Ignorance, Alternatives, & Implicature

David Barner

Sinn & Bedeutung, 2013

Language and Development Lab
UCSD

Is semantics possible?

Problem (circa 1950)**:** Natural language resists logical characterization because it is replete with ambiguity, vagueness, and because sentences change meaning from one context to the next – “ordinary language has no exact logic” (Wittgenstein / Strawson, Russell, etc.)

Solution: The inadequacy of logic is an illusion created in part by a failure to consider a role for pragmatic inference

Partee, 2011; Grice, 1967

Intended meaning goes beyond meanings of words and how they are combined

e.g., Do you like my cake?
I ate some of your cake.

Implied: I did not eat all of your cake.

The explananda of semantic theory may be both narrower and simpler than supposed by early linguists and philosophers of language

Is semantic development possible?

Problem: Acquiring some abstract content, like the positive integers, seems to require the construction of more powerful logical resources than those present in infants (Piaget / Carey). But this seems impossible (Fodor, 1980).

Solution: Theories of word learning & conceptual development, by placing all content in lexical concepts, try to account for too much, making hard problems seem impossible. The explananda of word learning are simpler when the role of pragmatic inference (among others) is considered.

Two Options

(1) Number words are incommensurable with content provided by natural language semantics, and require conceptual change that falls outside NL semantics

(2) Number words fall within NL semantics, and exactness is not unique to number words. Difference is pragmatic, not initially semantic.

UPSHOT: On analogy with Grice's move, appeal to pragmatics may allow a coherent semantic account of number word acquisition, without conceptual change / *ad hoc* postulation of content

Acquisition Stages

one, two, three, four, five, six, seven, eight, etc…

one two three four five six seven eight

Wynn, 1990, 1992

Proposal

- *One, two, three, four* learned initially like natural language quantifiers, using same hypothesis space of meanings – i.e., singular, dual, trial.

- **Exactness** is derived via a pragmatic strengthening

(another time: larger numbers acquired via counting)

See Davidson, Eng, & Barner, 2012, *Cognition*

Evidence for shared hypothesis space

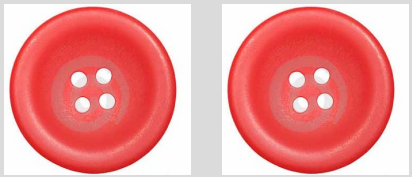
Cross-linguistic number marking

- “singular-plural” (English, French, Spanish, etc.)
- “singular-dual-plural” (Slovenian, Arabic, etc.)
- “singular-dual-trial” (Larike, Tolomako, etc.)

http://xkcd.com/1070/

Central Slovenian

- Two red buttons are lying on the table



- Dva rdeča gumba ležita na mizi.

two(DL) red(DL) button(DL) lying(DL) on table

Predictions

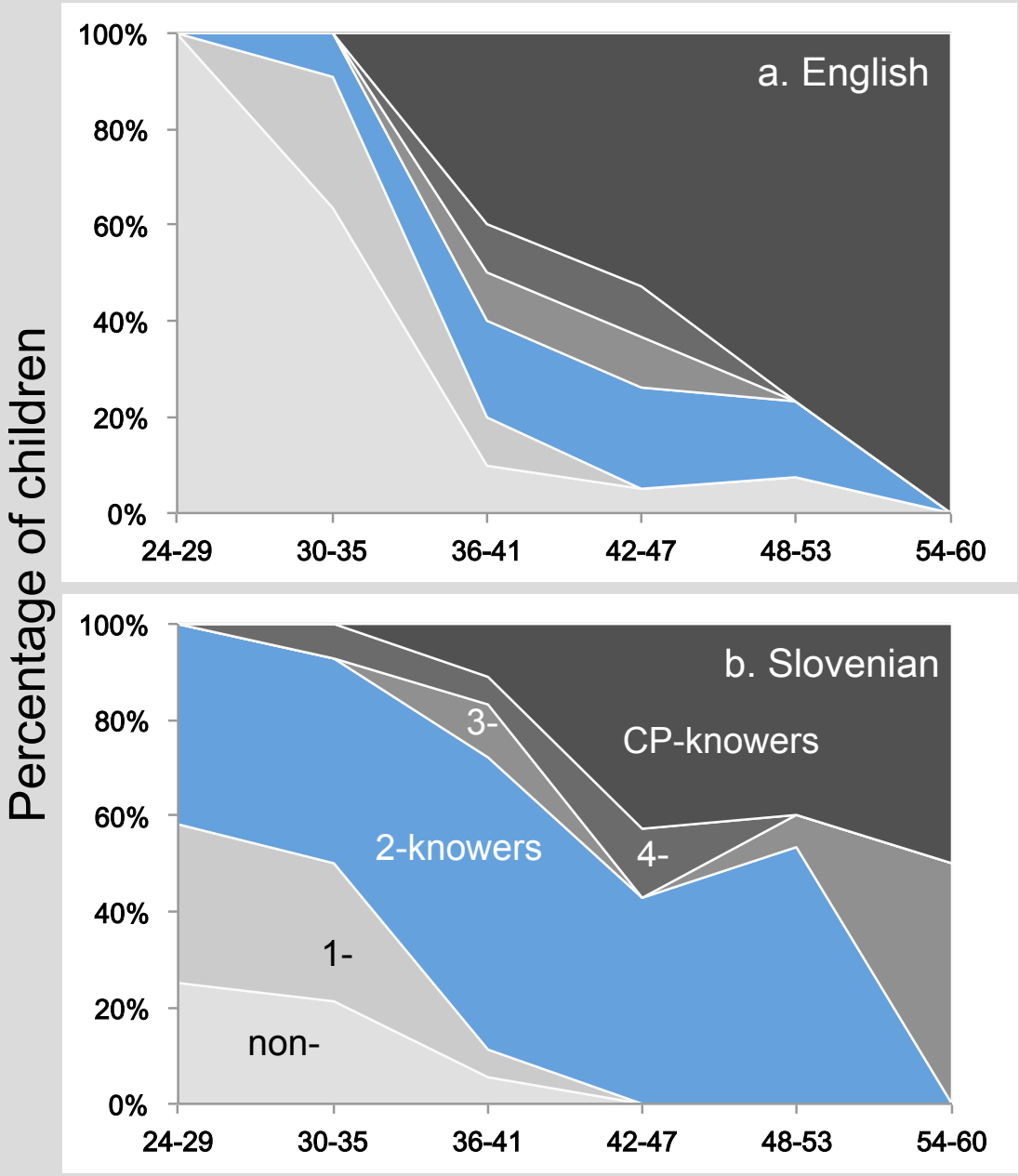
If children use dual morphology to acquire "two", then:

- high frequency of 2-knowers
- faster to acquire 2
- advantage specifically for 2, but not 3+
- dual knowledge correlated with 2-knowledge

Slovenian – a Dual language

- 71 Slovenian-speaking children in Ljubljana 28 2-yr-olds, 26 3-yr-olds, and 17 4-yr-olds (M=3;2)
- 79 English-speaking children in San Diego
  - 25 2-yr-olds, 30 3-yr-olds, and 24 4-yr-olds (M=3;5)

With Jess Sullivan, Lanko Marušič, Rok Žaucer (Nova Gorica), Tim O'Donnell (MIT), Chris Donlan (UCL), Alhanouf Almoammar (King Saud)

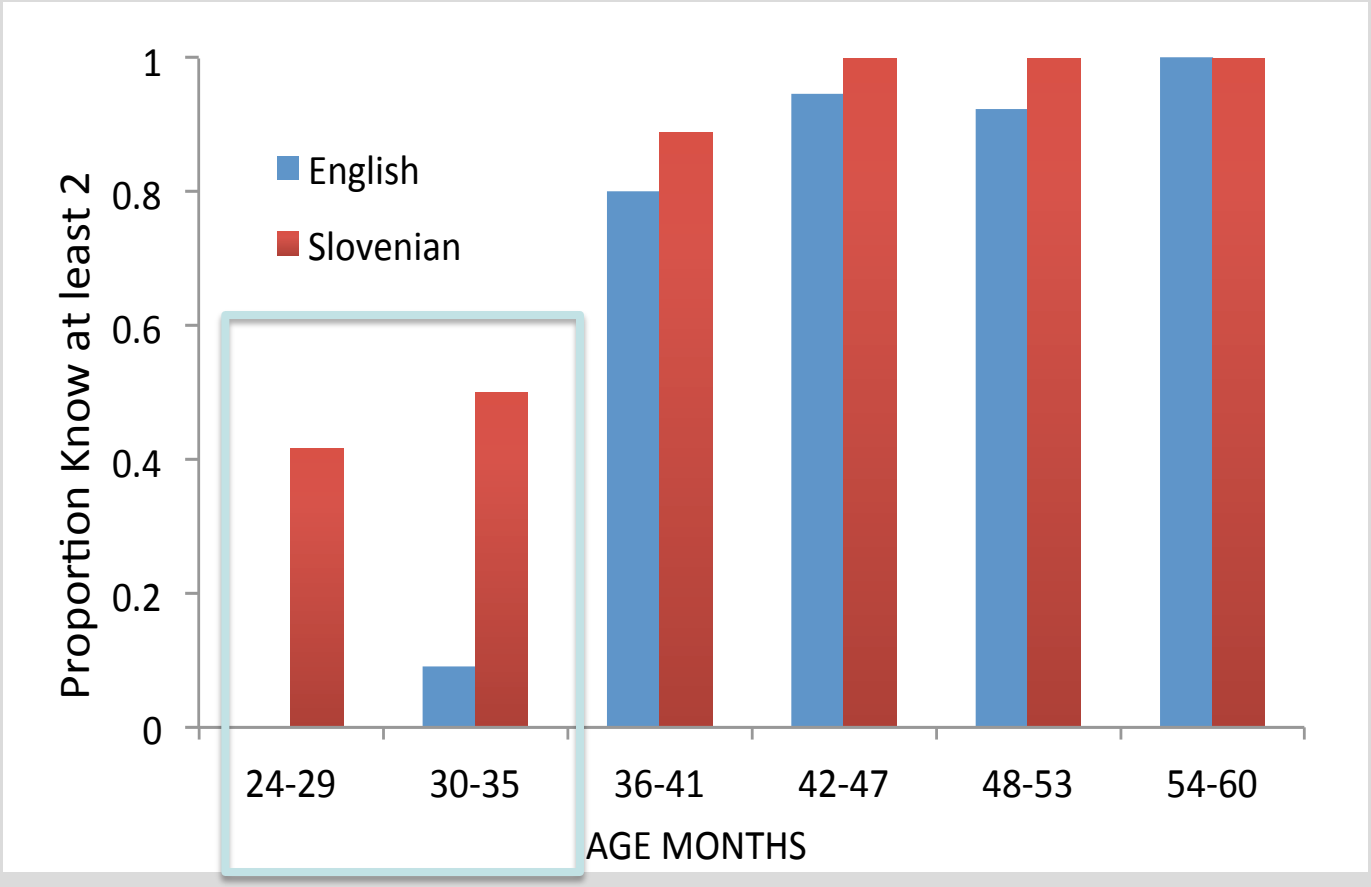


- Many more 2-knowers in Slovenian at all ages
- At 2-, 3-, and 4-years-old, nearly 50% of Slovenian kids are 2-knowers.

c. Saudi Arabic

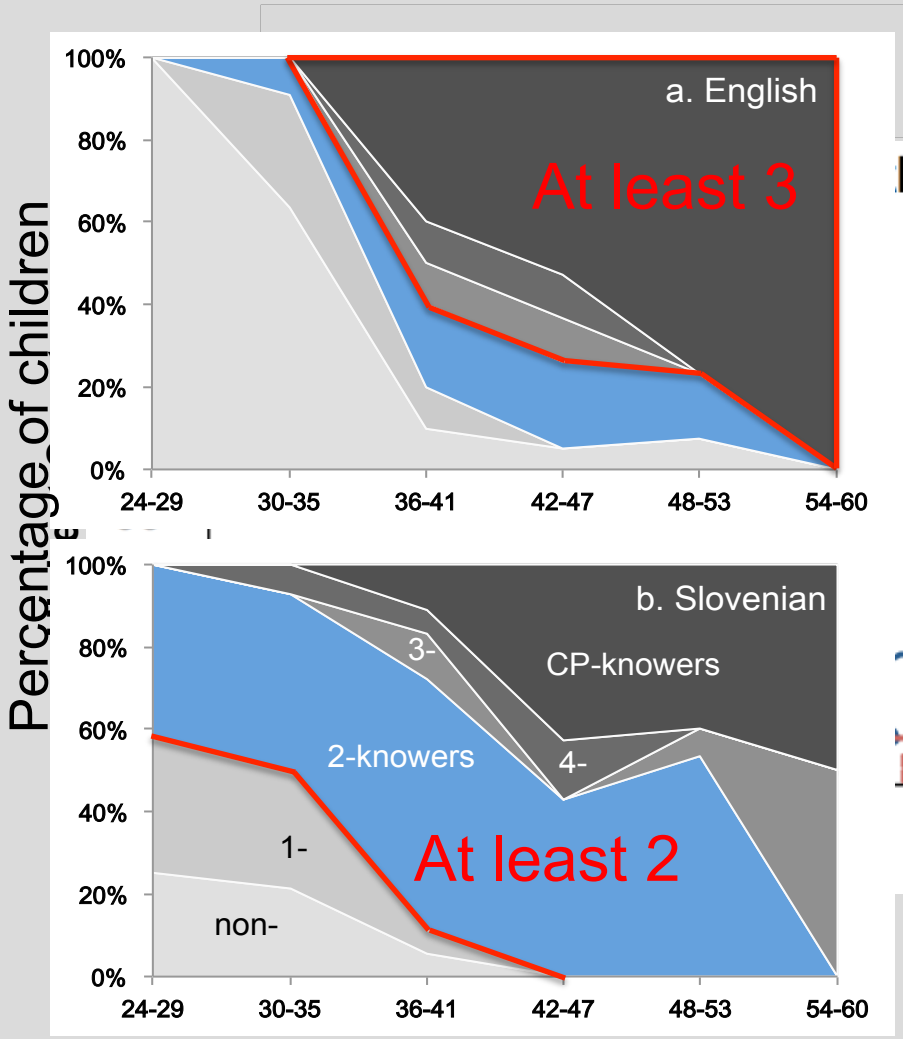
Two reasons for this frequency

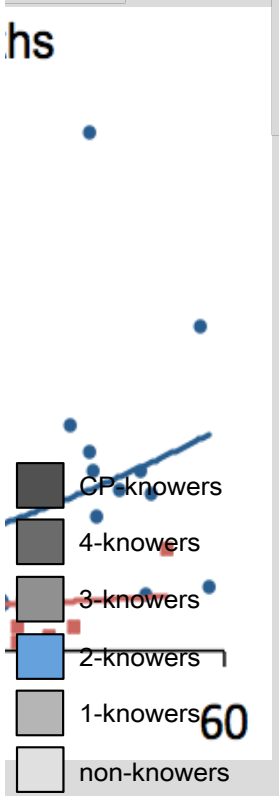
Slovenians Faster to learn 2



- Sig effect of language predicting status as "at least 2 knower
- Remains when only youngest groups considered

Slovenians get stuck at 2

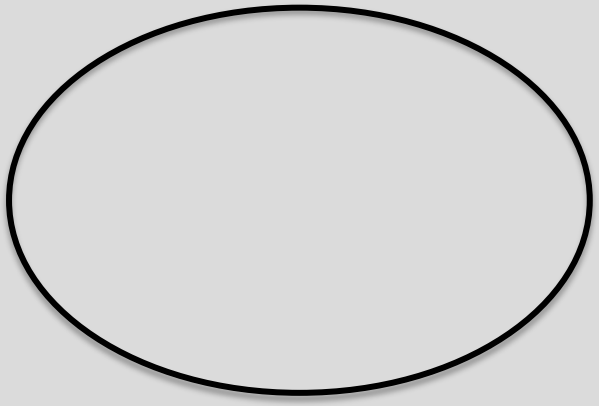


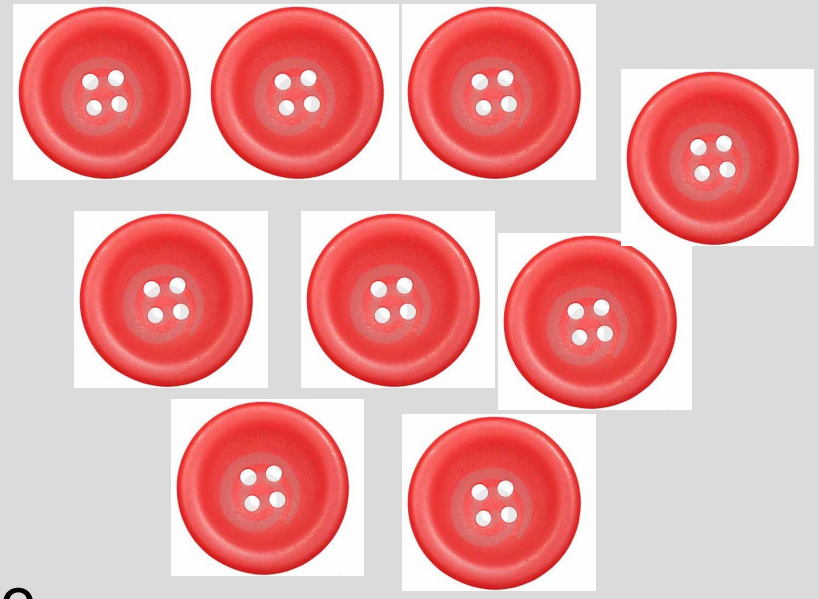


c. Saudi Arabic

How is this related to dual knowledge?

Give “Morphology” Task





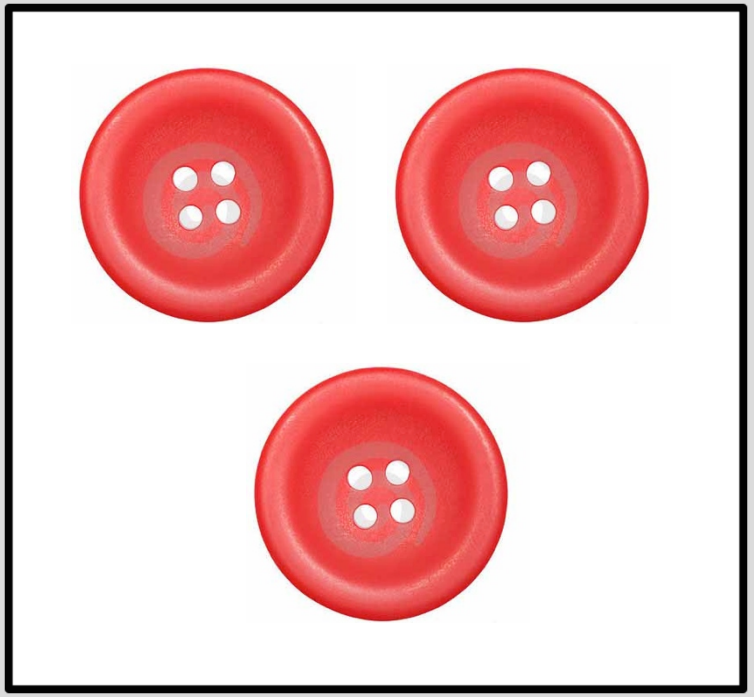
Put button(DL) into the circle
Put button(SG) into the circle
Put button(PL) into the circle

What's on this card?

Can you say "button"?

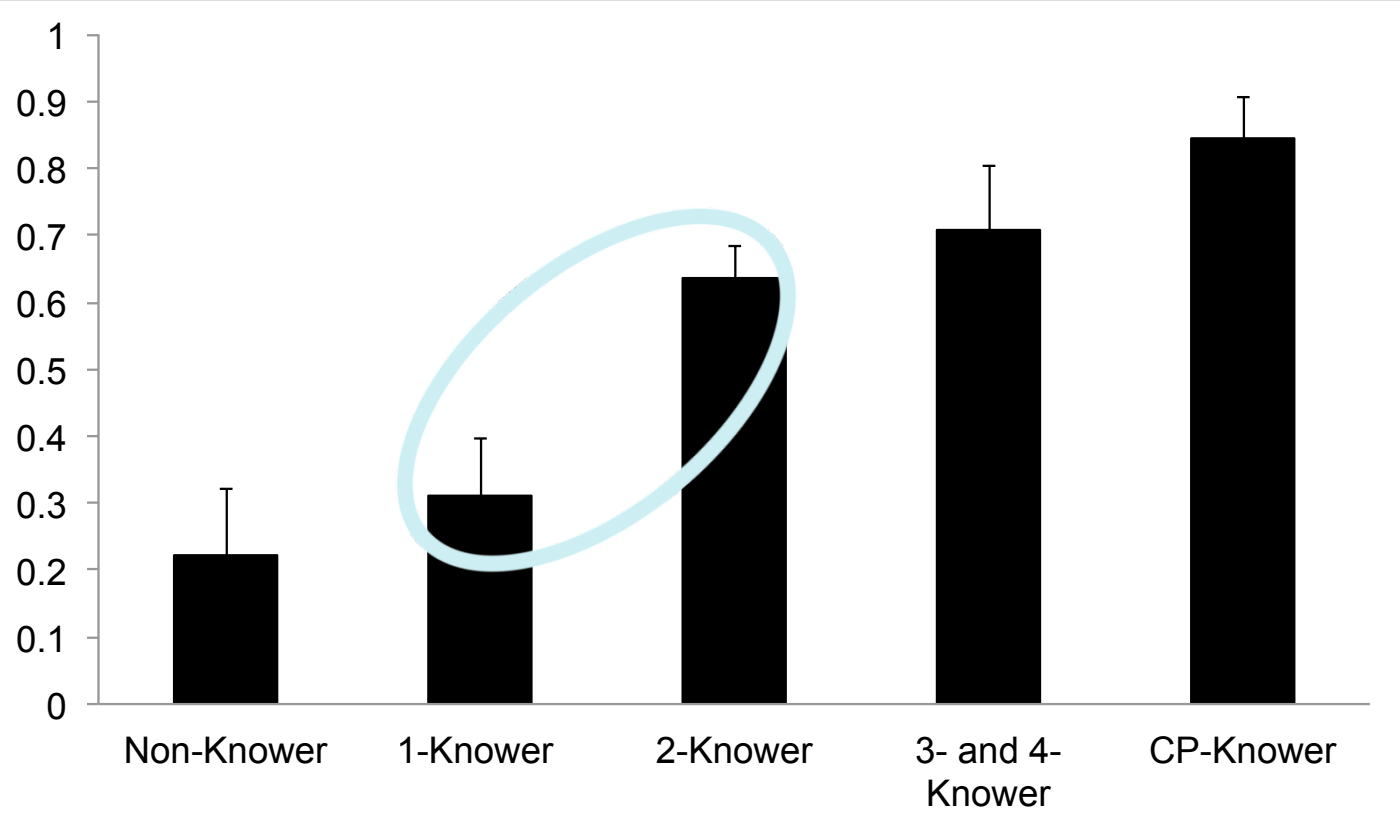
Good Job!

What's on this card?



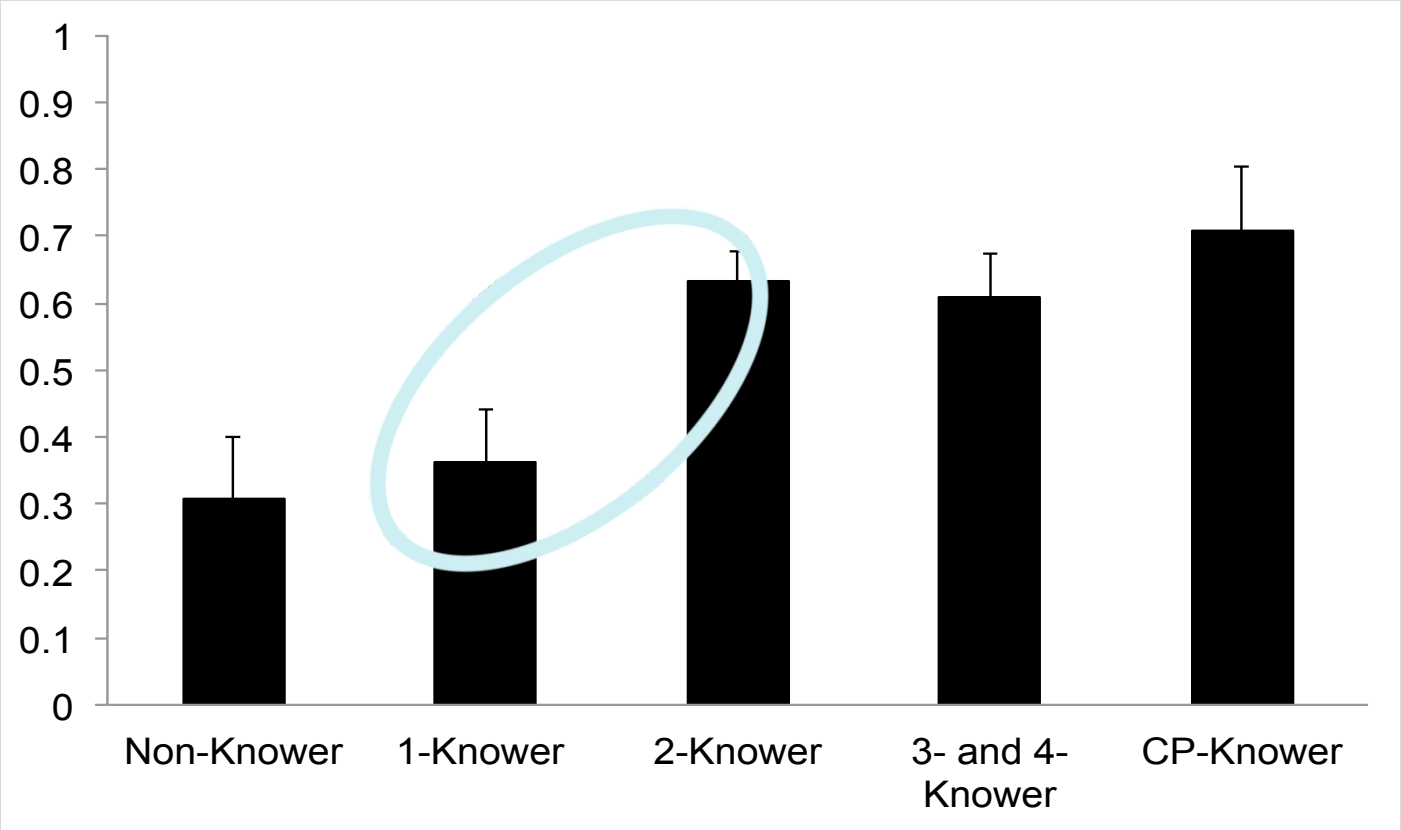
Sets of 1,2,3,4,5,6,8

Give-Morphology Task



- Two knowers ~ twice as likely to know dual

What's on this Card?

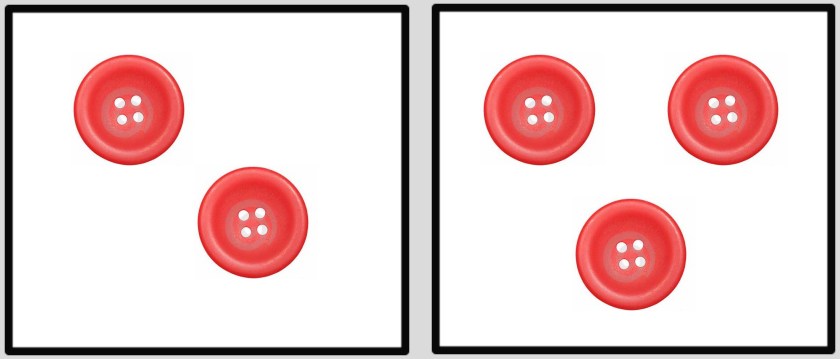


Saudi Surprise!

- Alhanouf Almoammer & Chris Donlan, UCL

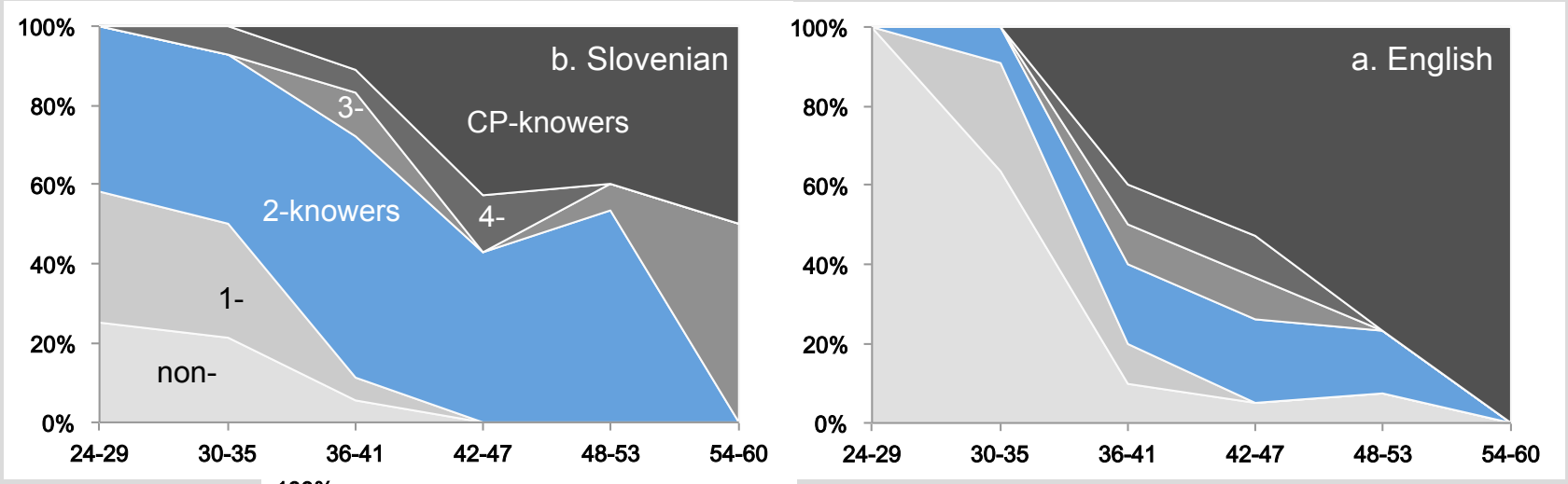
84 Saudi children (3- & 4-yr-olds)

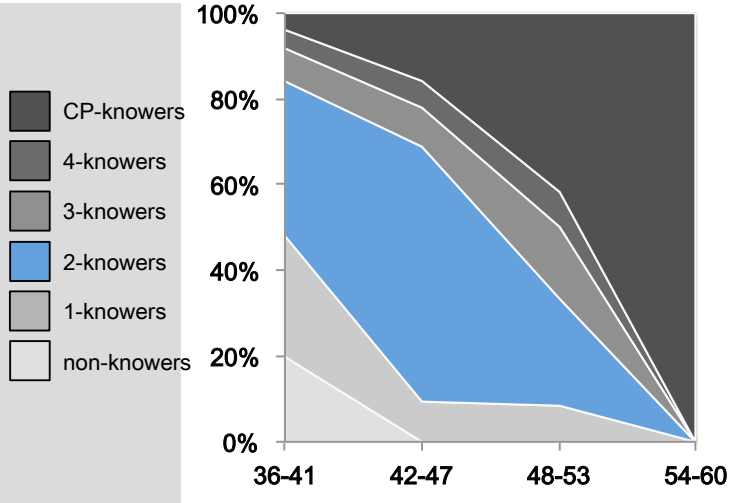
1. Give-a-Number
2. Forced Choice Morphology Task



Which card has button(DL)

Give-a-Number results





- More 2-knowers vs. English
  3-yr-olds: 49% vs. 20%
  4-yr-olds: 23% vs. 8%

- No difference in 2-knowers in Slovenian vs. Saudi Arabic

- Similar, more subtle relation with morphology

Almaoammer, Sullivan, Donlan, Marušič, Žaucer, O'Donnell, & Barner, under review.

Conclusions

- In two unrelated languages:
  - 2-knowers vastly more frequent
  - Knowledge of 2 related to dual comprehension
- In Slovenian
  - 2- acquired significantly earlier than in English
  - *despite* significantly worse counting ability
  - Advantage specific to 2-, not to 3+
  - 3+ are predicted by counting ability & age, not language

Conclusion

- Natural language morphology encodes content which can define specific number word meanings
- Learning this morphology can speed learning 1,2,3
- Maybe no domain-specific content or conceptual change required for learning 1-2-3?

Problem: Exactness

Exactness problem

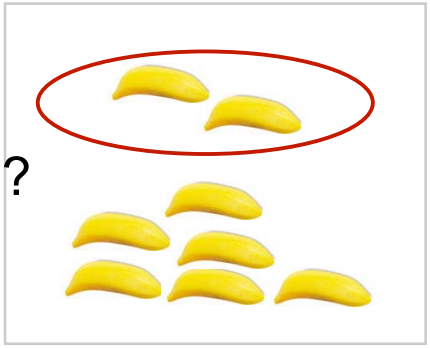
- Natural language has expressions that denote singleton, dual, and trial sets, but these appear to be non-exact for kids

English "one knowers"

Do not treat "a" as exact:

Give me a banana!

Is there are banana in the circle?



Do treat "one" as exact:

Give me one banana

Is there one banana in the circle?

Barner, Chow, & Yang, 2009

Solution: Deriving exactness pragmatically for 1-2-3

Example:

i. Children initially represent "*one*" with non-exact semantics, like singular "*a*". These kids are called "non-knowers"

ii. Children acquire weak meaning of "two", allowing them to strengthen "one" to mean "exactly one". These kids are called "one-knowers". Etc.

Problem

Context: All farmers cleaned both a horse and a rabbit

Children are terrible at computing implicatures

a/some, some/all, might/must, or/and, etc.

e.g., Every farmer cleaned a horse or a rabbit

Children: Totally fine ✔

Adults: Not ok. ✗

Chierchia et al., 2001; many others

Previous accounts

- Children are literal (restatement of data?)
- They lack pragmatic sophistication generally (and also have socio-pragmatic problems with presupposition, common ground, etc.)
- Children lack computational / memory resources to make computations / compute inferences
- Children are pragmatically “tolerant”

My claim

1. Children *can compute required inferences*

2. Children *have wm resources* to process and compare alternatives

3. Children *can reason about beliefs and knowledge* of others, and have sufficient ability to access and reason about alternative expressions

4. Children lack access to scalar alternatives.

Scalar implicature: Missing alternatives

(1) Compute basic meaning of a sentence S containing L, a scalar lexical item, where L has a weak (or basic) meaning.

(2) Generate a set of alternatives (a_1, a_2…a_n) to S, called S_{alt}.

(3) Restrict the alternatives in S_{alt} to the set containing only the stronger expressions, (i.e., such that A entails S, but S does not entail A), called S*.

(4) Augment (or “exhaustify”) the basic meaning of S (containing L) with the negation of all of the members of S*.

Access and exactness

- Kids have access to numeral list from beginning and use it to derive exactness
- Don’t treat quantifiers or S/DUAL/PL as scales
- Access depends on representing words as relevant alternatives. Many possible semantic scales exist, but only some are acquired and support implicature. This requires some degree of learning to identify scale mates.

Evidence for Role of Alternatives

1. Children fail to access scalar alternatives for quantifiers (*some-all*) even when computing entailments.

2. Children can compute ignorance implicatures.
   - require mental state reasoning of SI, reasoning about alternatives, but maybe different alternatives

Claim I: Children have inferential and processing ability to reason about alternatives, when available

Children succeed when given alternatives

Farmer cleaned the horse then he cleaned the rabbit

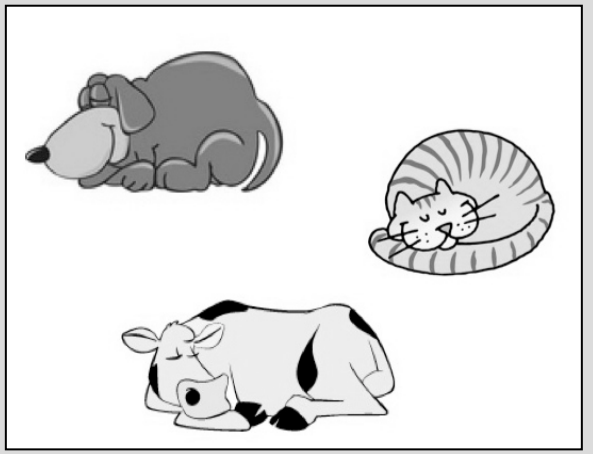
90% of children 3- to 6 prefer “AND”

Gualmini et al. (2001)
…children are unable to “to construct the relevant alternatives on-line, such that they fail to compute implicatures if the alternatives are not explicitly presented to them.”

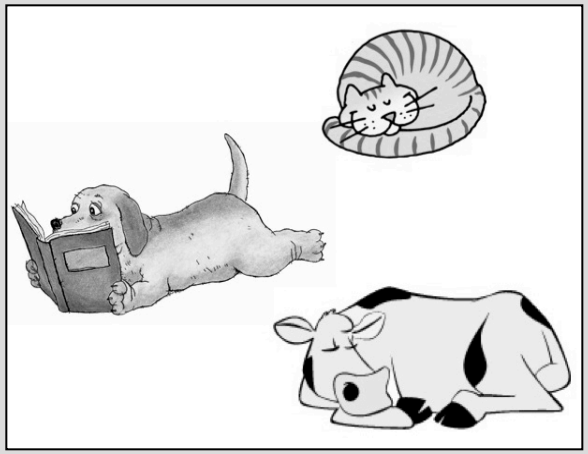
Every farmer cleaned a horse **or** a rabbit
Every farmer cleaned a horse **and** a rabbit

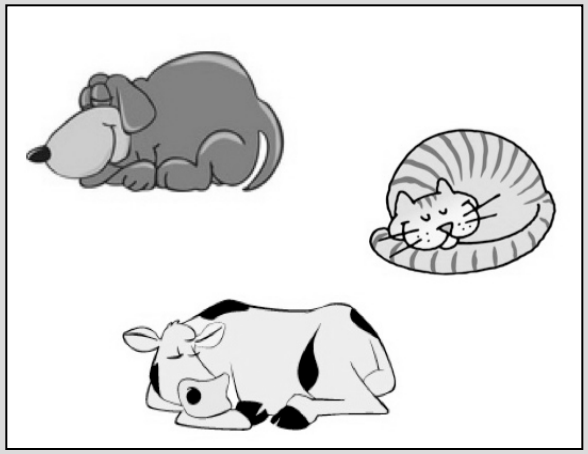
Chierchia et al., 2001; Gualmini et al., 2001; Foppolo et al., 2012

Kids can strengthen for ad hoc scales, but not Horn scales, when forced grammatically



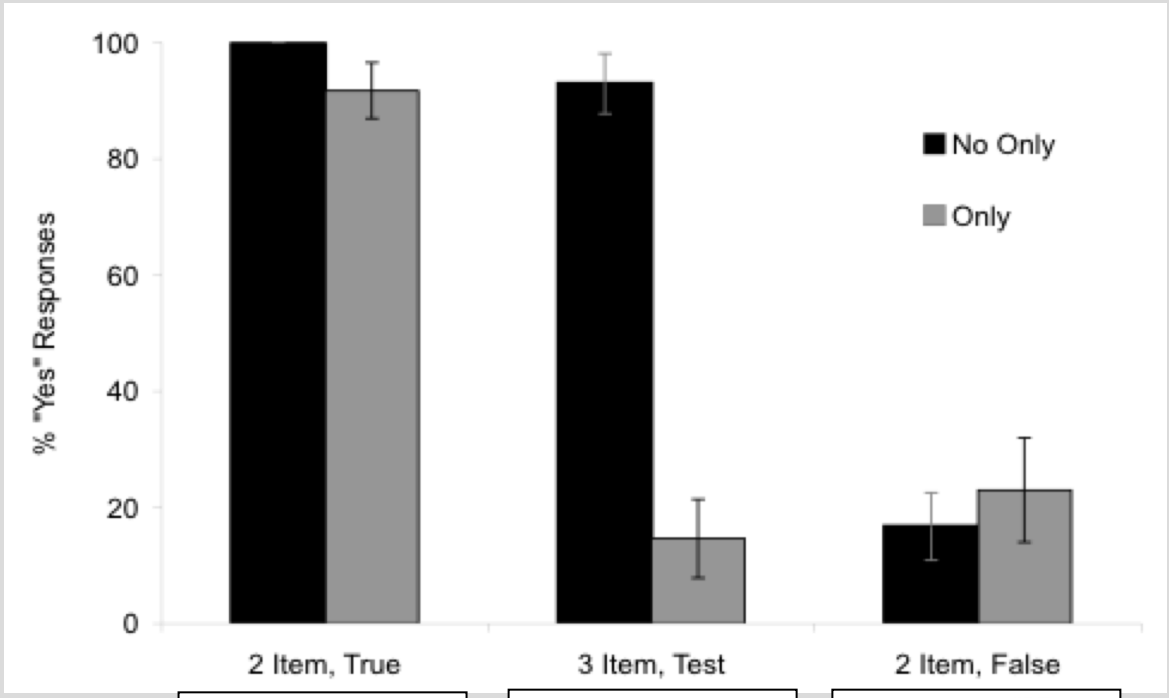
Horn scales vs. contextual alternatives

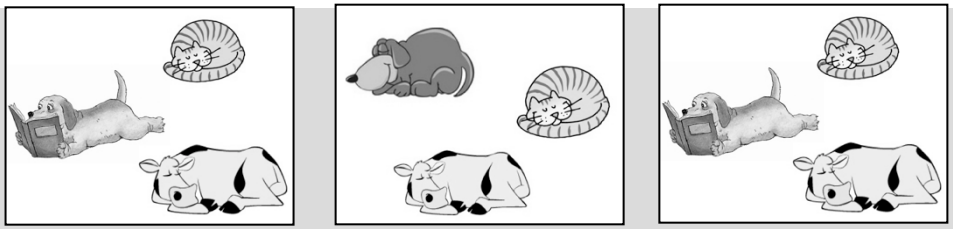




a. Are some of the animals sleeping?
b. Are only some of the animals sleeping?
c. Are the cat and the cow sleeping?
d. Are only the cat and the cow sleeping?

Contextual alternatives

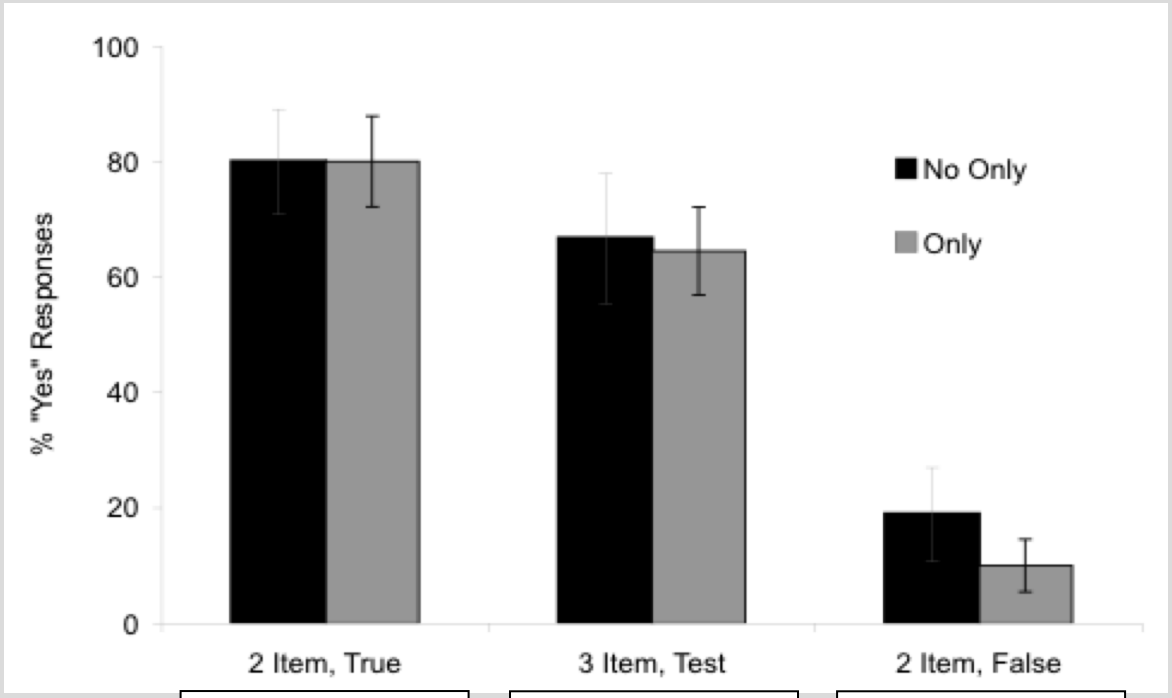


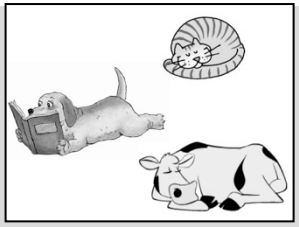


cat & cow/Only cat & cow? cat & cow/Only cat & cow? cat & cow & dog?

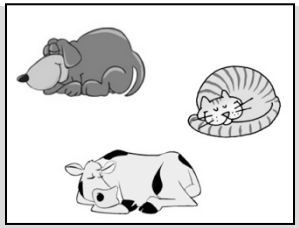
Barner, Brooks, & Bale, 2011

Horn scale

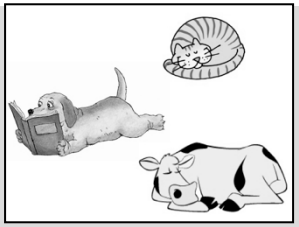




Some/Only some?



Some/Only some?

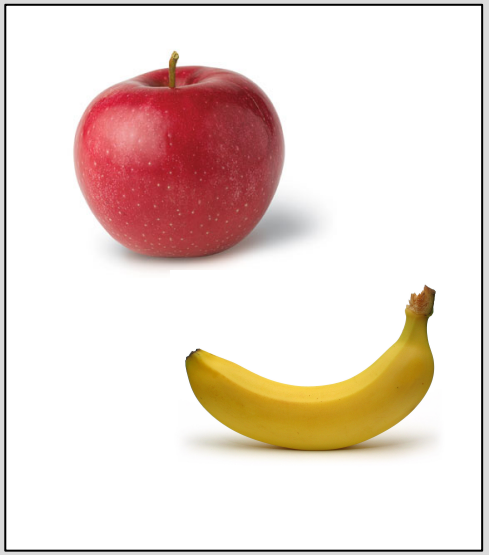


All?

Claim 2: Children can reason about knowledge states of others, and can negate active scalar alternatives

Ignorance Implicature

Speaker: “The Cow ate an Apple or an Banana”



Speaker (K)nows (C ate A or B)

Speaker ¬K (C ate A)

Speaker ¬K (C ate B)

~>The speaker is ignorant about A, and about B.

See Spector / Sauerland / Soames / Horn / Gazdar

Ignorance Implicature

1. Involves reasoning about mental states. Implicatures suspended if speaker is clearly knowledgeable

ergo: tests if SI failure is due to problem w/ intentional ascription

2. Involves reasoning about alternatives and negating them. But alternatives are explicitly mentioned & activated – no requirement to spontaneously access.

ergo: tests ability to reason about alternatives

Gricean View: Epistemic Step

a. ~> ¬K A (speaker does not know if “Billy went to the bar” is true)

b. ~> ¬K B (speaker does not know if “Billy went to the café” is true)

c. ~> ¬K (A & B) (speaker does not know if “Billy went to the bar and the café” is true)

Epistemic Step (Speaker is knowledgeable / opinionated)

d. ~> K ¬A (blocked due to contradiction)

e. ~> K ¬B (blocked due to contradiction)

f. ~> K ¬(A & B) (speaker knows that “Billy went to the bar and the café” is false)

Grammatical view

- Ignorance implicature Gricean, over contextually salient alternatives
- SI: exhaustification via grammatical operator, defined over Horn scales

Test of Ignorance Implicature

Look! Here come Farmer Brown and Captain Blue!

We're going to put a blindfold on Captain Blue! He has a blindfold on, so he can't see. He can still hear, but he can't see anything, so he might say things that are funny or are not true.

Who can see what's happening?

And who can hear what's happening?

The bear says: "It's me the bear. Look! A banana and an apple! Look what I'm taking!"

Okay! Someone said, Bunny took an apple or a banana. Who do you think said that?

blindfolded

seeing

Klainerman, Bale, Fox, Barner, under review.

Ignorance implicature trials

Trial Type	Animal Takes	Someone Says…	Correct
Ignorance	Cup	The bear took a cup **or** a plate.	Ignorant
TRUE	Cup	The bear took a cup.	Knowledgeable
TRUE	Cup AND Plate	The bear took a cup and a plate.	Knowledgeable
False	Cup	The bear took a plate.	Ignorant

Klainerman, Bale, Fox, Barner, in prep.

Test of Scalar Implicature

Look! Here come 2 puppets!

This is Smart Puppet. He always says things that are right. This is Silly Puppet. He says things that are kind of weird and silly.

silly

smart

Which one says smart things? And which one says silly things?

Great job!

Look!

Animals appear with items (e.g., sticker & lemon)

Someone said, "Each animal has a sticker or a lemon" Who said that?

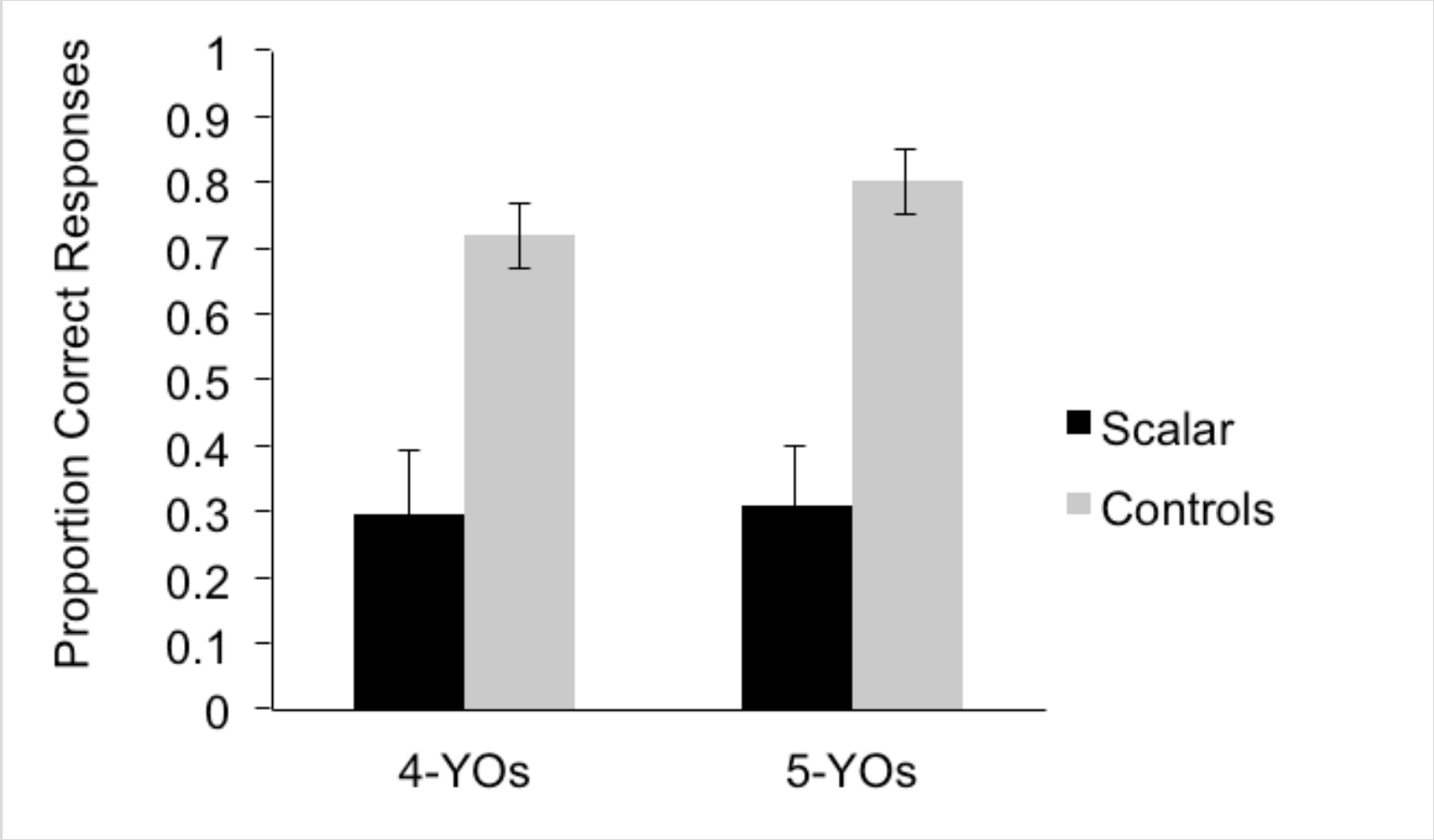
Klainerman, Bale, Fox, Barner, under review.

Scalar implicature trials

Trial Type	X has…	Y has…	Someone Says…
Scalar Or	A&B	A&B	Each animal has an Apple **or** a Banana.
TRUE or	A	B	Each animal has an Apple **or** a Banana.
TRUE and	A&B	A&B	Each animal has an Apple **and** a Banana.
2 vs. 3	3 Apples	3 Apples	Each animal has **two** Apples

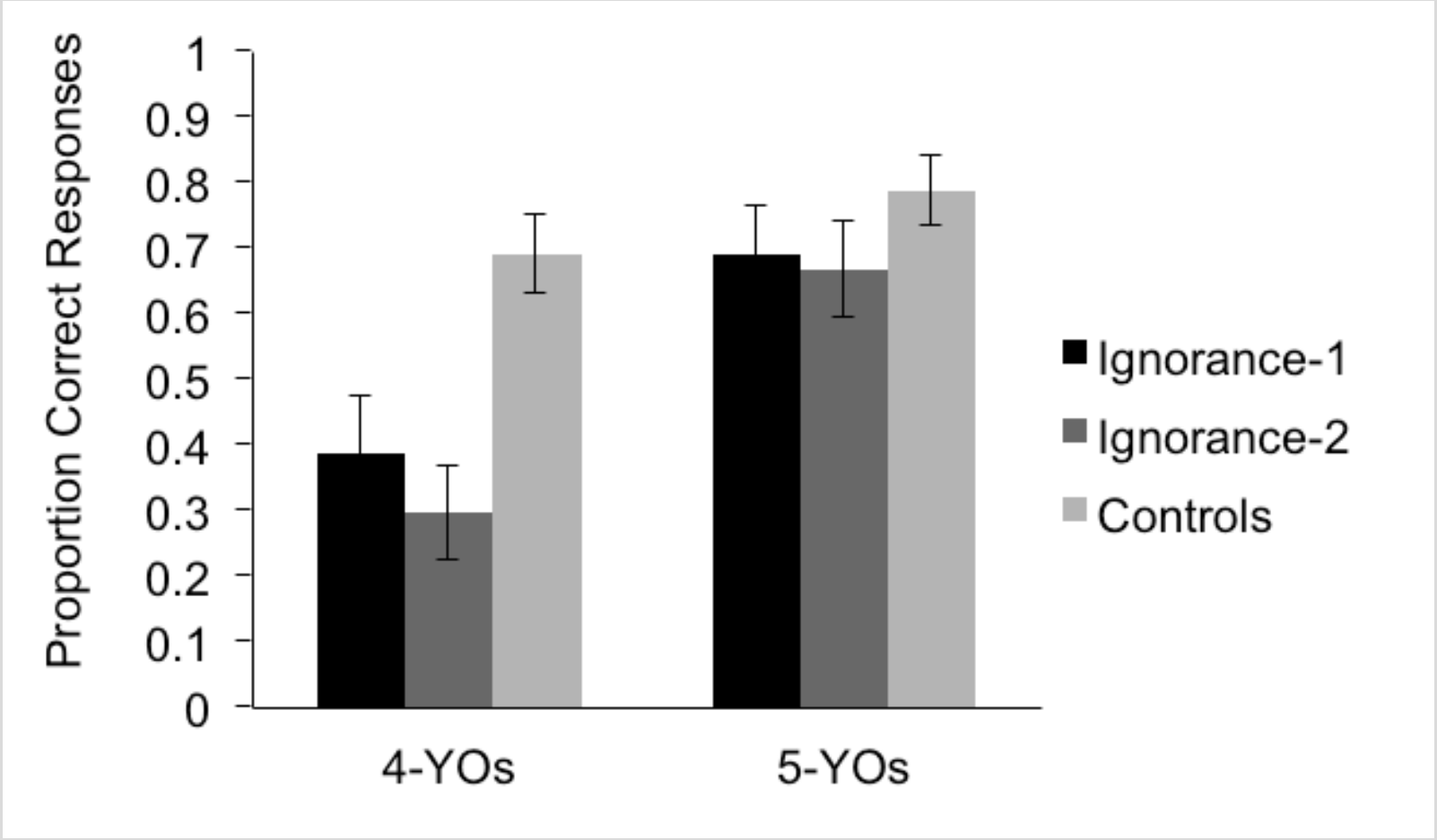
Klainerman, Bale, Fox, Barner, under review.

Scalar Implicature



SI trials differ from all controls; Kids prefer smart puppet.

Ignorance Implicature



No sig. differences with controls; but ignorance trials diff from SI trials

Problem: Access to Alternatives

1. Epistemic Step? ✗

2. Unavailability of subdomain disjuncts
   - under universal, negating disjuncts maybe too strong

3. Unavailability of Horn scale
   - Grammatical view

Footnote about subdomain alternatives

Ignorance requires them

Speaker: **“The Cow ate an Apple or an Banana”**

Speaker (K)nows (C ate A or B)

Speaker ¬K (C ate A)

Speaker ¬K (C ate B)

Footnote about subdomain alternatives

Speaker: “Each animal ate an Apple or an Banana”

Negation of Disjunct 1: ¬Each animal has an apple.

Negation of Disjunct 2: ¬Each animal has a banana.

Negation of Conjunction: ¬(Each animal has an apple and a banana)

Problem: Access to Alternatives

1. Epistemic Step? ✗

2. Unavailability of subdomain disjuncts
   - under universal, negating disjuncts maybe too strong

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Alternatives & Number Words

- Children can exhaustify if they have access to alternatives
- Number word alternatives are learned first, before meanings
- Exactness may be derived pragmtically, despite failures with quantifiers

Conclusion

Early exact meanings do not require domain-specific explanation (e.g., domain specific conceptual change or special innate knowledge)

Singular, dual, trial + exhaustification sufficient for 1-2-3

(more needed for 4+, and math – another day)

Back to Analogy with Grice

- Possible to provide a unified account of numbers (and other quantity expressions) rooted in the semantics of natural language

….if semantic representations are individuated with pragmatic inference in mind.

Vastly simpler acquisition theory

Thank you to:

- Rok Zaucer, Lanko Marusic, Chris Donlan, Alhanouf Almoammer, Jessica Sullivan
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