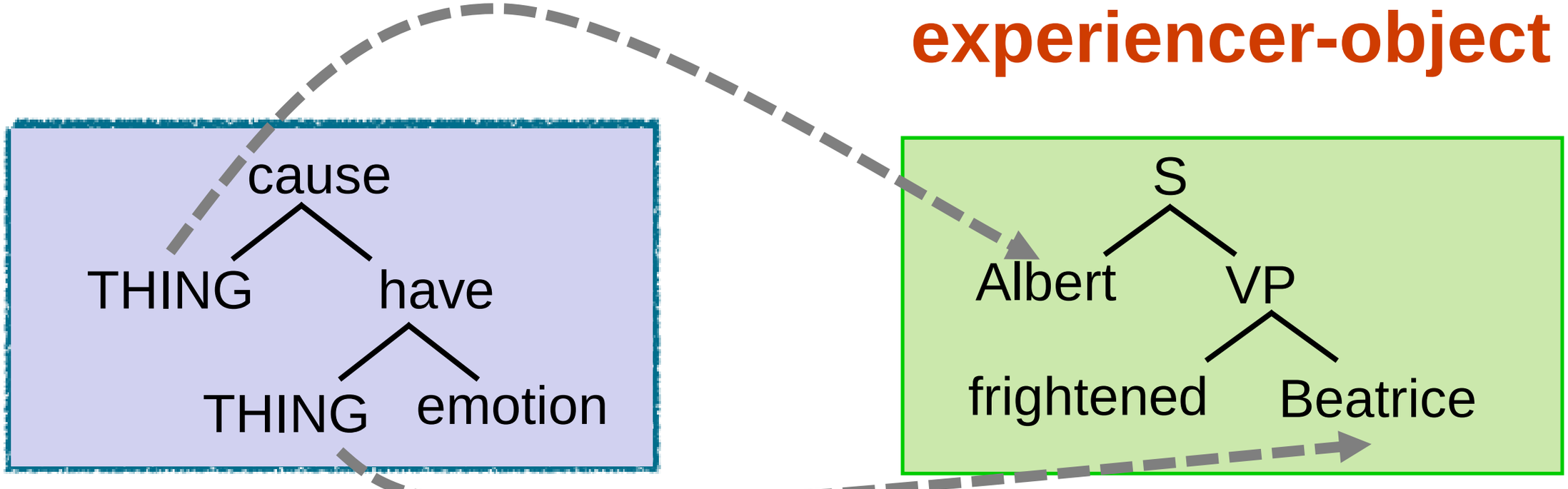


emotion verbs

experiencer-subject

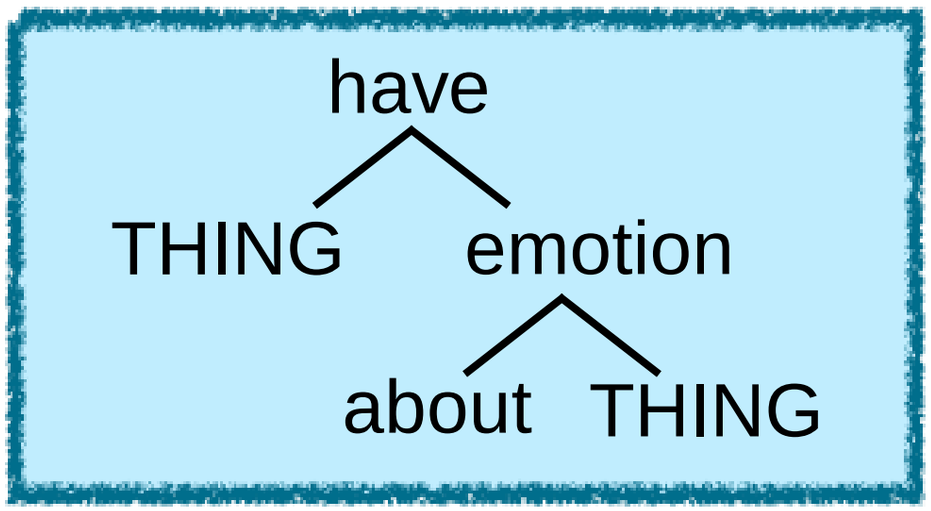


experiencer-object

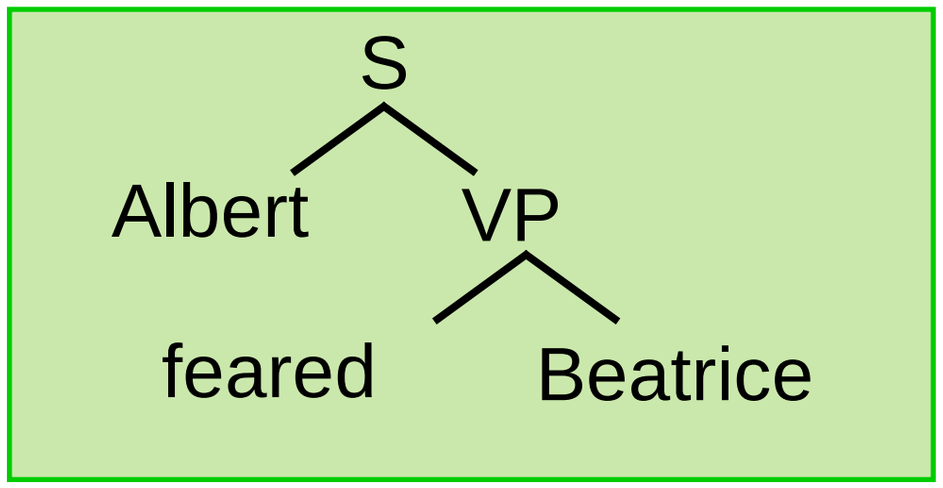


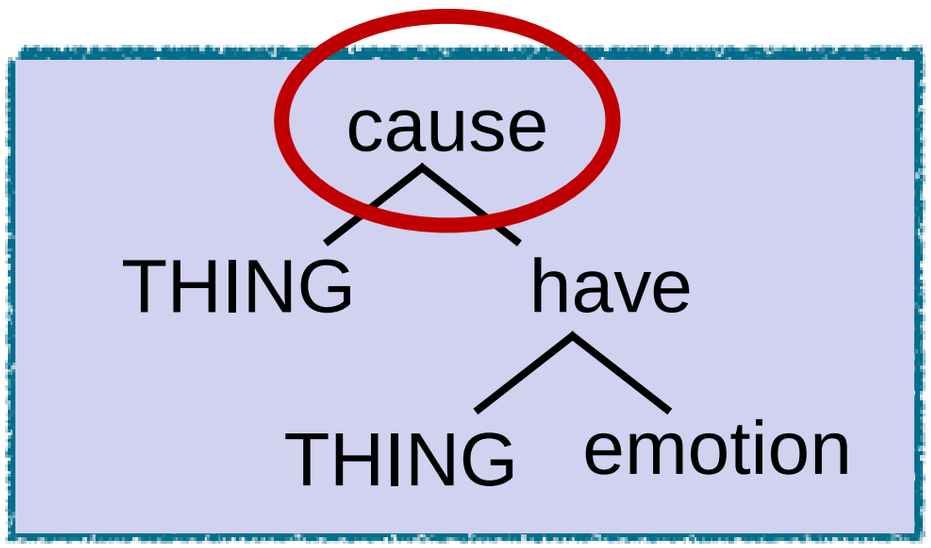
inspired by Pestesky, 1995

emotion verbs

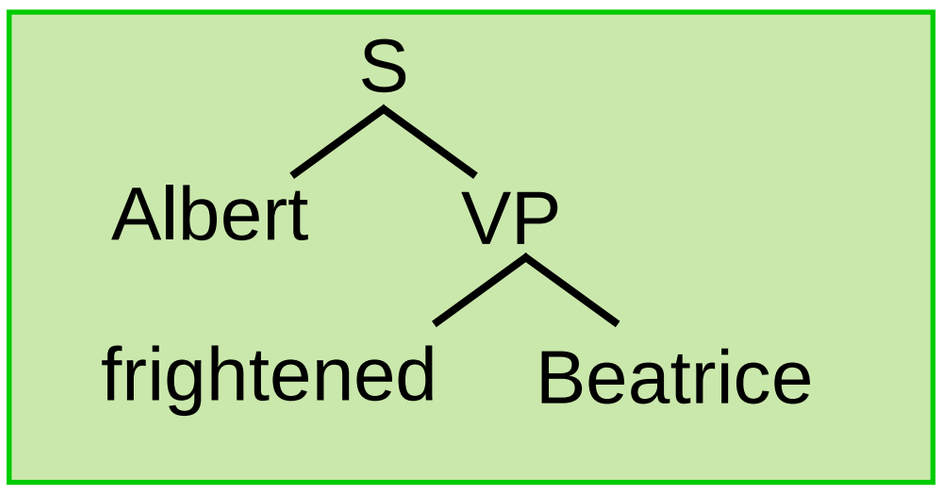


experiencer-subject





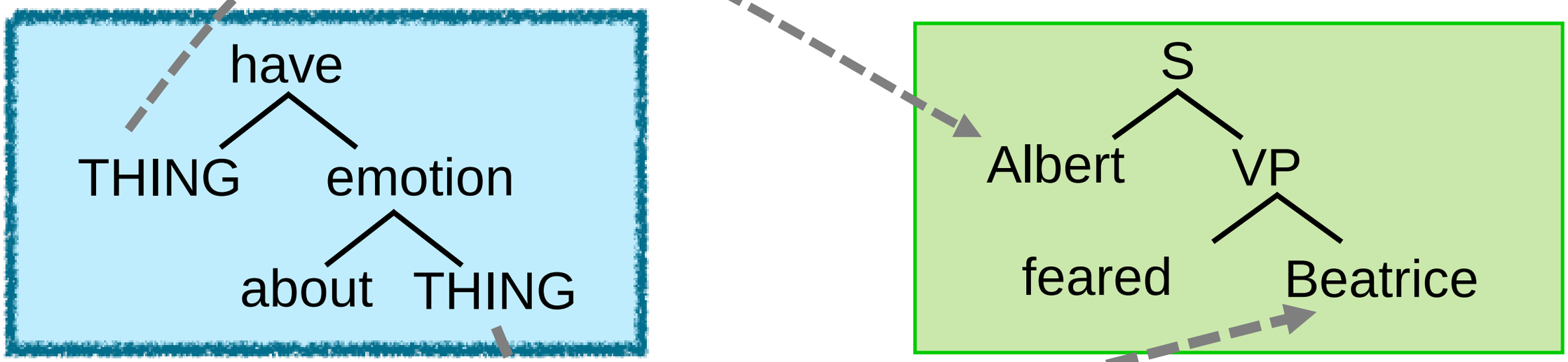
experiencer-object



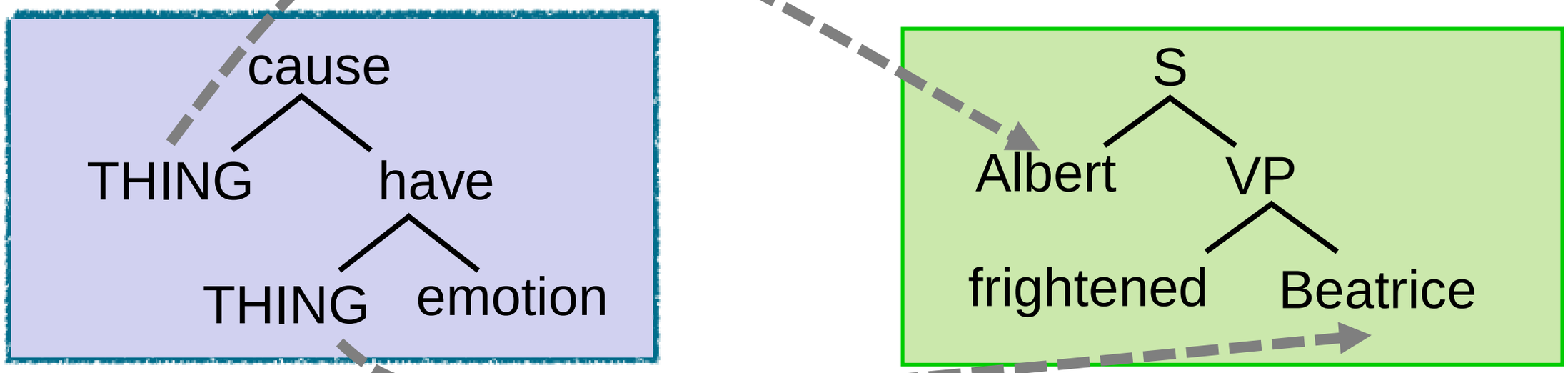
inspired by Pestesky, 1995

emotion verbs

experiencer-subject



experiencer-object



Evidence for two conceptual structures

Joshua Hartshorne
Boston College

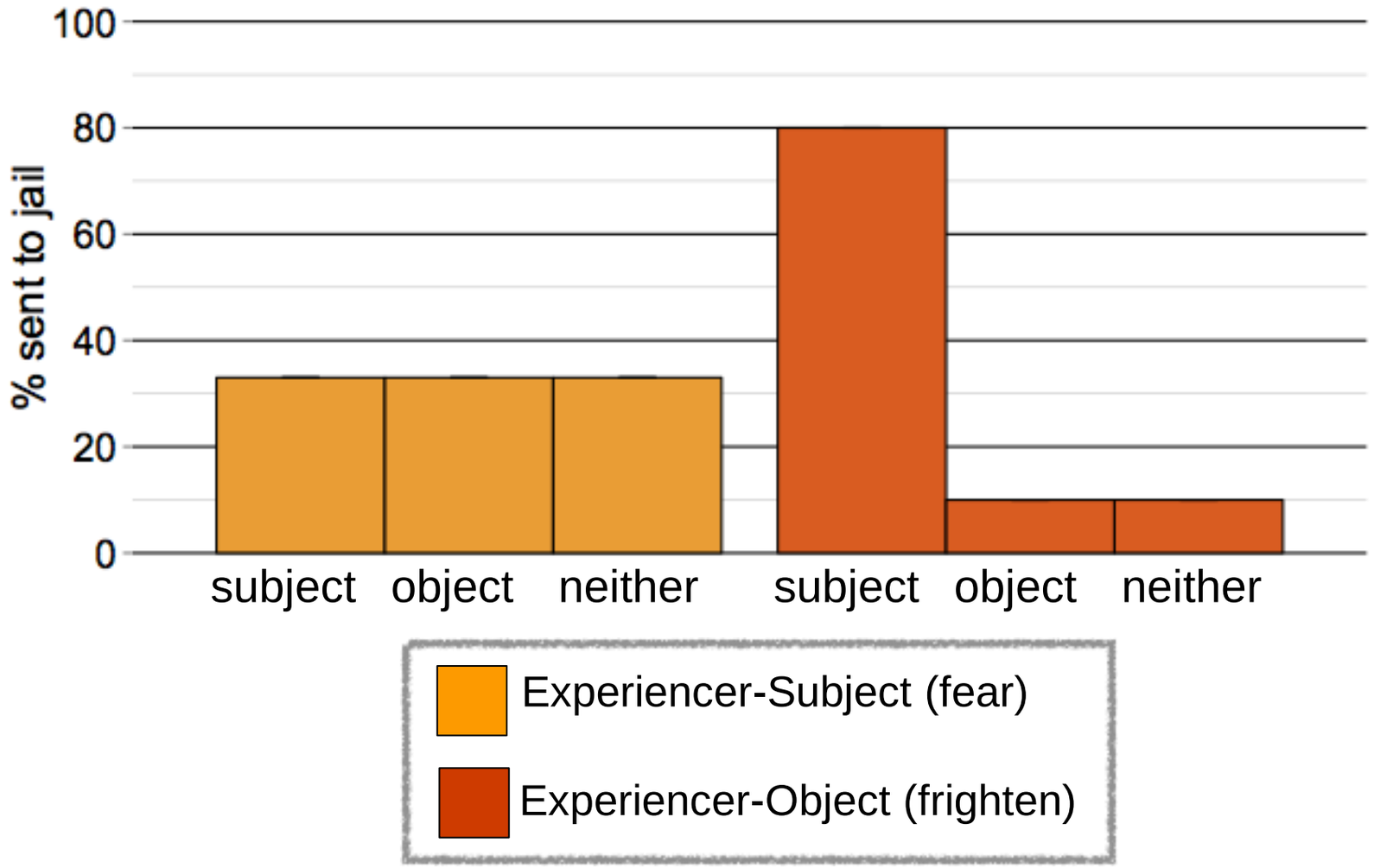
Hartshorne, O'Donnell, Sudo, Uruwashi, Lee & Snedeker

Causal differences in real verbs

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

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

Predicted Results



Causal differences in real verbs

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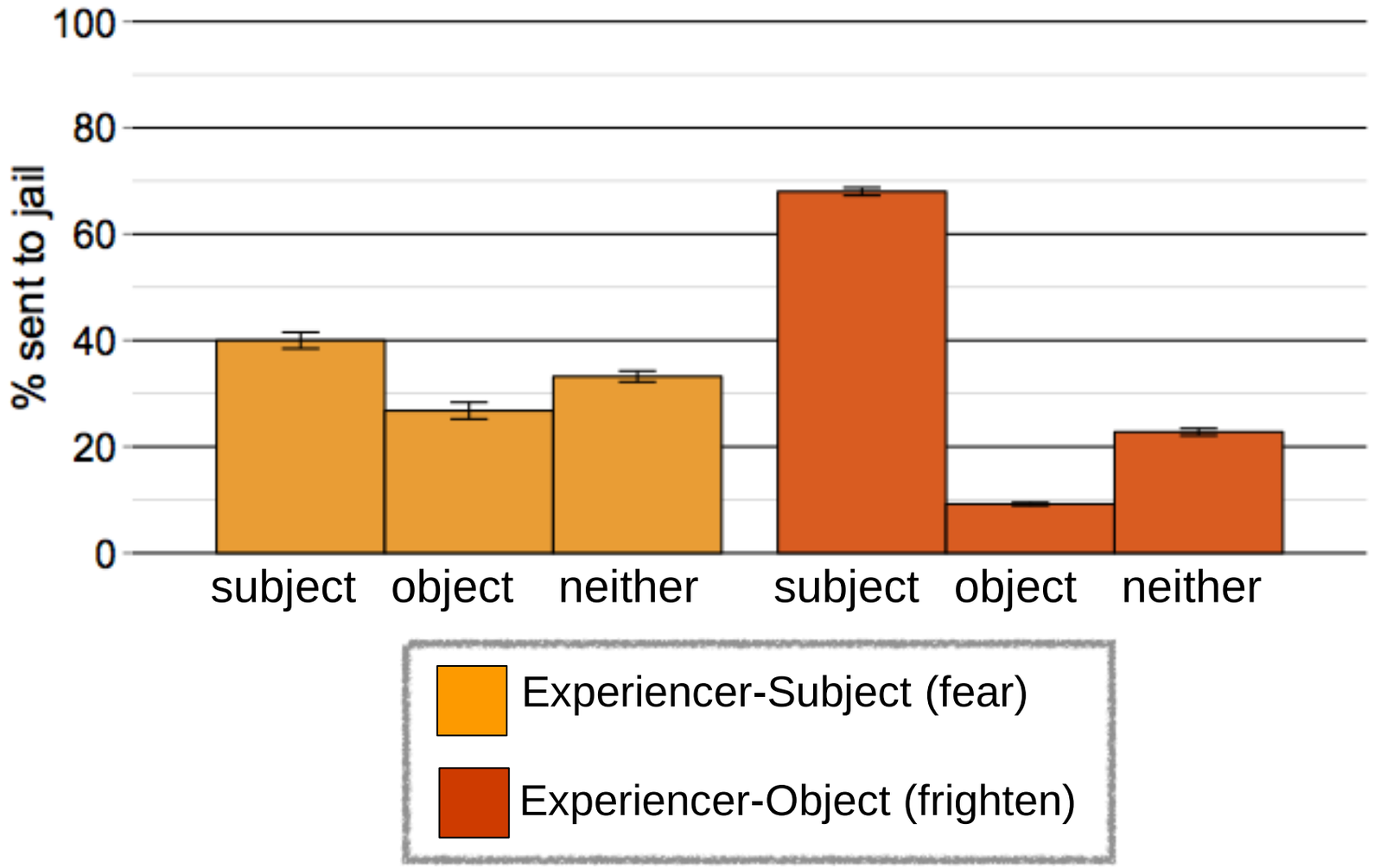
Observed Results

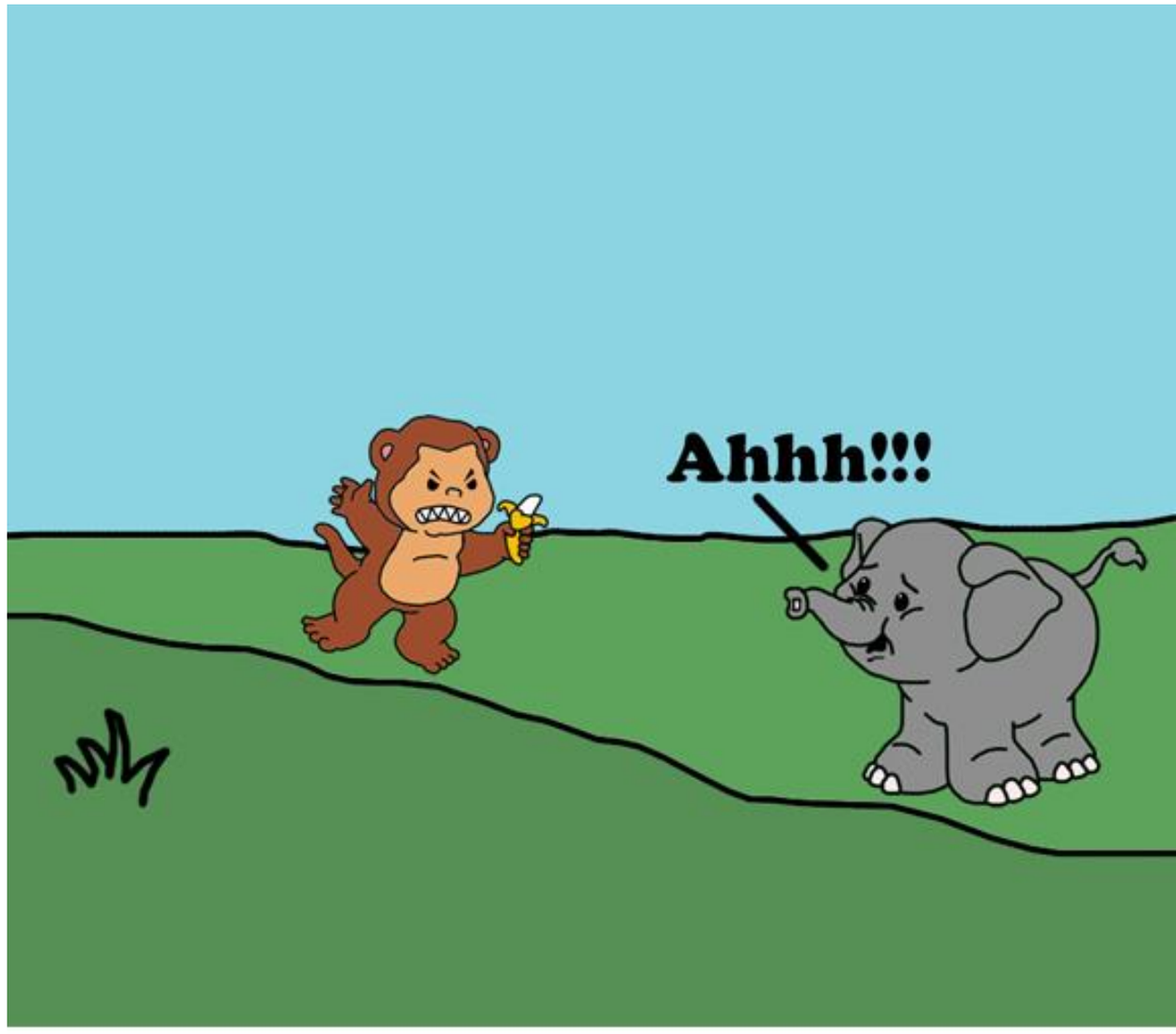


When does this knowledge develop?

- 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

Argument realization for known verbs

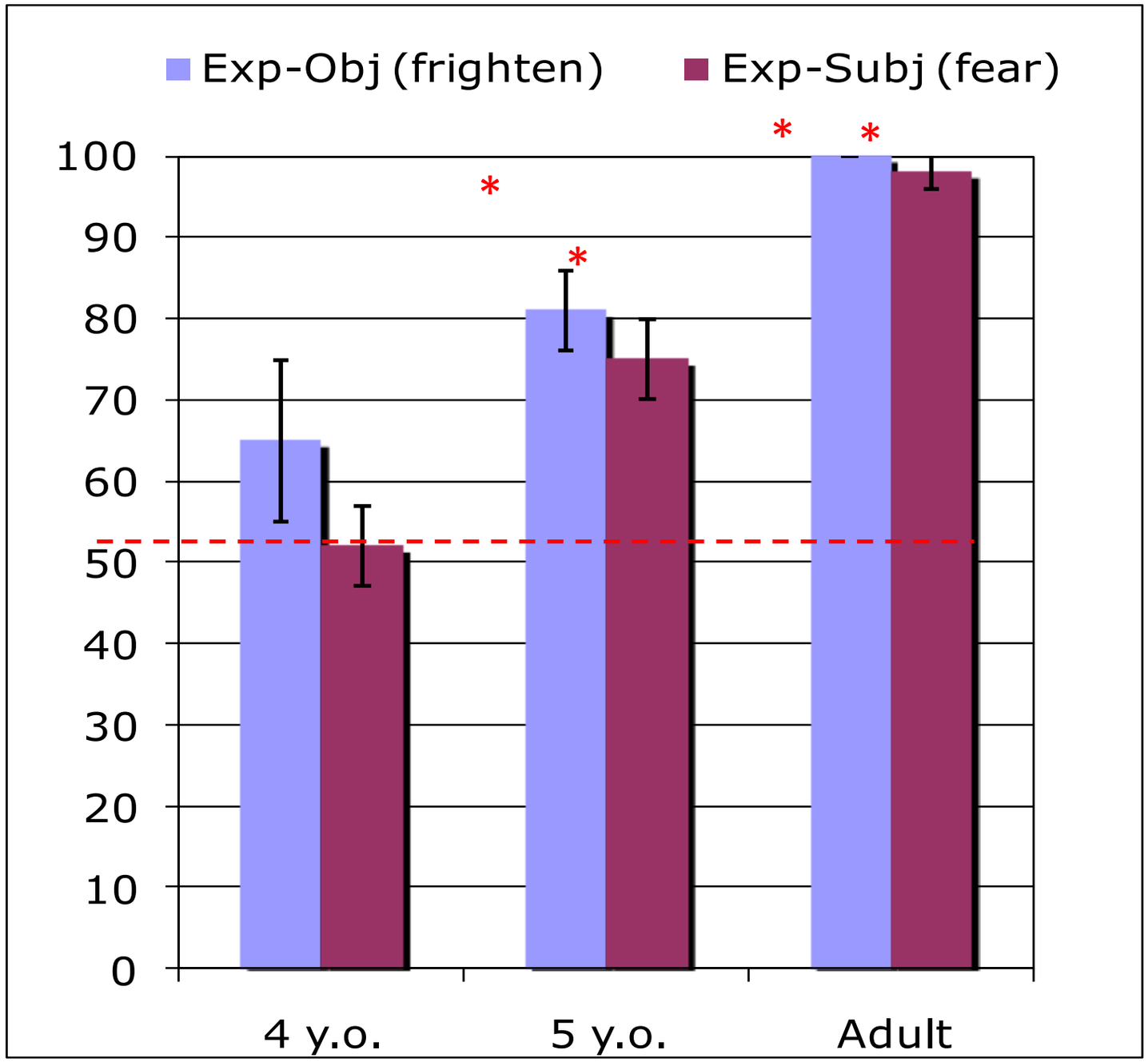
See Monkey? Monkey is walking along. Then he sees Lion. Monkey screams and runs away. Monkey hides from Lion.



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



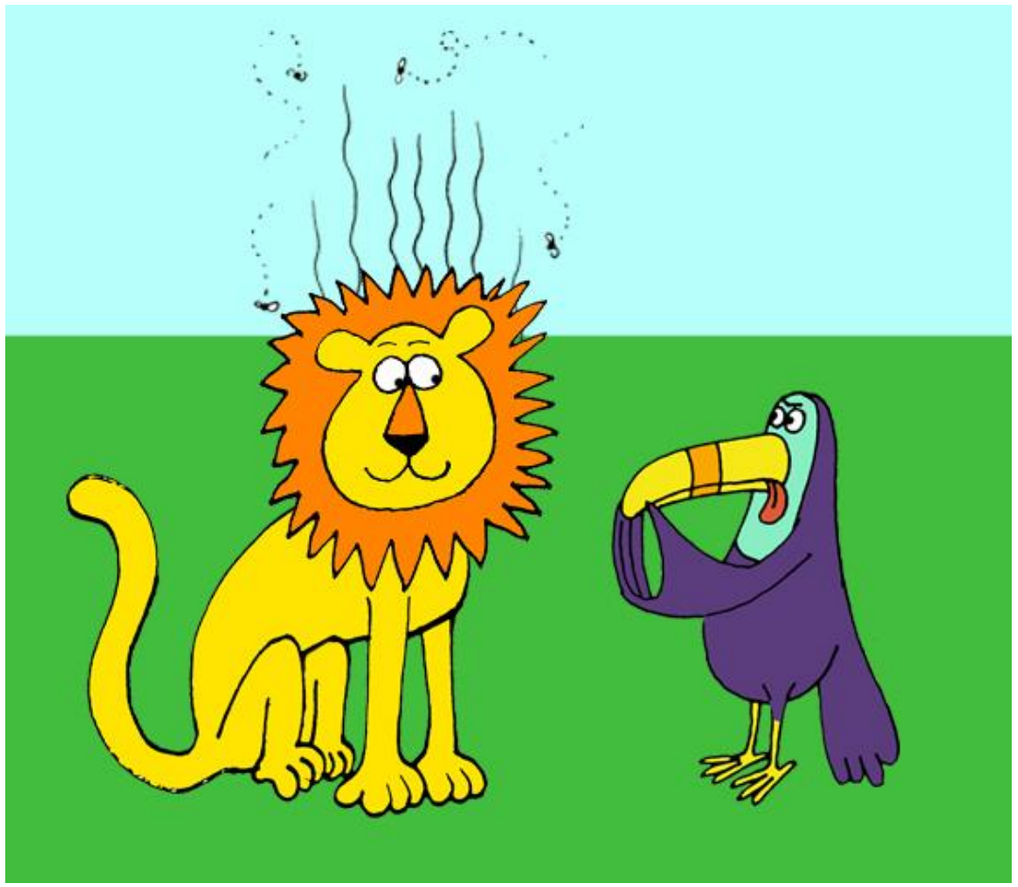
Hartshorne, Pogue & Snedeker (in press)

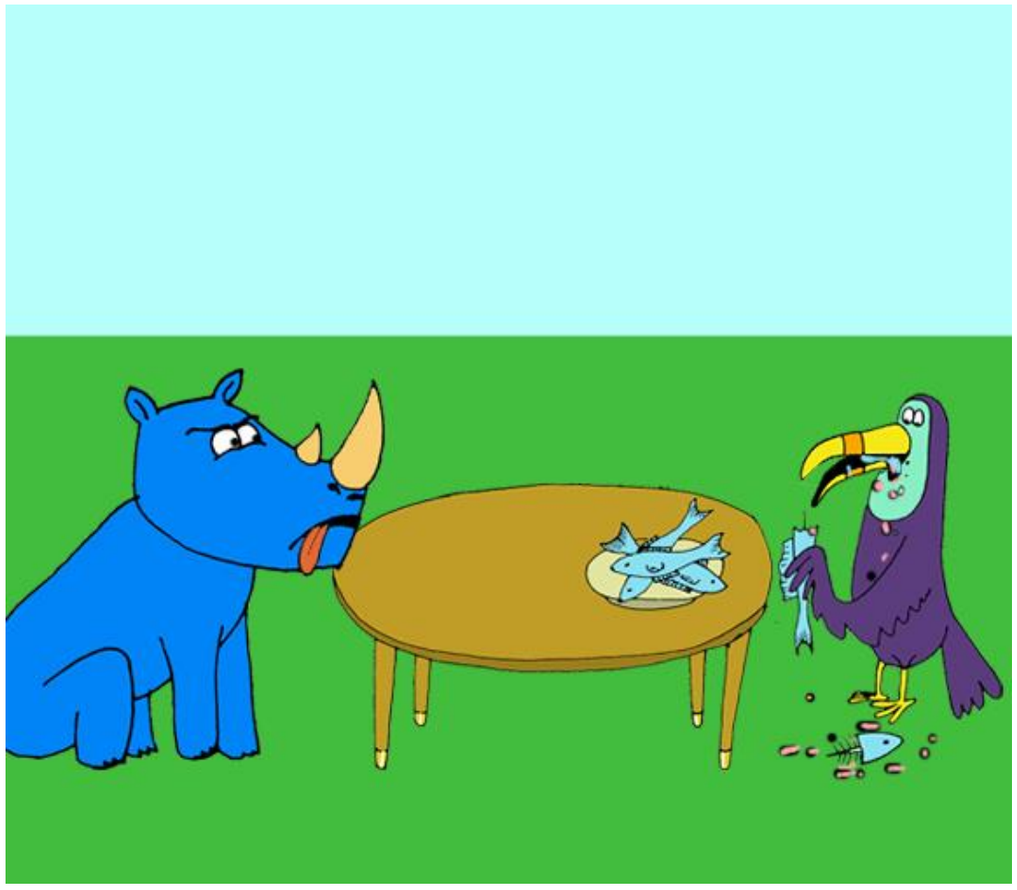
Can children generalize these patterns to novel verbs?

Non-causal emotion (envy):

Who does Bear wixter?

Can children generalize these patterns to novel verbs?

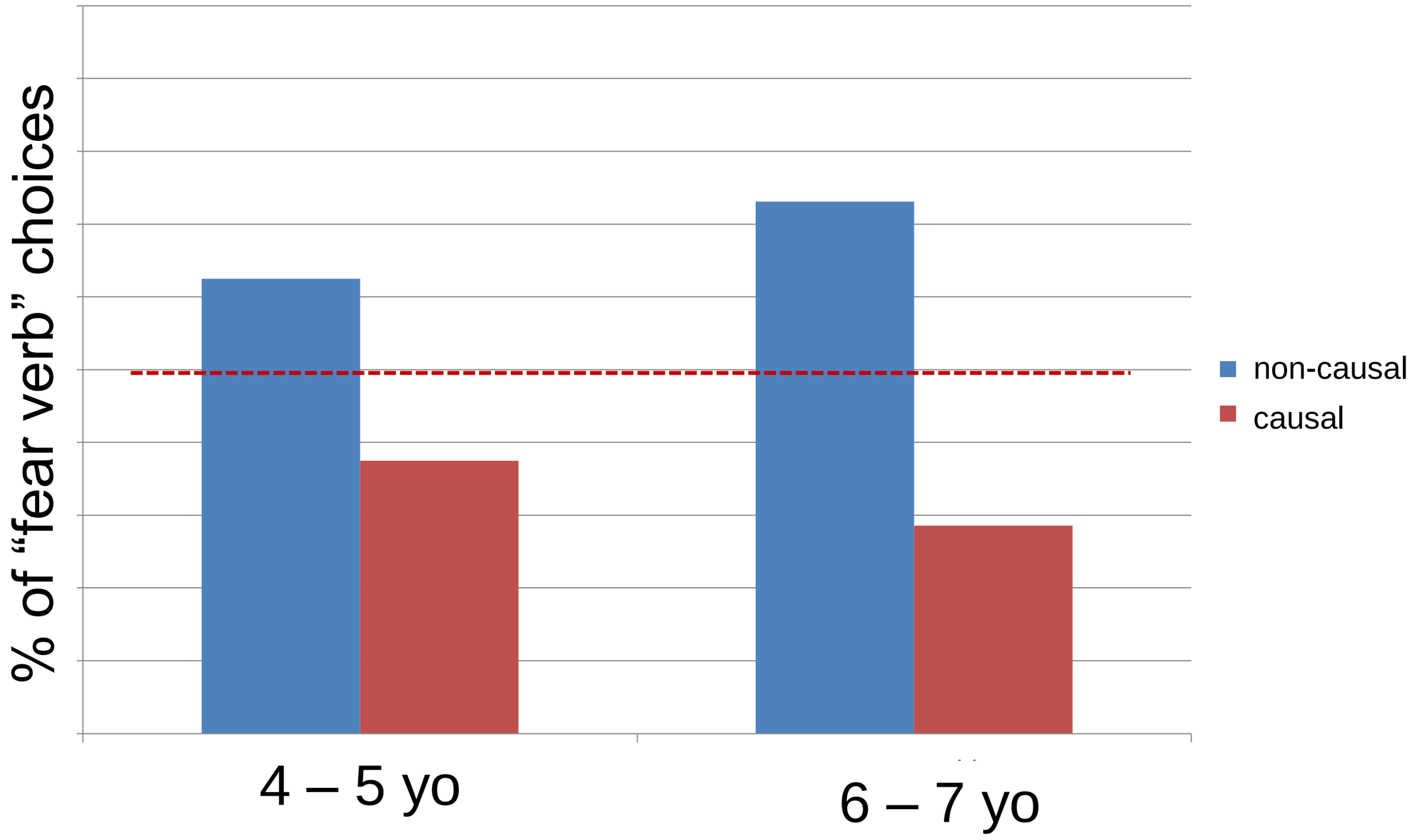




Causal emotion (disgust):

Who does Bird gorphin?

Kids use different mappings for causal and non-causal psych verbs



2. Evidence for the psychological reality of event primitives

Amy Geojo
Harvard

Carissa Shafto
Louisville

Catherine Havasi
MIT Media Lab

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

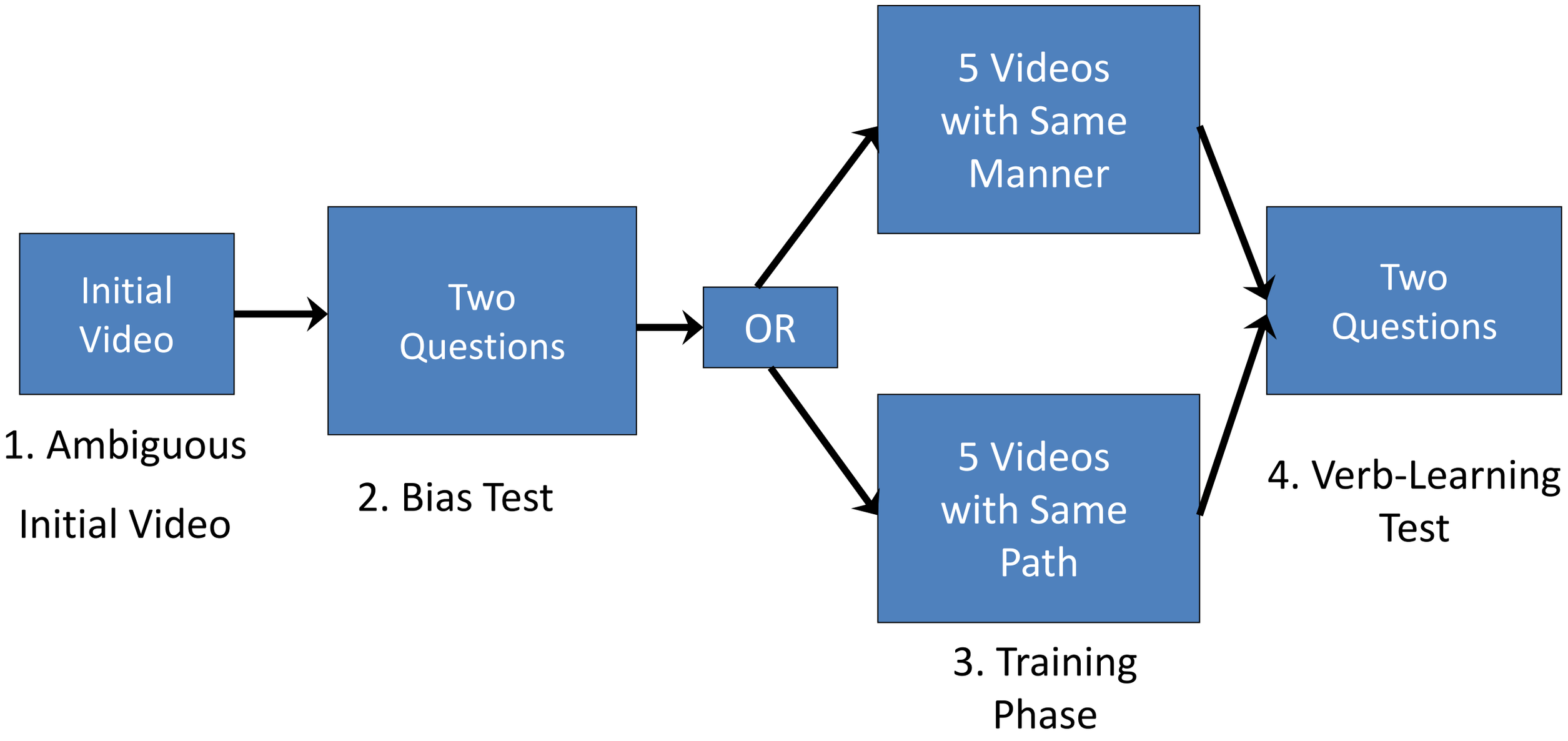
Slobin, 1997; Naigles, et al., 1998; Gentner & Boroditsky, 2001; Goksun, Golinkoff & Hirsh Pasek, 2010 ; Papafragou & Selmis, 2010

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



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

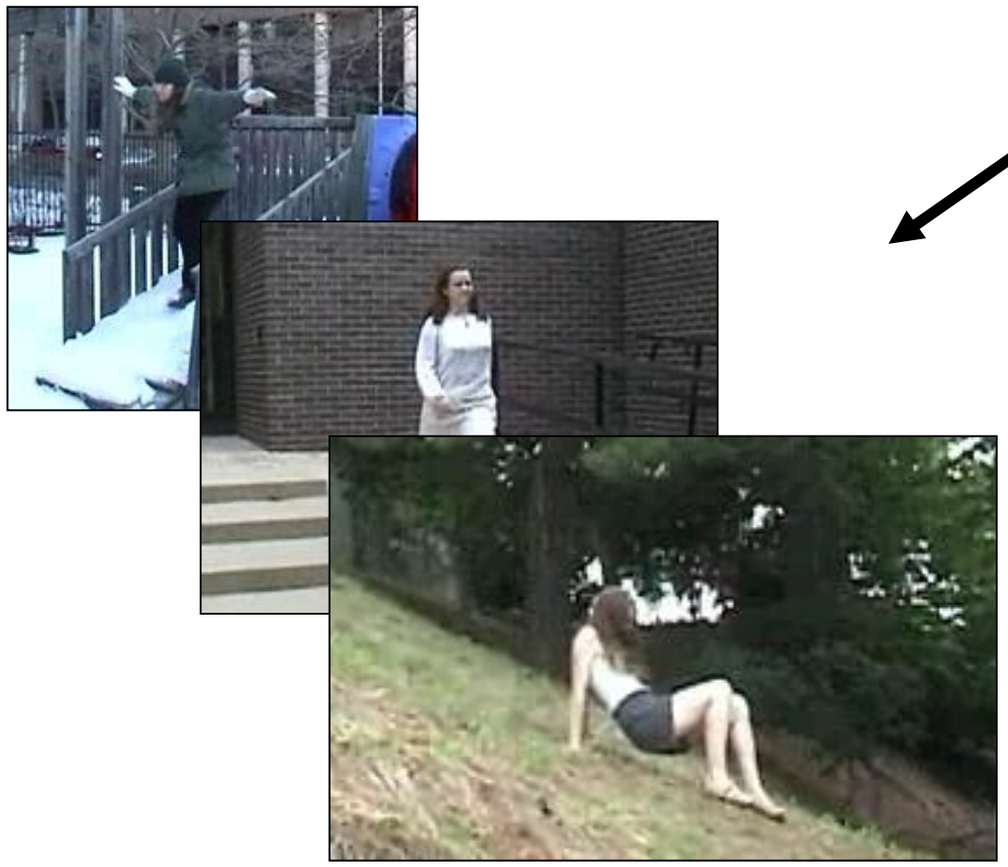
Manner: stoop-walk

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

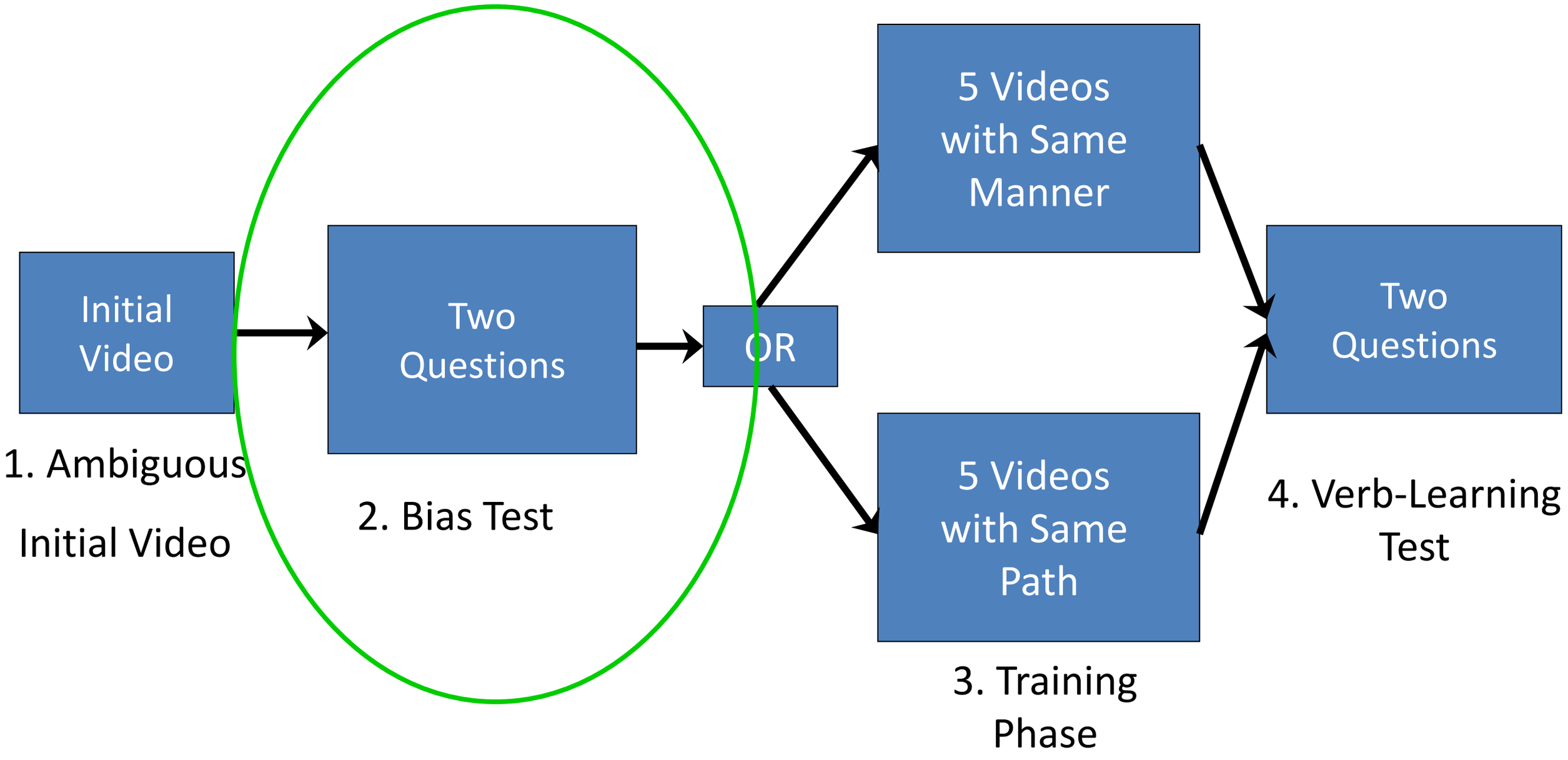
"Is this glipping?"

Manner Match

Manner: stoop-walk

Path: out

Trial Structure



Repeat for each verb (6-16)

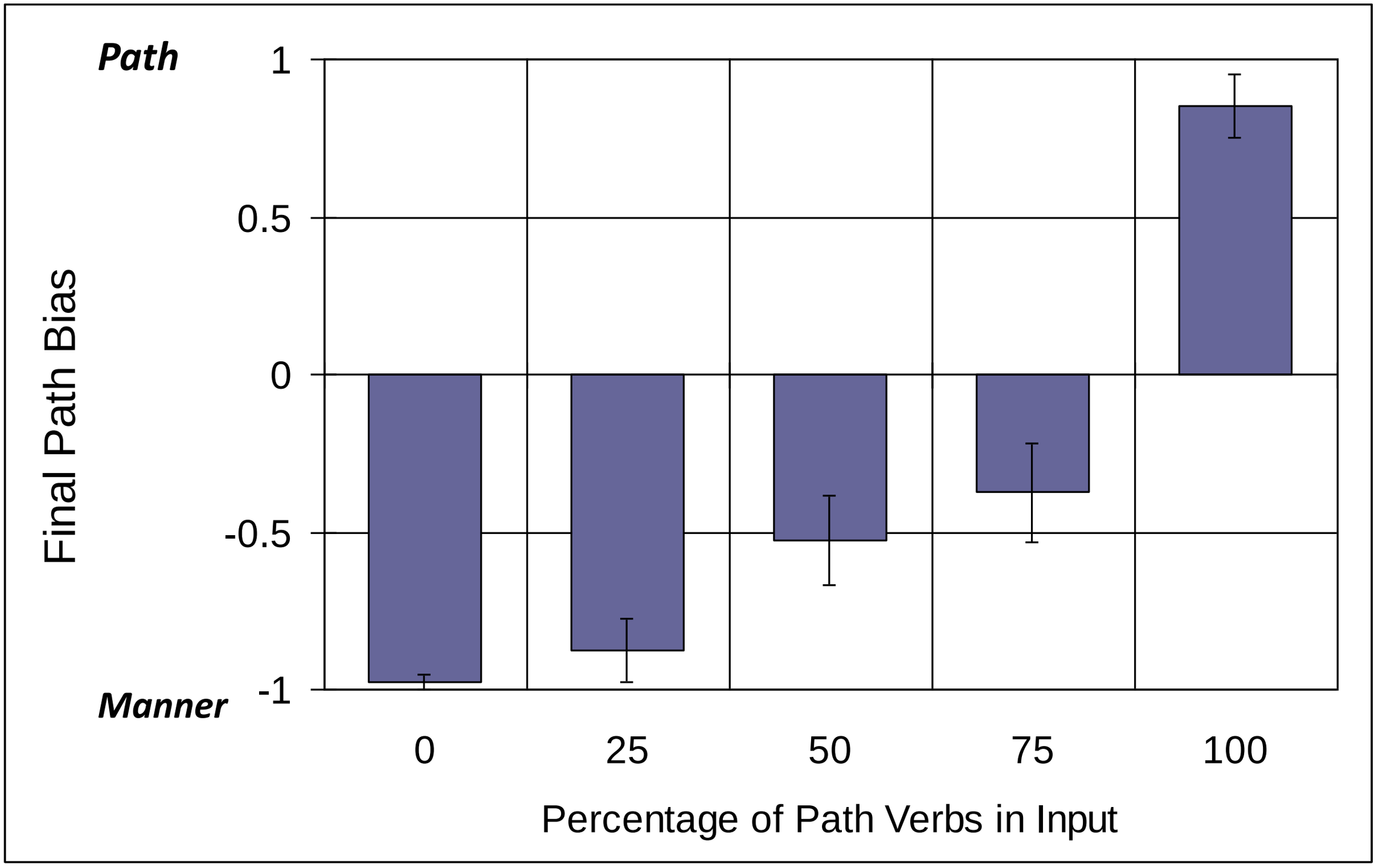
Shafto, Havasi & Snedeker (2012)

Adult English speakers

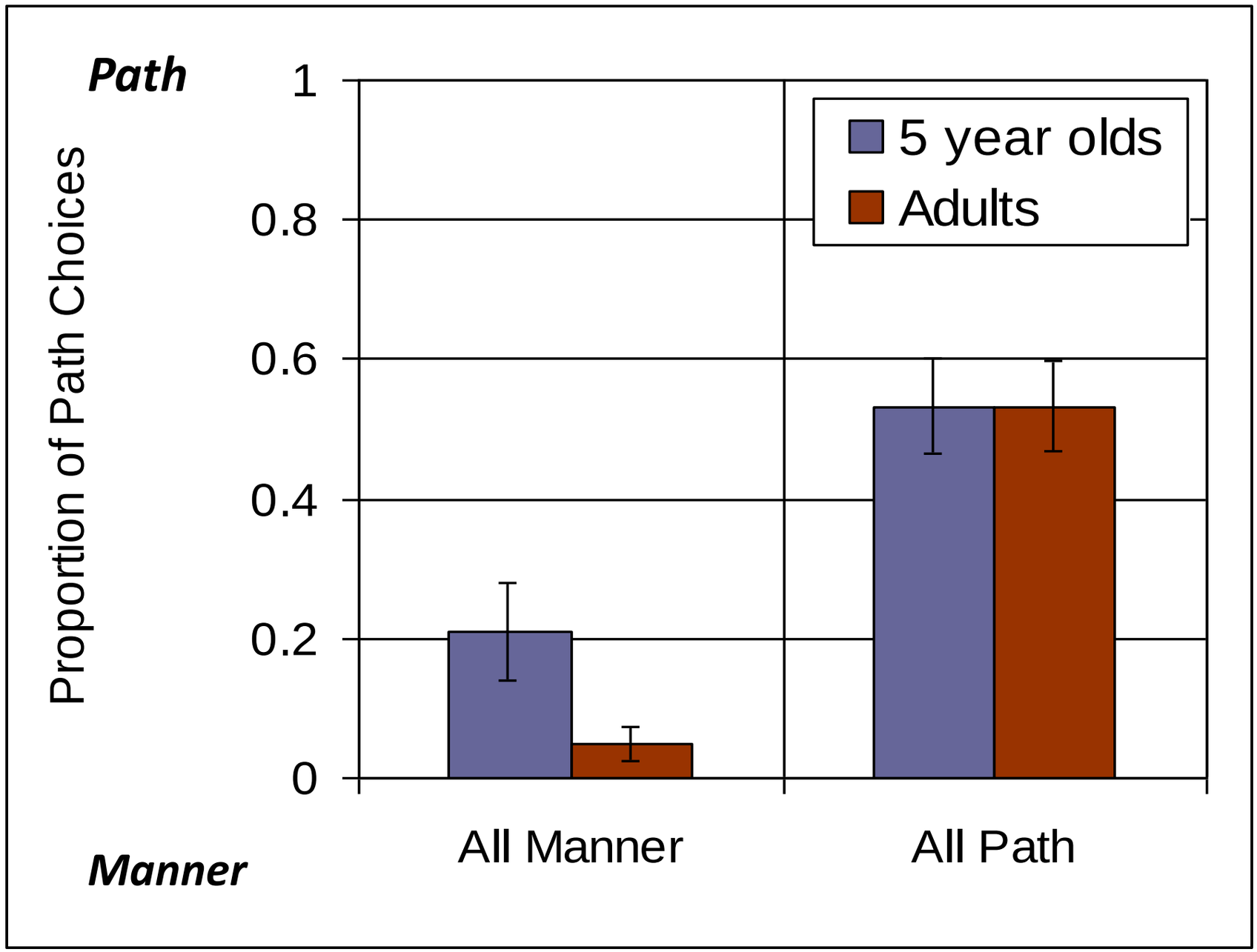
Conditions

- 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

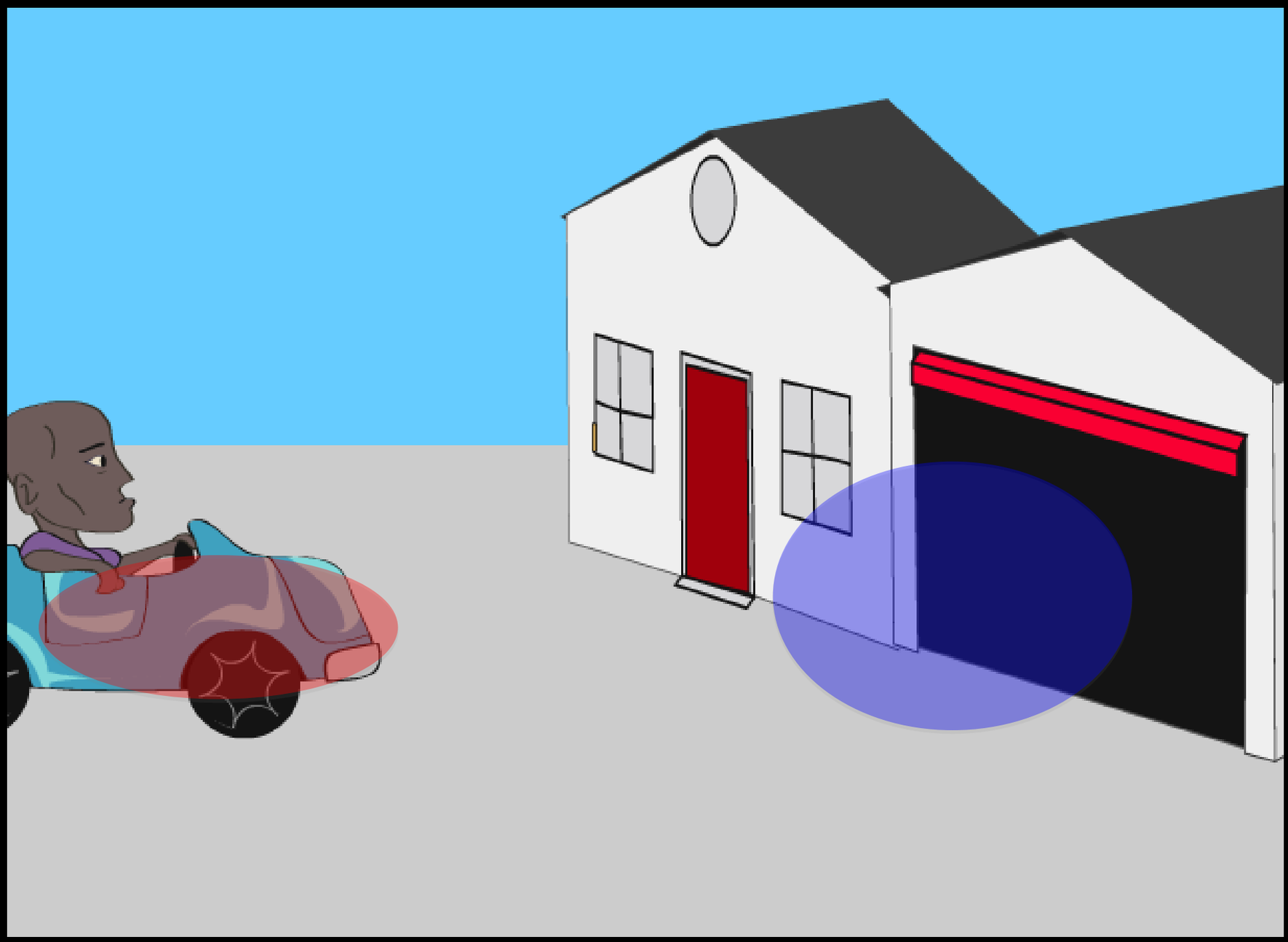


Children's Bias Shaped by Verb Learning



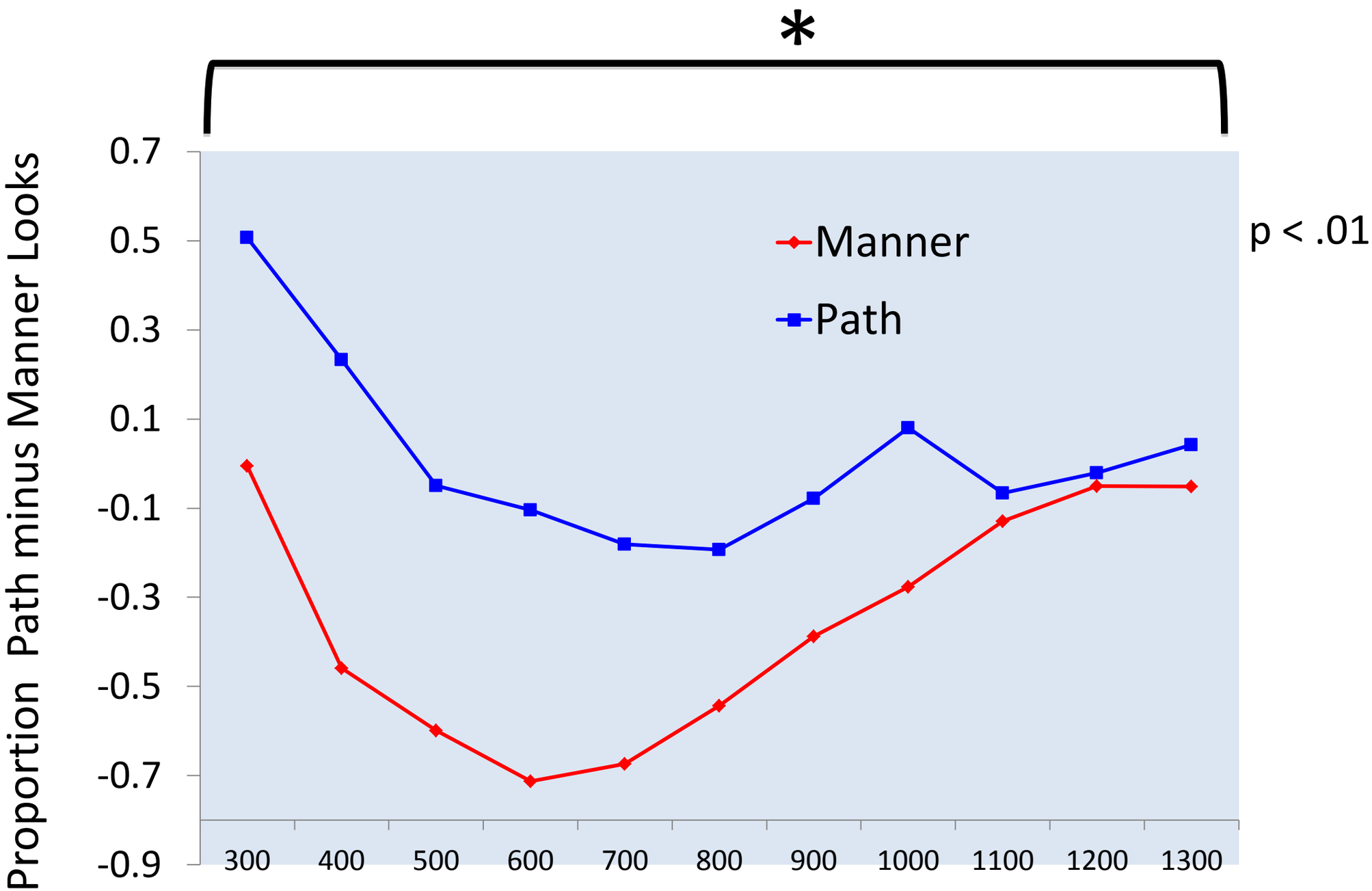
Bias Learning affects attention during initial encoding

Geojo & Snedeker, submitted



The man is krading into the garage

Experience rapidly shapes attention to new events



Trials 3-10

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) manner → [x ACT<*MANNER*>]
(e.g., *jog, run, creak, whistle, . . .*)

(8) instrument → [x ACT<*INSTRUMENT*>]
(e.g., *brush, hammer, saw, shovel, . . .*)

(9) container → [x CAUSE [y BECOME AT <*CONTAINER*>]]
(e.g., *bag, box, cage, crate, garage, pocket, . . .*)

(10) internally caused state → [x <*STATE*>]
(e.g., *bloom, blossom, decay, flower, rot, rust, sprout, . . .*)

(11) externally caused, i.e. result, state →
[[x ACT] CAUSE [y BECOME <*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 ???

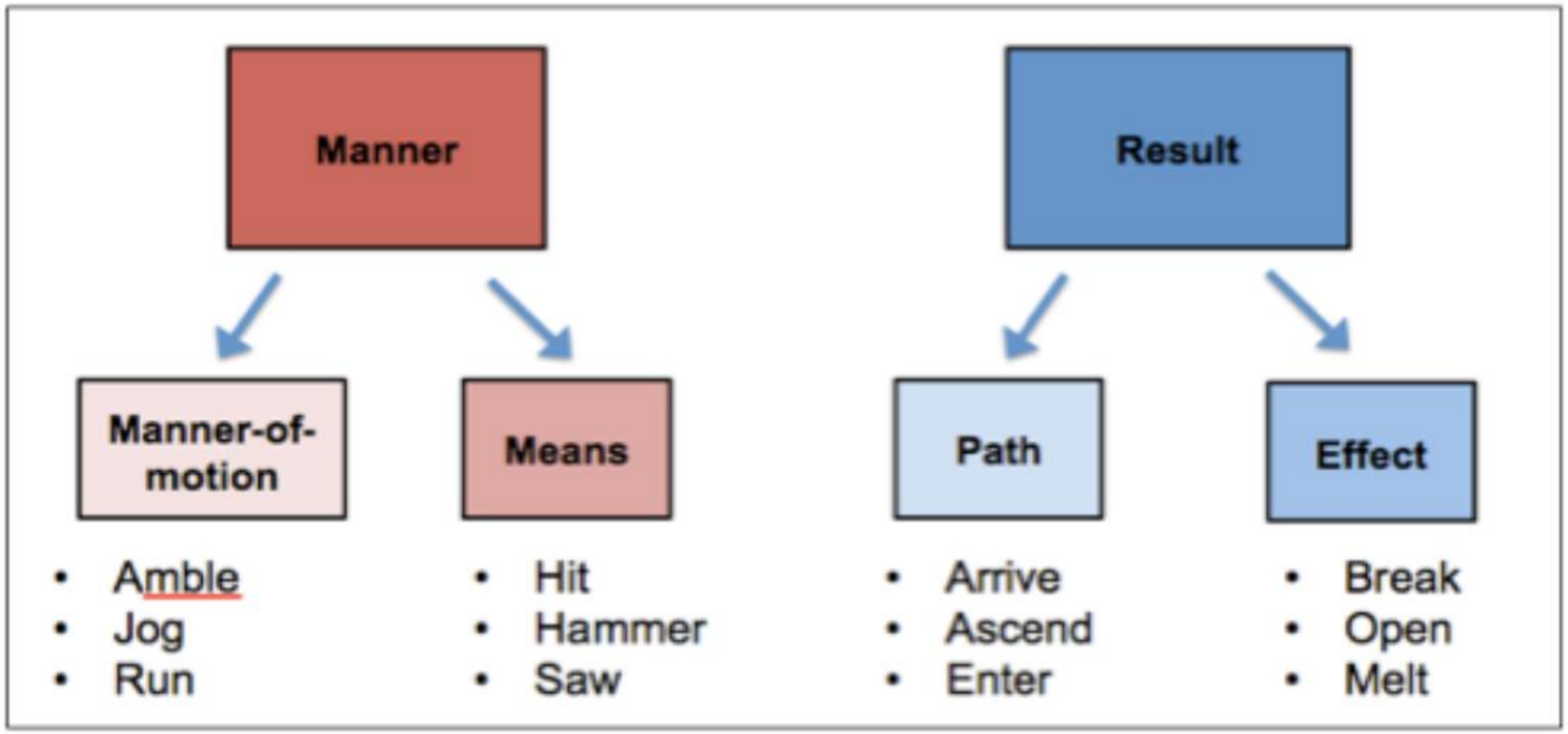
The distinction cuts across semantic fields

Semantic Field	Manner Verb	Result Verbs
Verbs of Damaging	hit	break
Verbs of Putting	pour	fill
Verbs of Removal	shovel	empty
Verbs of Combining	shake	combine
Verbs of Killing	stab	kill

Is the manner / result distinction psychologically salient ?

Is it available to individual word learners or is it emergent property of language use and transmission?

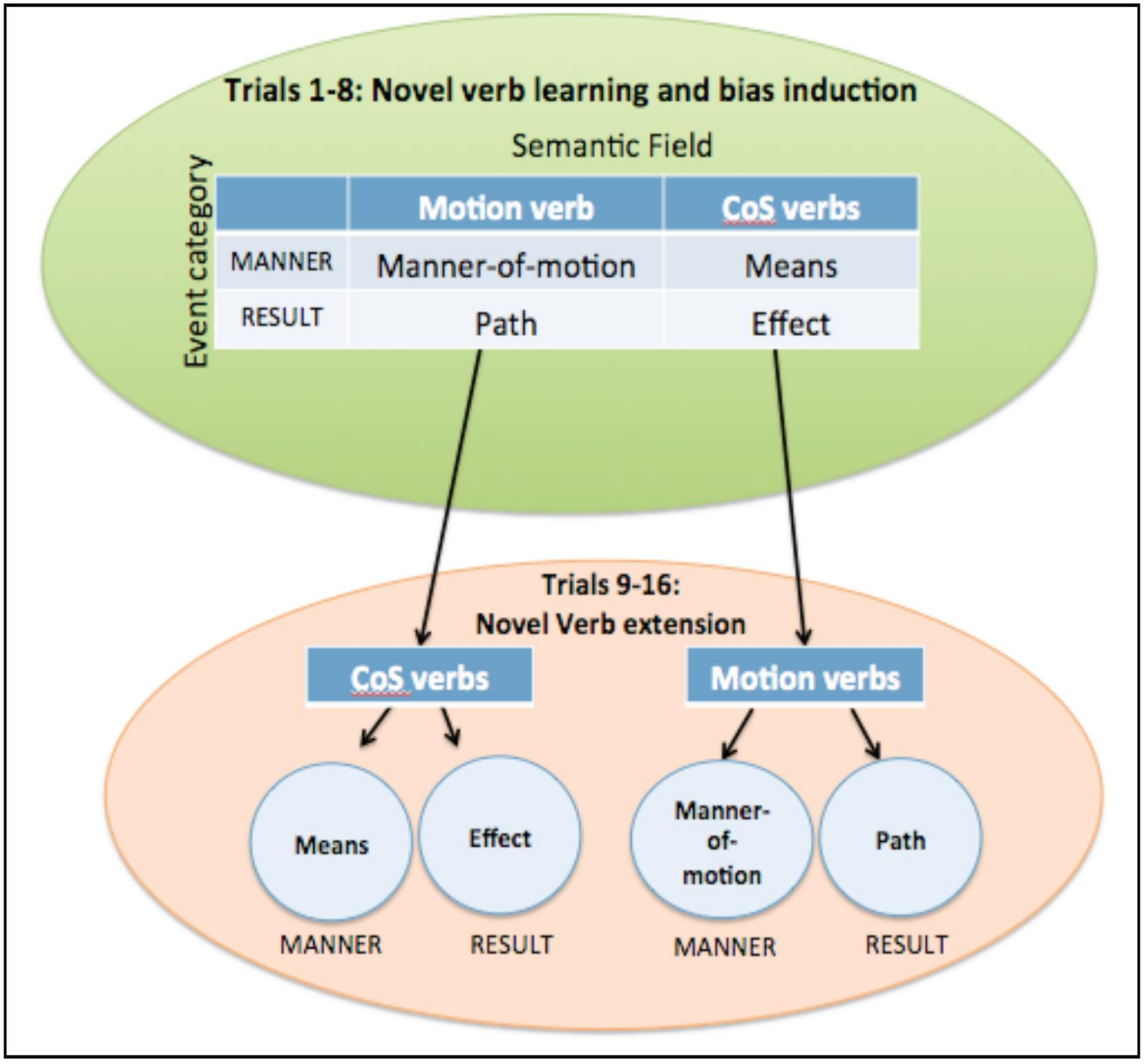
What is the scope of lexicalization biases?



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

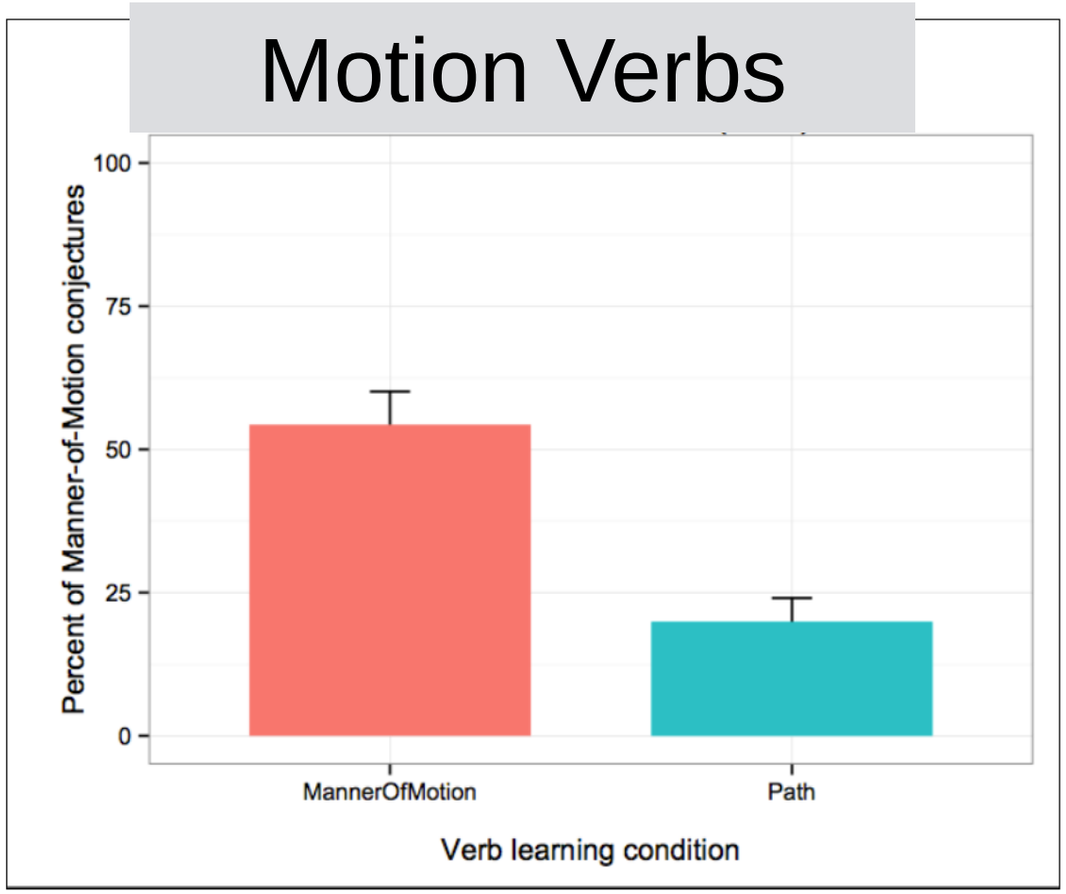
Geojo & Snedeker (in prep)

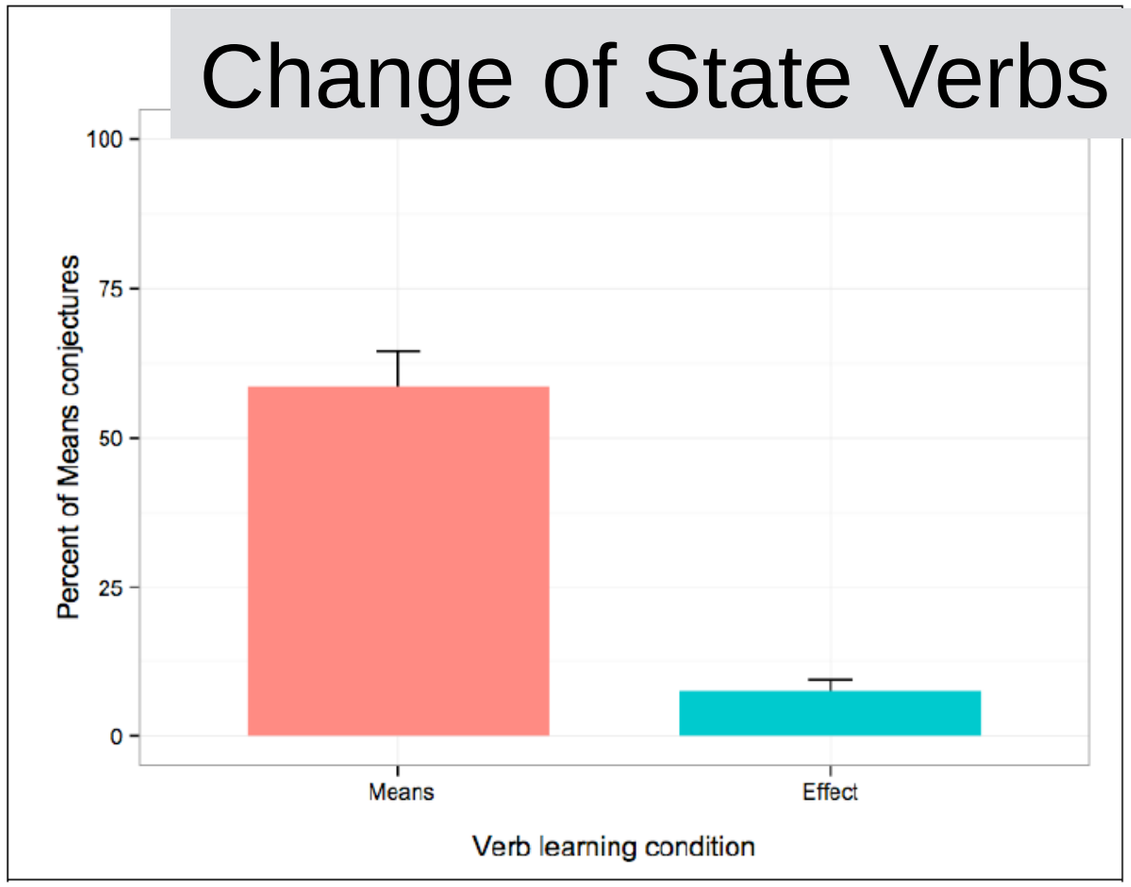
Two Phases



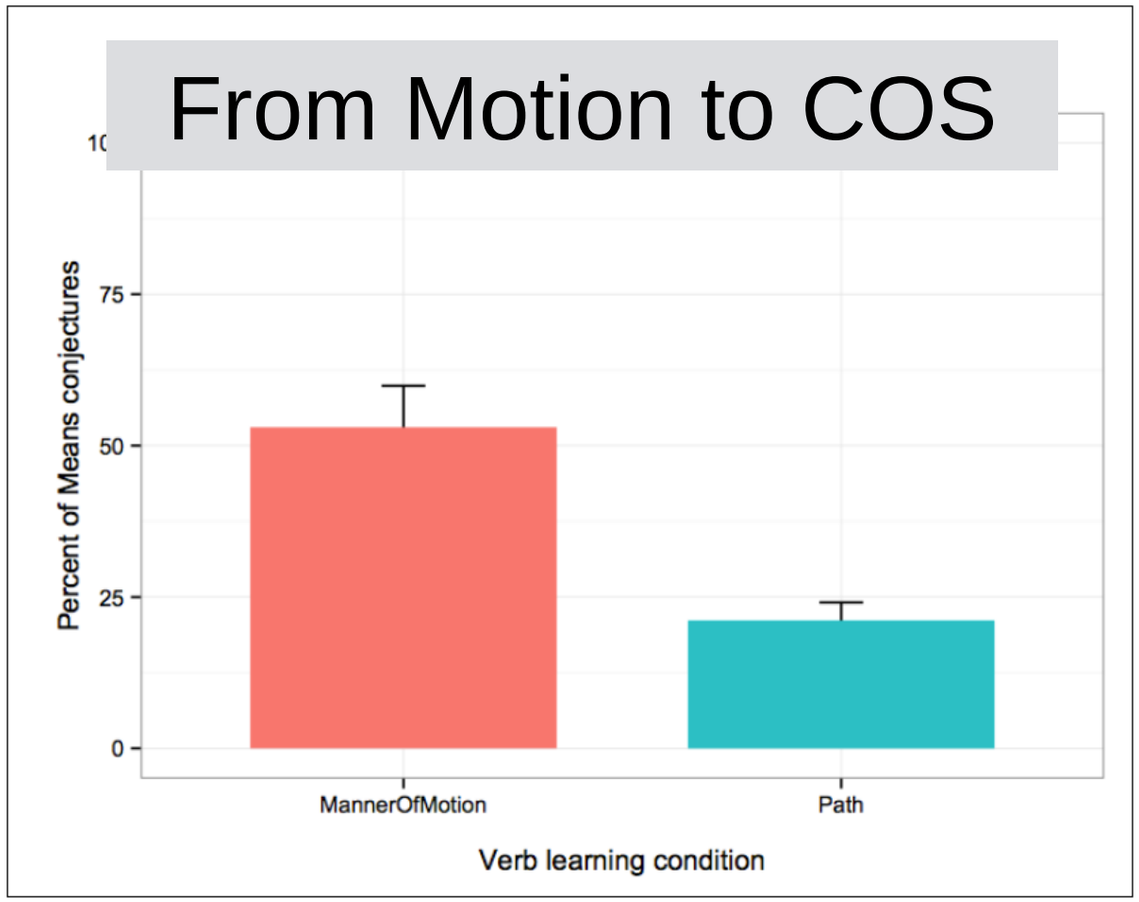
Geojo & Snedeker (in prep)

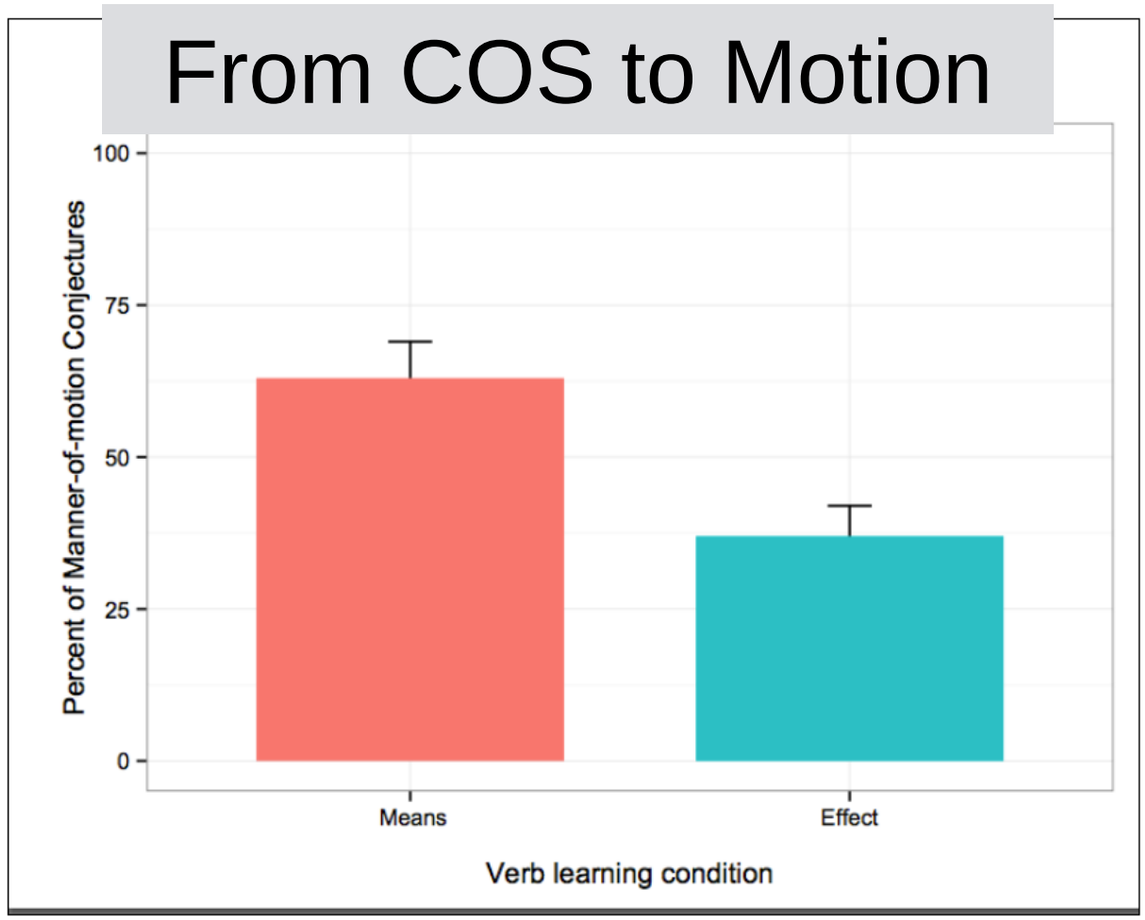
Biases formed within each semantic field





Biases readily extend across semantic fields





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

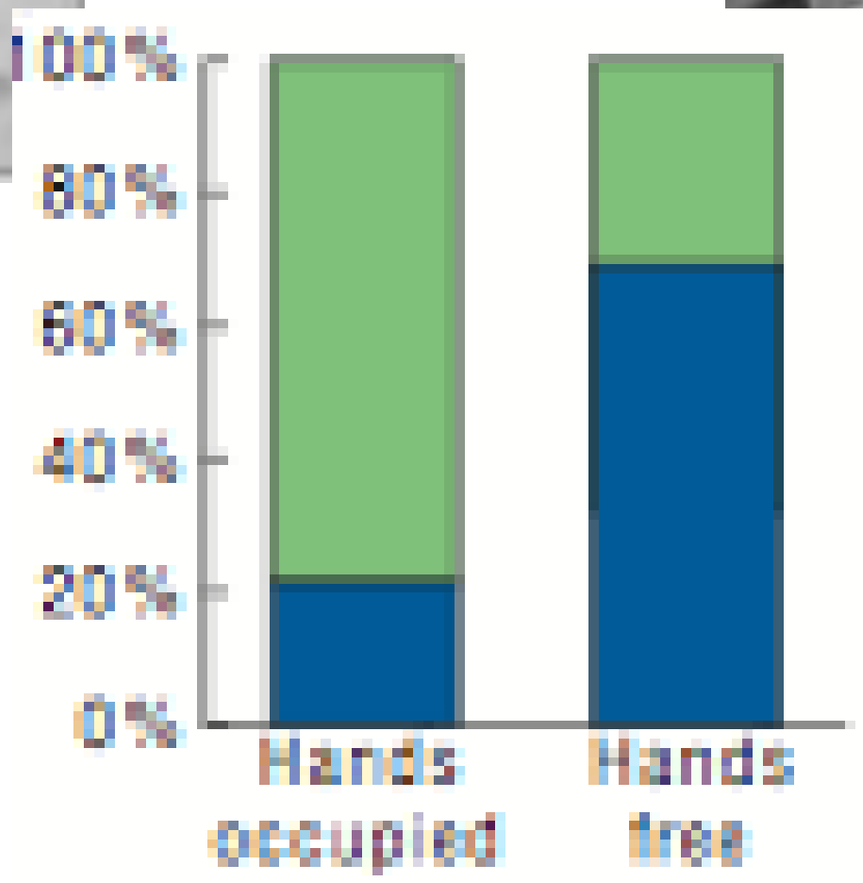
Hypothesis: same representation underlies prelinguistic conceptual structure, guides syntax acquisition, and provides semantic content in mature state.

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?

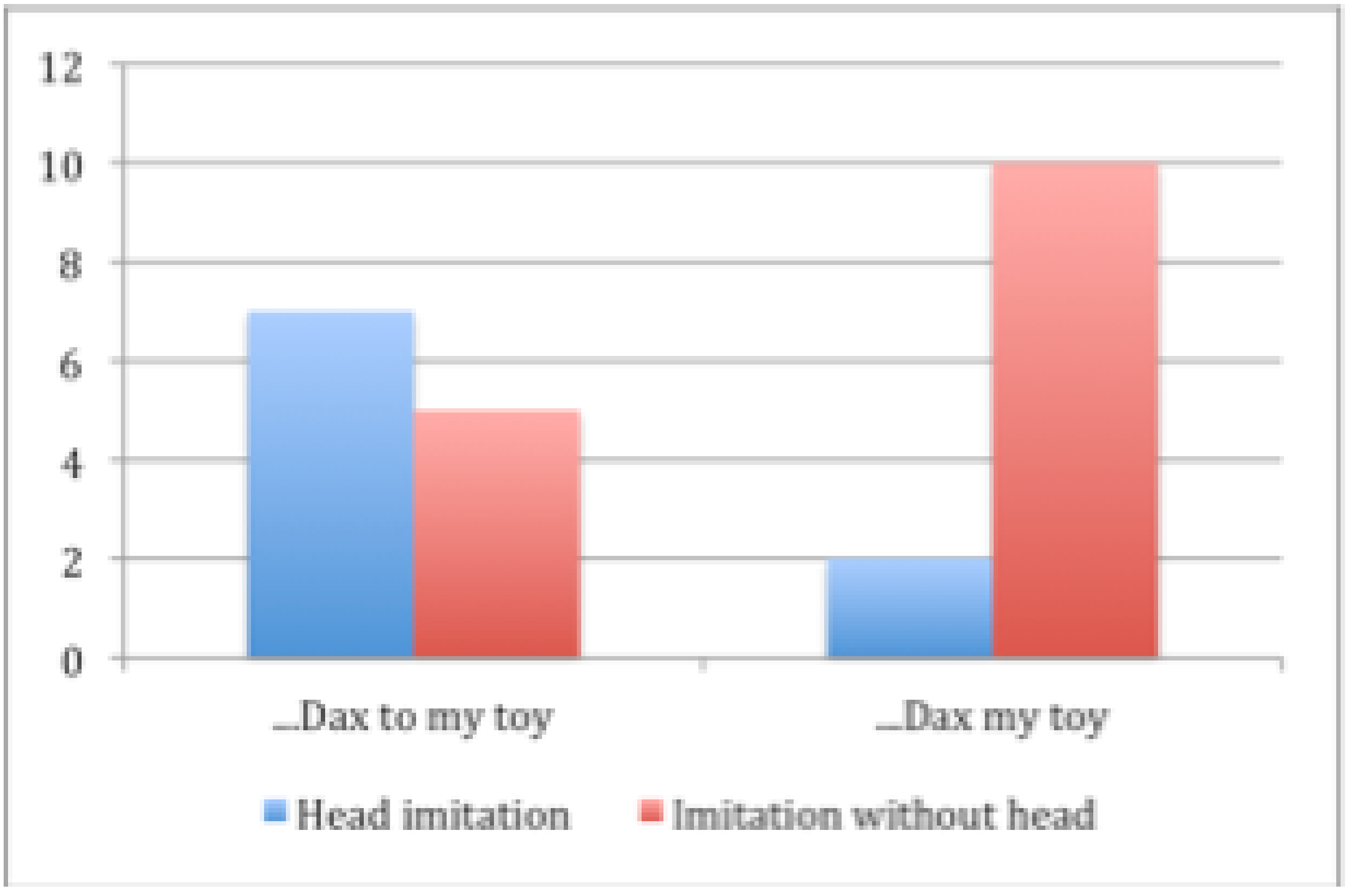
I’m daxing my toy (result-bias frame)

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

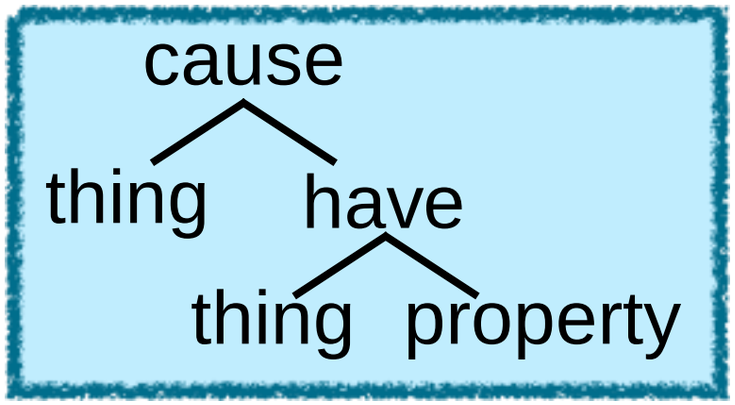


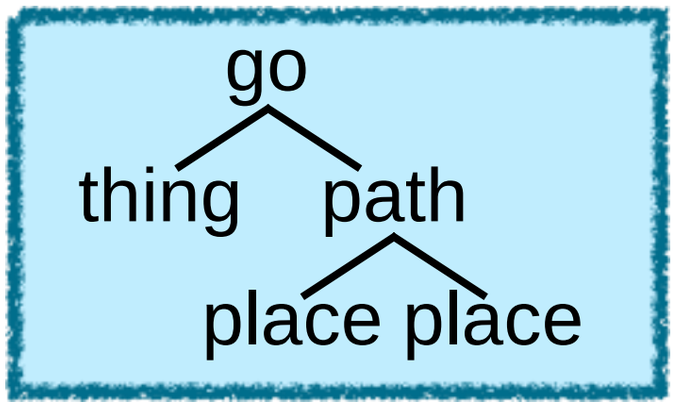
Head Touch Summary

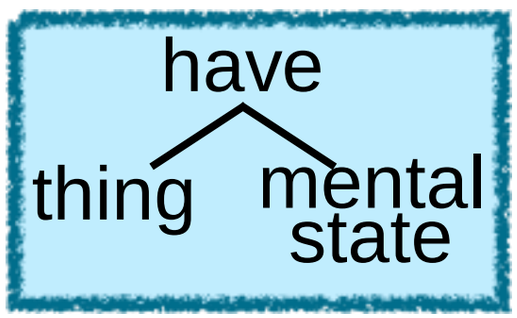
- Children who hear ‘dax to my toy’ believe the manner is being labeled (and thus is the goal)
    - Syntax guides interpretation of goal-directed action
- A missing piece - complementarity?
    - Do children expect a verb to label either means or result?
    - Persistence measures (turn off box)
  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

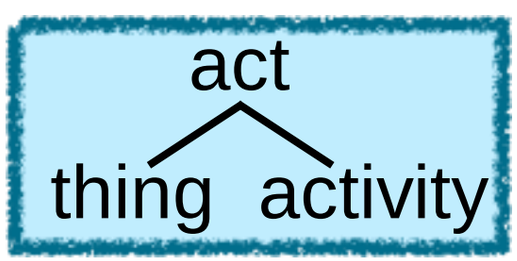
Infant's Starting State

Semantic Structure









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

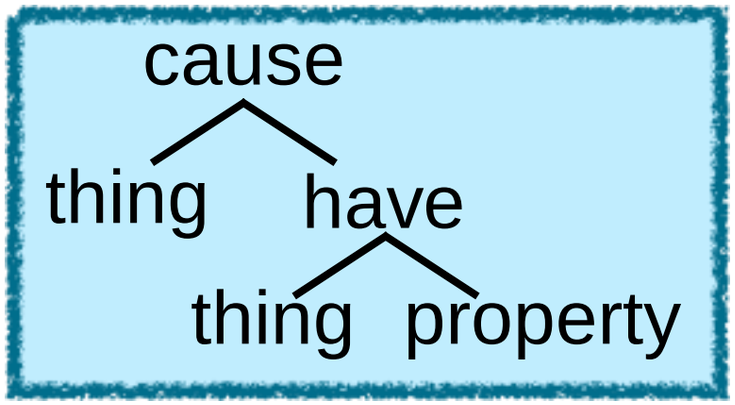
[Cluster 1 + Cluster 2]

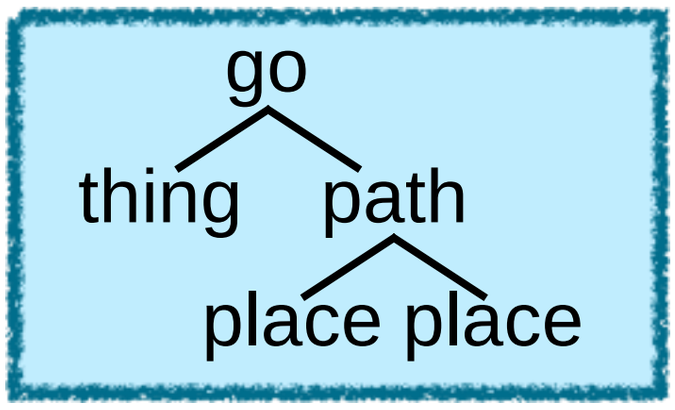
[Cluster 3 + Cluster 4]

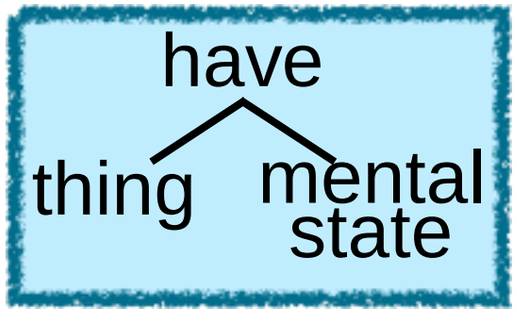
etc...

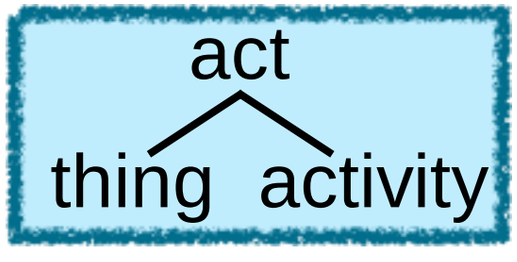
Infant's Starting State

Semantic Structure









etc...

Clean Mapping Principle

syntactic structure reflects semantic structure

- Mappings are cleaner than they appear
- Children know this fairly early

Syntactic Structure

Categories

Cluster 1 | Cluster 2

Cluster 3 | Cluster 4

Cluster 5 | Cluster 6

etc...

Structure

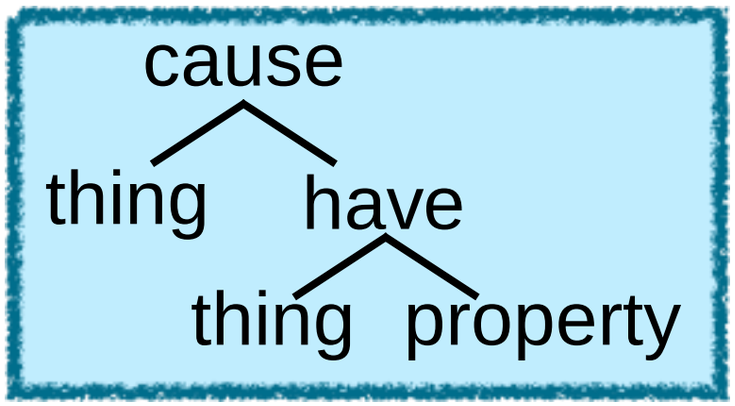
[Cluster 1 + Cluster 2]

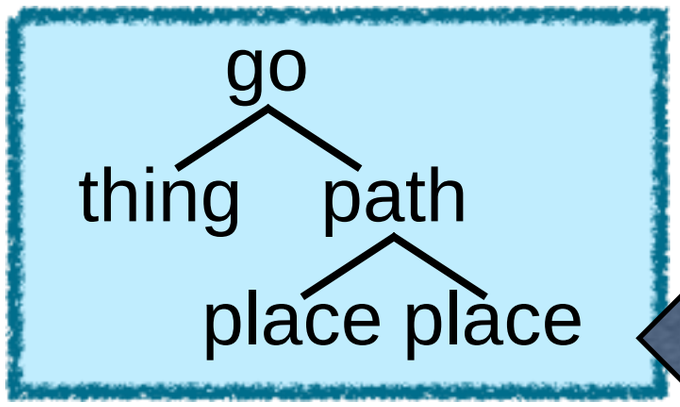
[Cluster 3 + Cluster 4]

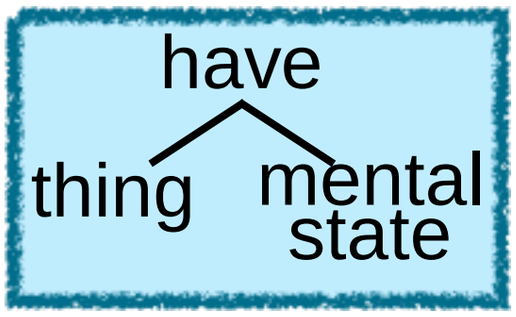
etc...

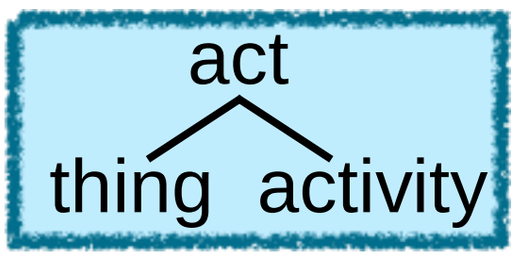
Infant's Starting State

Semantic Structure









etc...

Clean Mapping Principle

syntactic structure reflects semantic structure

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

Syntactic Structure

Categories

Cluster 1

Cluster 2

Cluster 3

Cluster 4

ter 6

etc...

er 2]

[Cluster 3 + Cluster 4]

etc...

Thank you