A mentalistic semantics explains *each* and *every* quantifier use

Tyler Knowlton, John Trueswell, Anna Papafragou

University of Pennsylvania

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Theories of linguistic meaning aim to account for how meanings…

- ➥ are formally represented
- ➥ can combine into larger units
- ➥ get pragmatically used/interpreted
- ➥ connect to non-ling cognitive systems

Prioritized by formal approaches

Prioritized by cognitive approaches

e.g., Davidson 1967; Montague 1973; Lewis 1975; Heim & Kratzer 1998; Jackendoff 1983; Carston 2002; Pietroski 2018; Fauconnier 1984; Lakoff 1987; Langacker 1987; Talmy 2000

Theories of linguistic meaning aim to account for how meanings…

- ➥ are formally represented
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Unified approach to meaning

Roadmap

Linguistic & Psycholinguistic data

➥ Suggests *each* is somehow more individualistic than *every*

Psycho-semantic proposal

➥ *Each* interfaces with object-files; *Every* interfaces with ensembles

Novel predictions about pragmatic use

➥ Quantifying over small & local vs. large & global domains

Each is more individualistic than *every*

(1) a. Take **every** one of them

b. Take **each** one of them…

and examine it in turn

(2) In this talk,

a. ✓I combine **every** theory of quantification

b. # I combine **each** theory of quantification

(3) Which book did you loan to **each** student?

Frankenstein to Frank

Persuasion to Paula

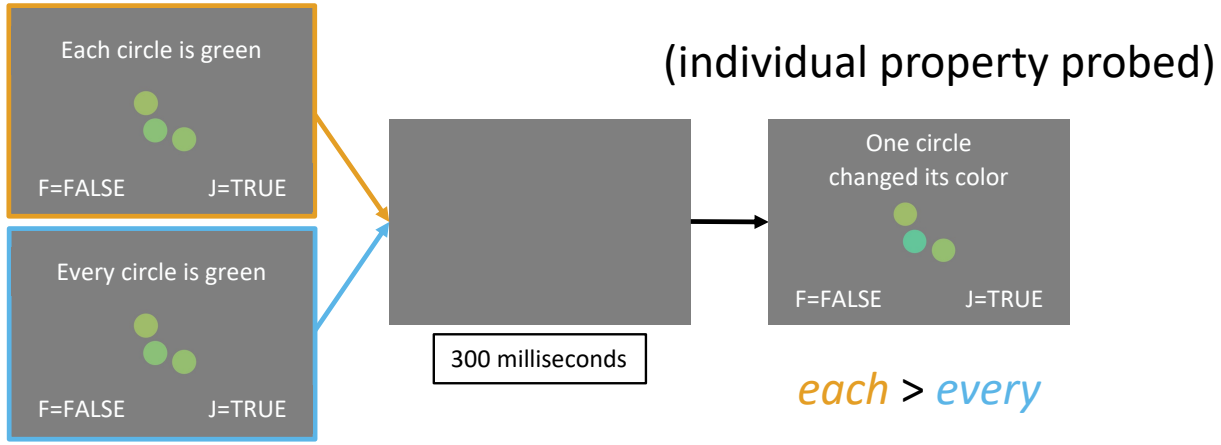
Dune to Dani

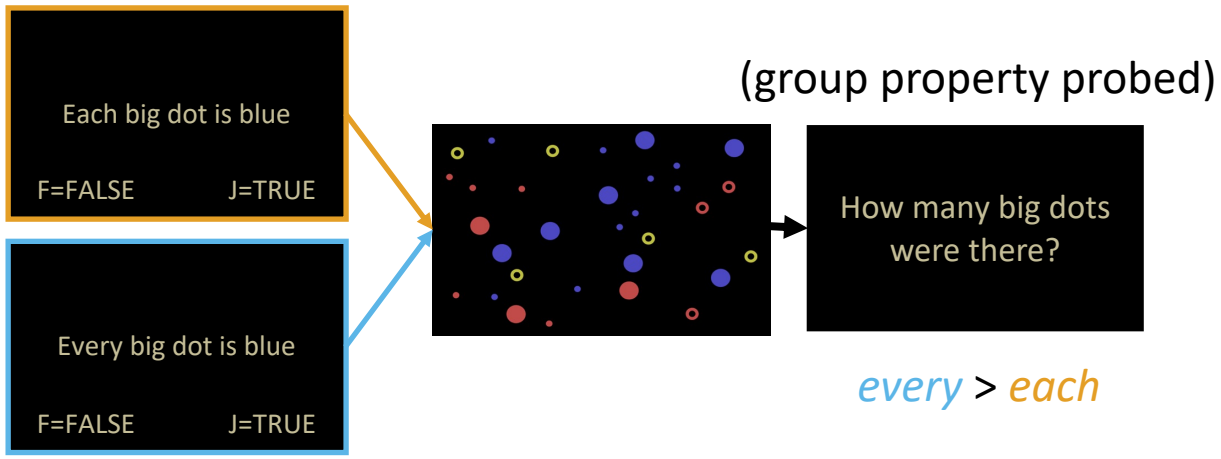
(4) Which book did you loan to **every** student?

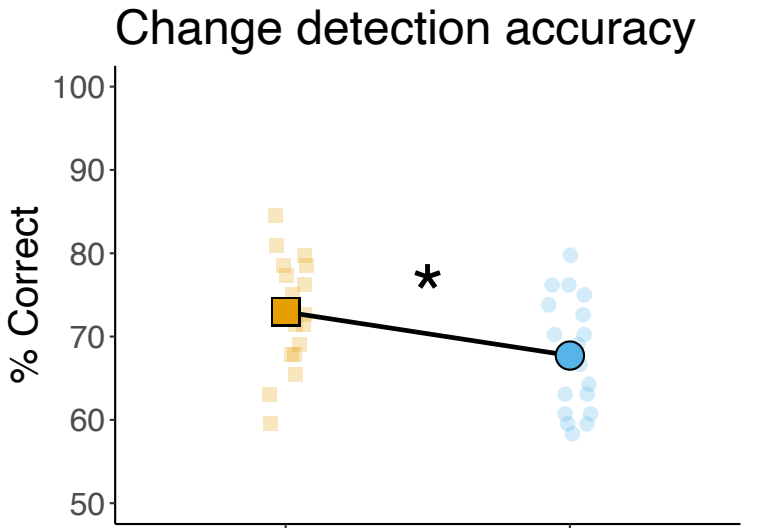
A: *There's no one book I loaned to every student*

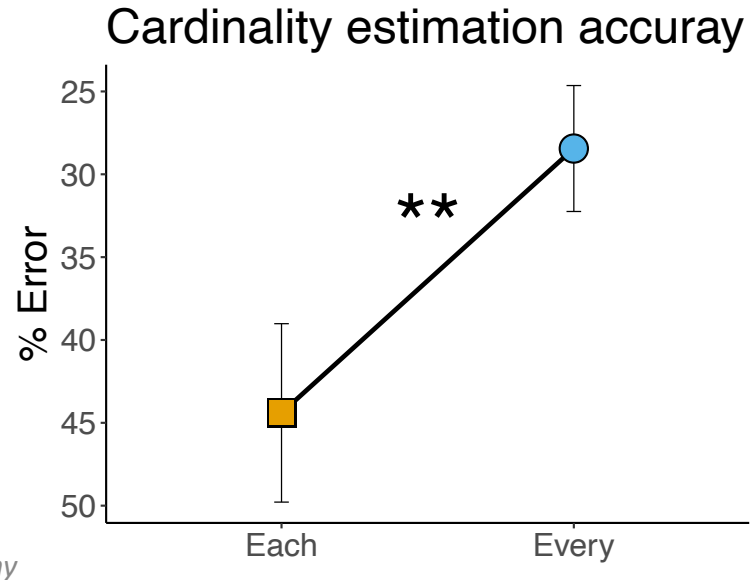
e.g., Vendler 1962; Beghelli & Stowell 1997; Beghelli 1997; Tunstall 1998; Landman 2003; Surányi 2003

Each is more individualistic than *every*









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Psycho-semantic proposal

"Each frog is green"

∀x:Frog(x)[Green(x)]

Individuate the frogs

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"Each frog is green"

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"Every frog is green"

TheF:Frog(F)[∀x:F(x)[Green(x)]]

Group the frogs

Psycho-semantic proposal

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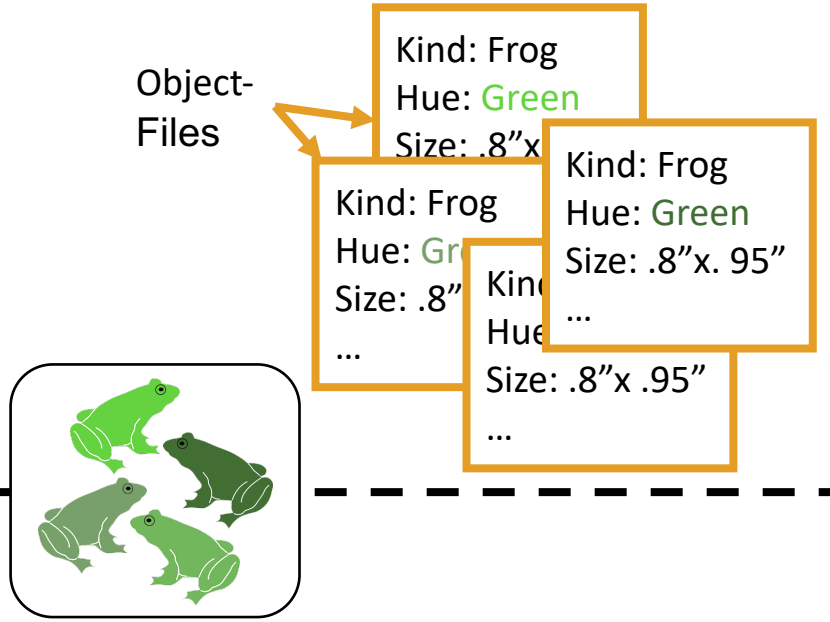
Individuate the frogs



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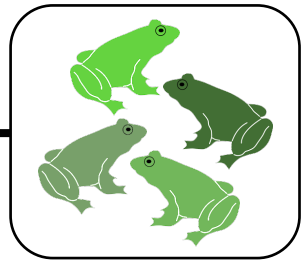

Object-Files

Kind: Frog
Hue: Green
Size: .8"x

Kind: Frog
Hue: Gr
Size: .8"
…

Kind: Frog
Hue: Green
Size: .8"x. 95"
…

Kin
Hue
Size: .8"x .95"
…

"Every frog is green"

TheF:Frog(F)[∀x:F(x)[Green(x)]]

Group the frogs

Kind: Frogs
Average Hue: Green
Average Size: .8" x .95"
Cardinality: 4
…

Ensemble

Psycho-semantic proposal

"Each frog is green"

∀x:Frog(x)[Green(x)]

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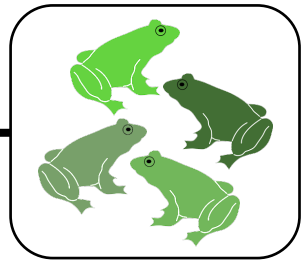

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Group the frogs

Kind: Frogs
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Average Size: .8" x .95"
Cardinality: 4
…

Ensemble

Object-files

➥ Individual properties encoded

(e.g., Kahneman & Treisman 1984; Kahneman et al. 1992; Xu & Chen 2009; Carey 2009)

➥ Strict working memory limit

(e.g., Vogel et al. 2001; Feigenson & Carey 2005; Wood & Spelke 2005; Alvarez & Franconeri 2007)

Ensembles

➥ Summary statistics encoded

(e.g., Ariely 2001; Chong & Treisman 2003; Haberman & Whitney 2011; Sweeny et al. 2015)

➥ No working memory limit

(e.g., Halberda et al. 2006; Zosh et al. 2011; Alvarez & Oliva 2008; Im & Halberda 2013)

Roadmap

✓ **Linguistic & Psycholinguistic data**

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Novel predictions about pragmatic use

➥ Quantifying over small & local vs. large & global domains

Predictions

Those representations should lead to downstream pragmatic consequences:

All else equal, *every* should be preferred for

➥ larger domains of quantification

➥ generalizing beyond locally-established domain

Object-files (*each*)

➥ Individual properties encoded
(e.g., Kahneman & Treisman 1984; Kahneman et al. 1992; Xu & Chen 2009; Carey 2009)

➥ Strict working memory limit
(e.g., Vogel et al. 2001; Feigenson & Carey 2005; Wood & Spelke 2005; Alvarez & Franconeri 2007)

Ensembles (*every*)

➥ Summary statistics encoded
(e.g., Ariely 2001; Chong & Treisman 2003; Haberman & Whitney 2011; Sweeny et al. 2015)

➥ No working memory limit
(e.g., Halberda et al. 2006; Zosh et al. 2011; Alvarez & Oliva 2008; Im & Halberda 2013)

Prediction 1: *every* is better for larger domains

The bartender at the local tavern has made three martinis.

He said that {**each**/every} martini he made had an olive.

The bartender at the local tavern has made three thousand martinis.

He said that {each/**every**} martini he made had an olive.

12 items; within-subjects; n=100

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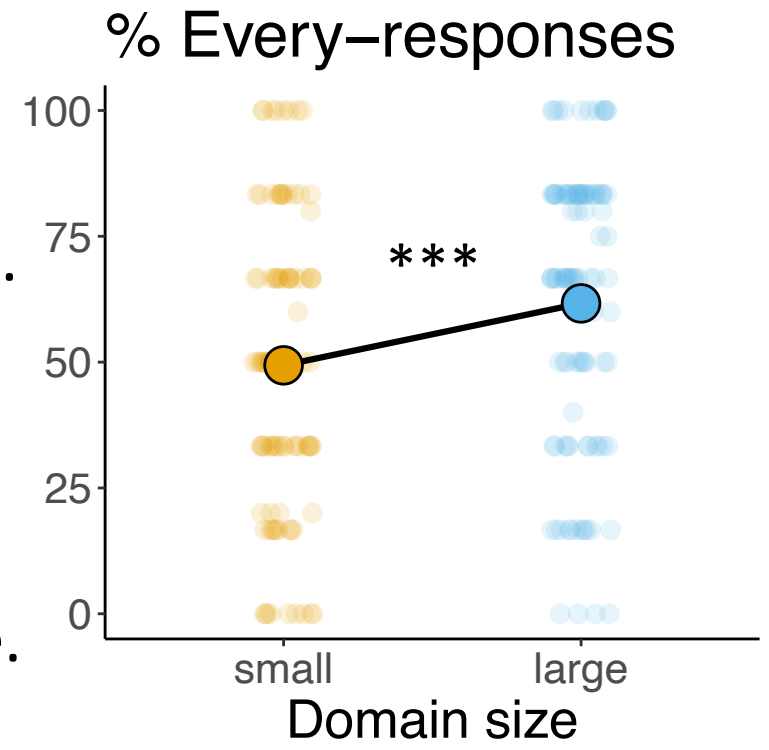
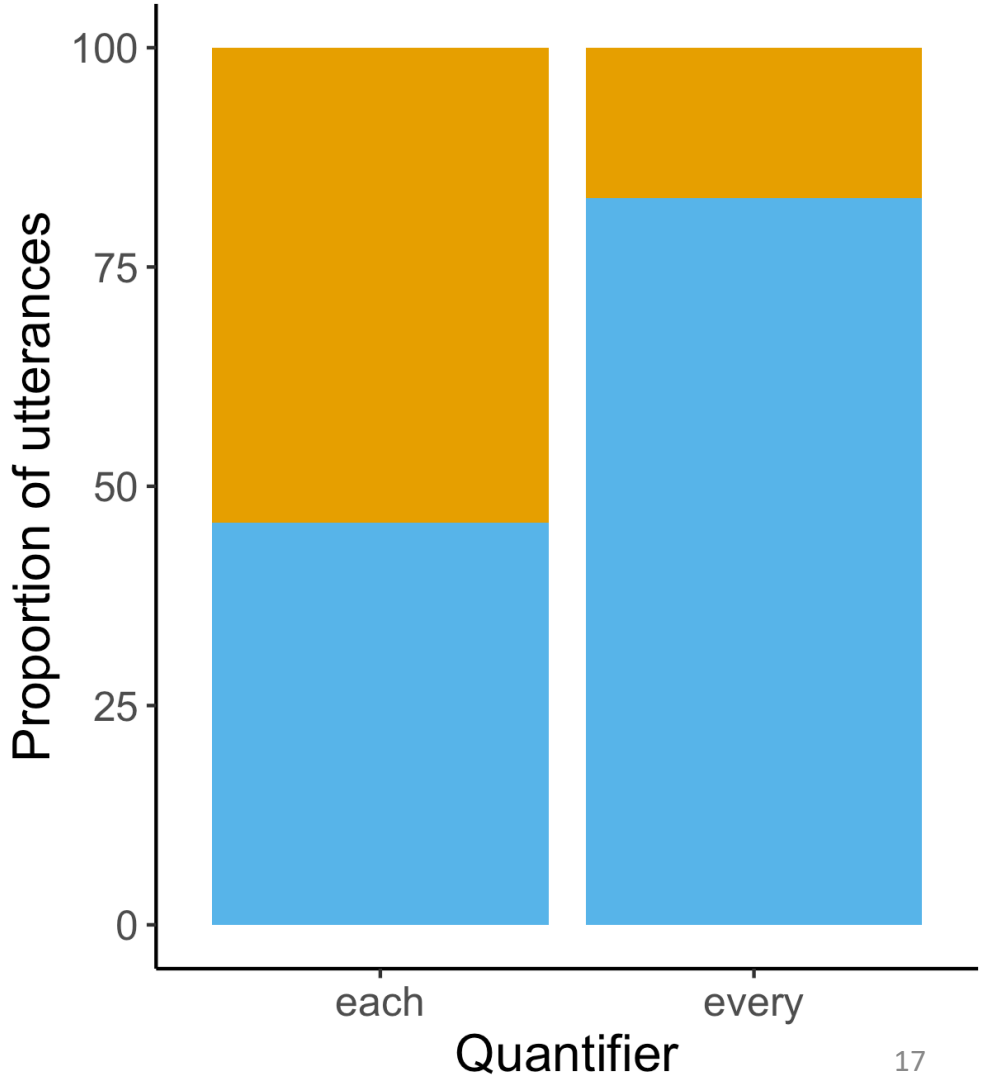


12 items; within-subjects; n=100

Prediction 1: *every* is better for larger domains

Parent-Child interaction from the Language Development Project corpus

"You want one bite of each piece, huh?"



Prediction 1: *every* is better for larger domains

If someone said

Each martini needs an olive

how many martinis would you guess they have in mind?

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If someone said

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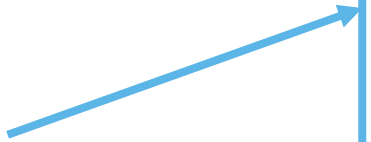

"all martinis generally"
"all martinis!"
"every martini ever made"
"every one that is made"
"an unlimited amount"
"as many as there are in the world"

how many martinis would you guess they have in mind?

% responses below 4:
Each: 67%
Every: 30%

χ^2=11.97, p<.001

1 item; n=198

Prediction 2: *every* is better for generalizing

Each martini needs an olive ≈ some particular cocktails need garnishes

Every martini needs an olive ≈ part of a cocktail recipe

Ensembles

➥ No working memory limit (can support arbitrarily large domains)
(e.g., Halberda et al. 2006; Zosh et al. 2011; Alvarez & Oliva 2008; Im & Halberda 2013)

➥ Represented in terms of summary statistics
(e.g., Ariely 2001; Chong & Treisman 2003; Haberman & Whitney 2011; Sweeny et al. 2015)

Prediction 2: *every* is better for generalizing

The bartender at the local tavern made a few martinis.

He said that {**each**/every} martini that he made
has an olive.

He said that {each/**every**} martini that's worth drinking
has an olive.

12 items; within-subjects; n=100

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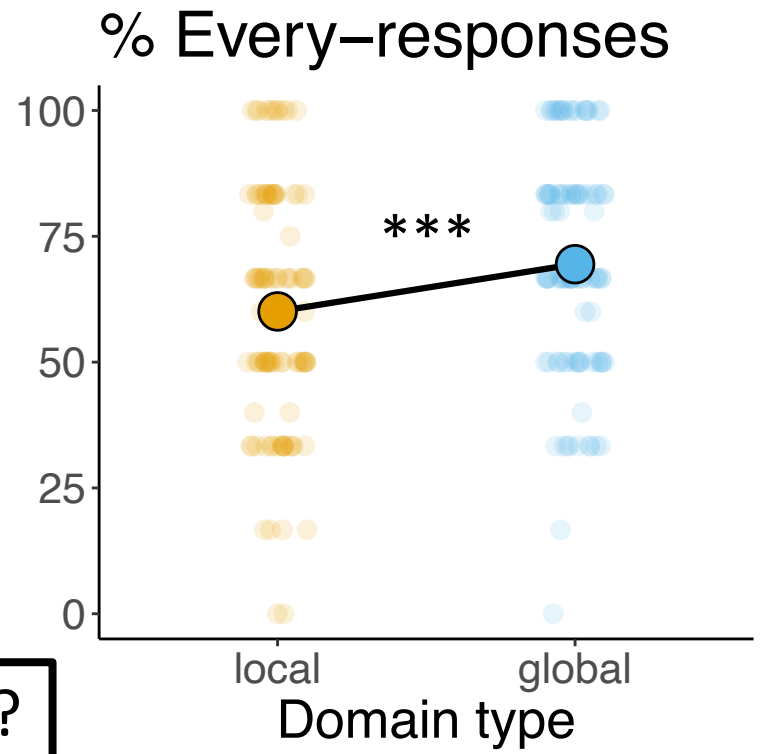

Isn't this just domain size all over again?

|Martinis worth drinking| >
|Martinis the bartender made|

ms; within-subjects; n=100

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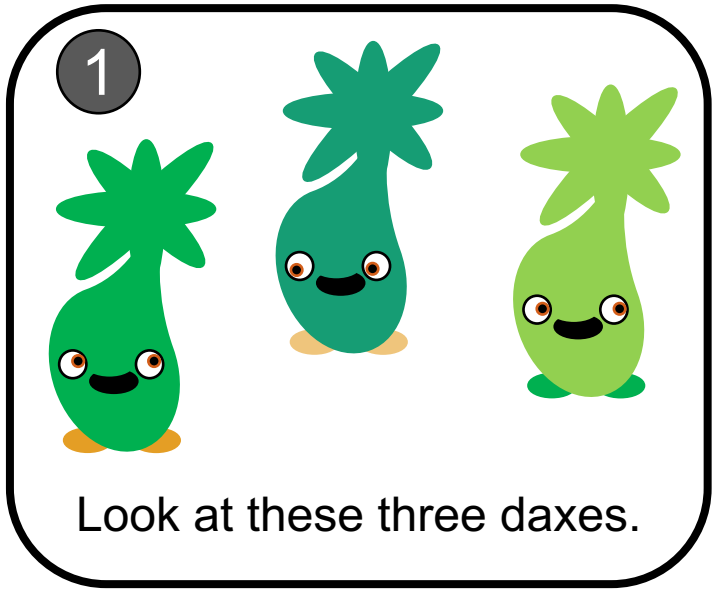

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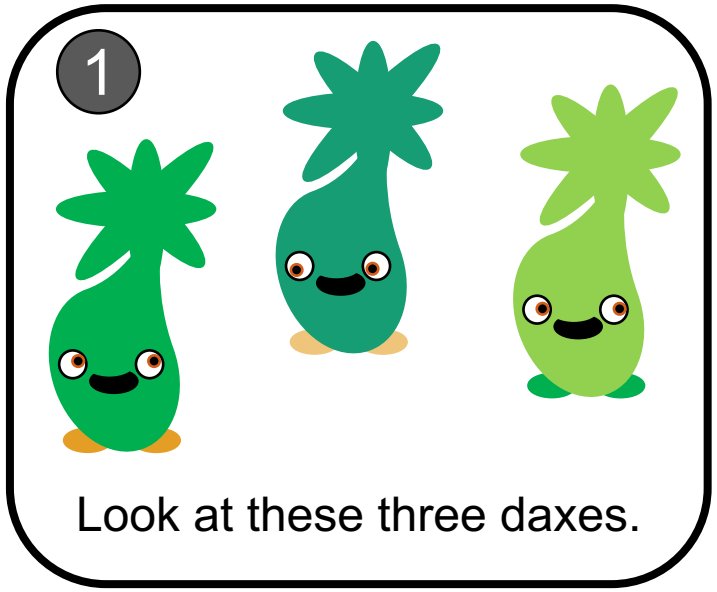

Prediction 2: *every* is better for generalizing

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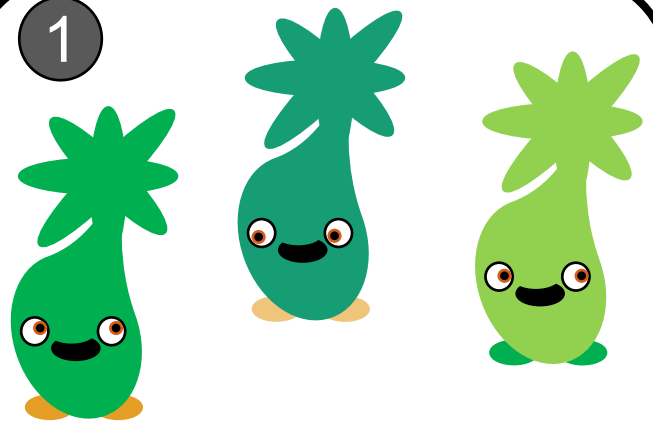
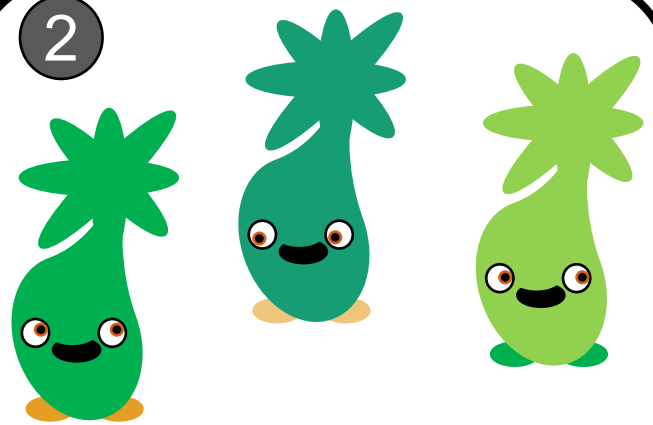


Look at these three daxes.

2



Each/Every dax is green.

3

There's another dax under that tree, hidden by the shadow.

Prediction 2: *every* is better for generalizing

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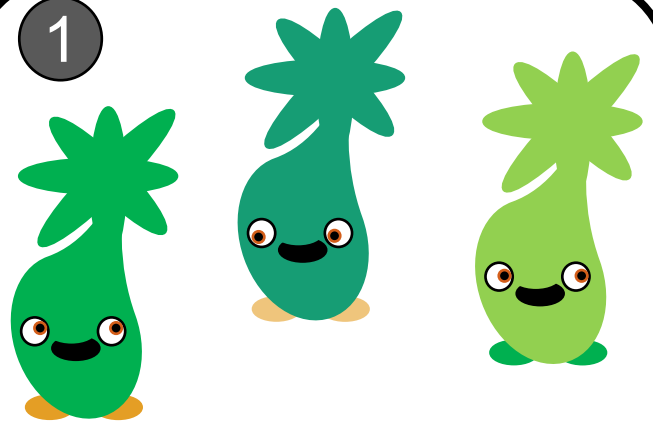

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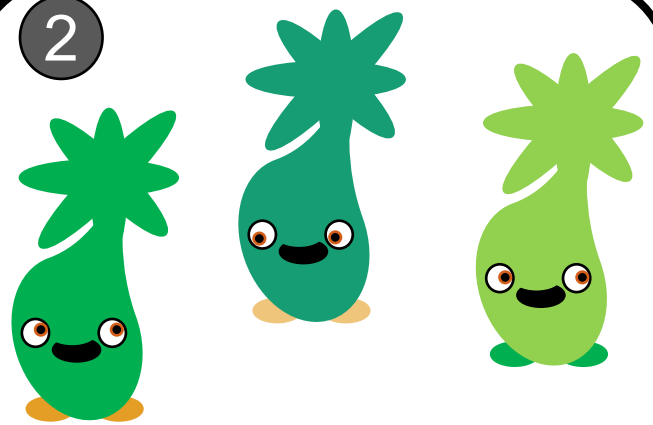

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How confident are you that this dax is green?

Prediction 2: *every* is better for generalizing

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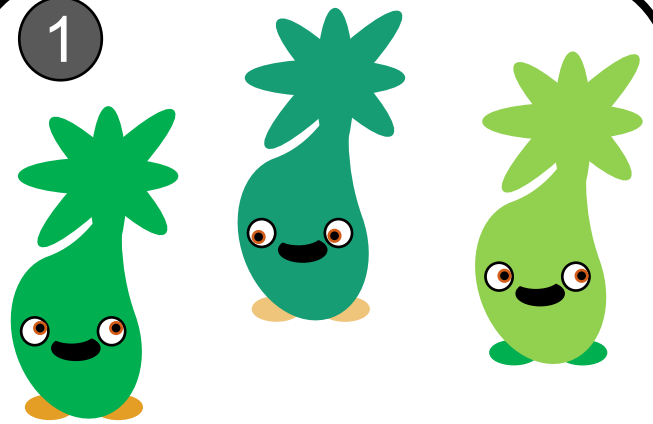

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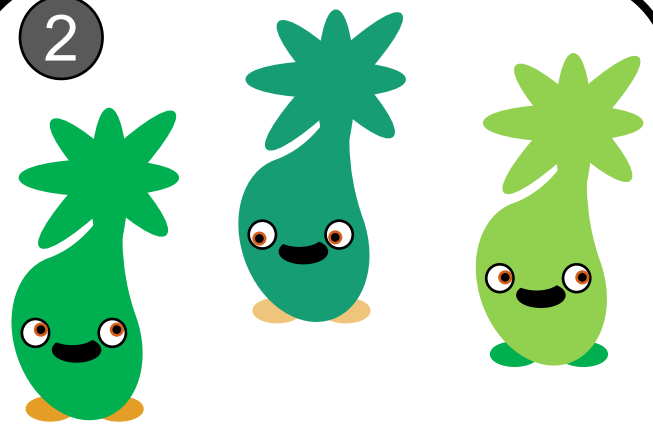

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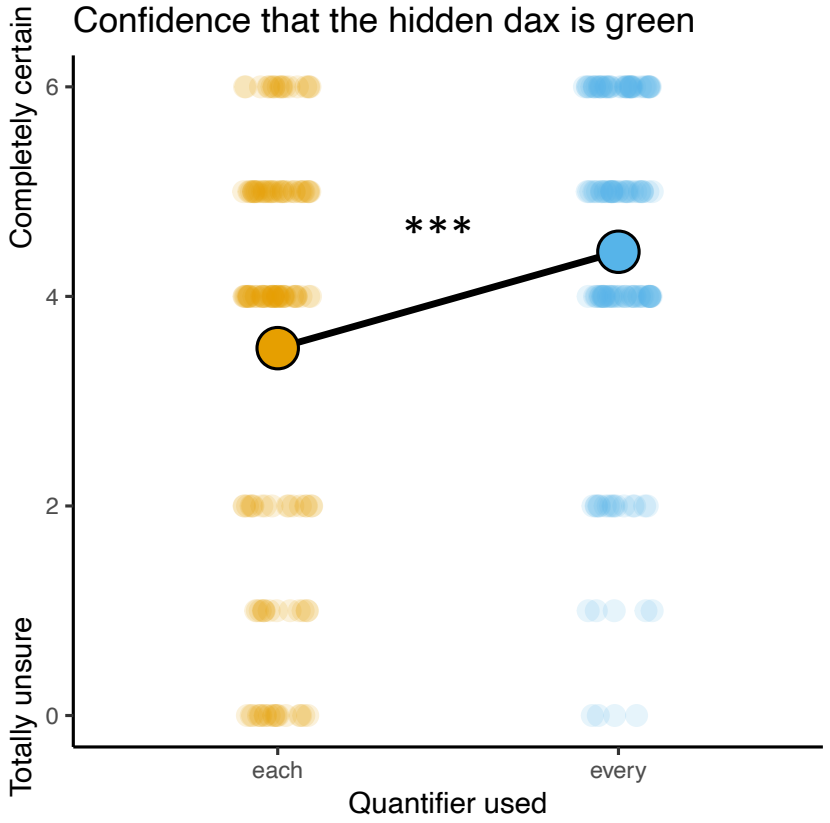

1 item; n=300

Prediction 2: *every* is better for generalizing

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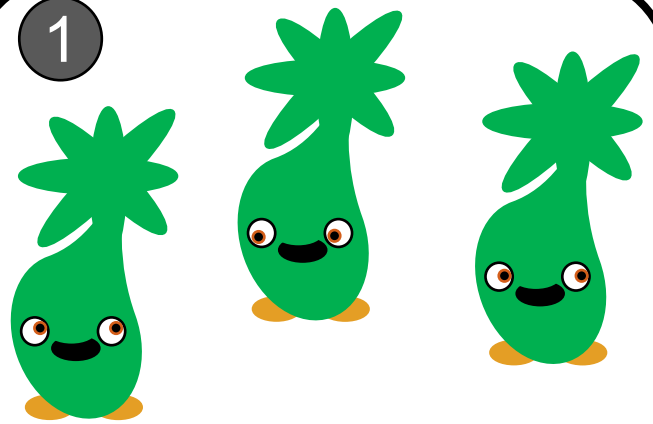

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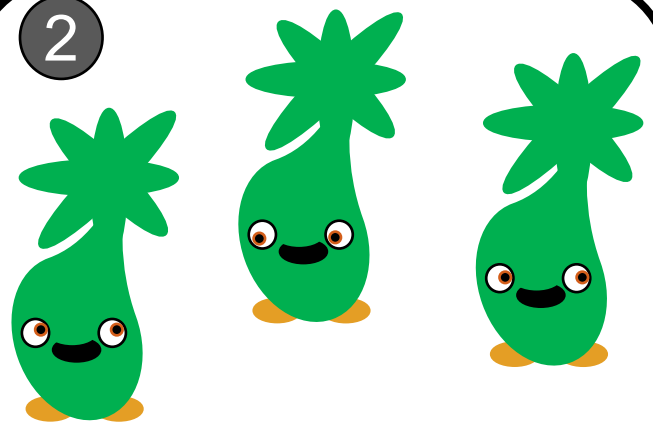

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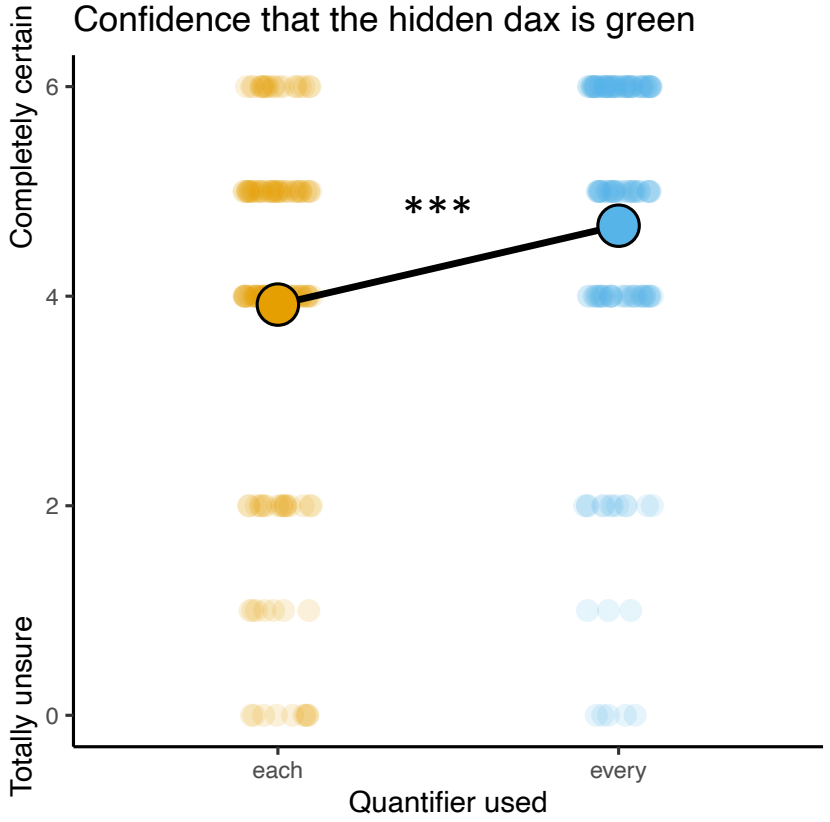

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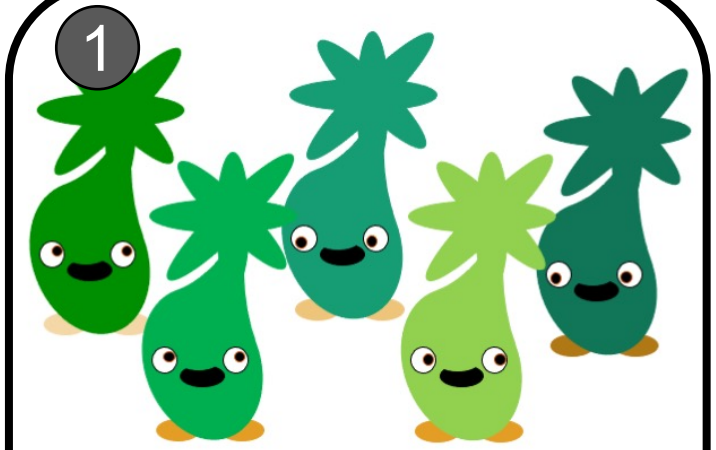

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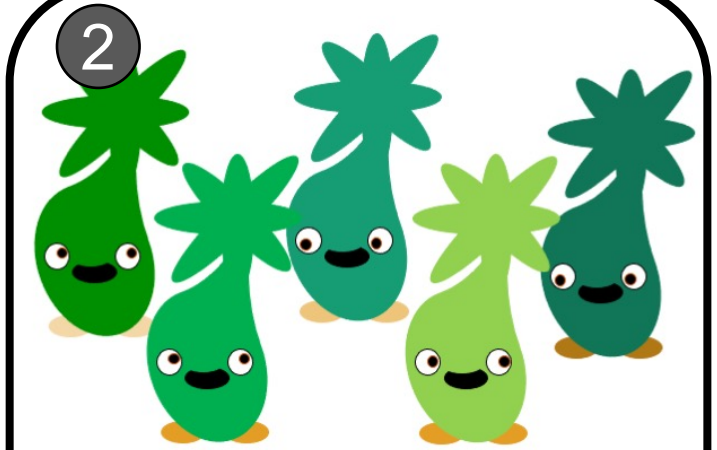

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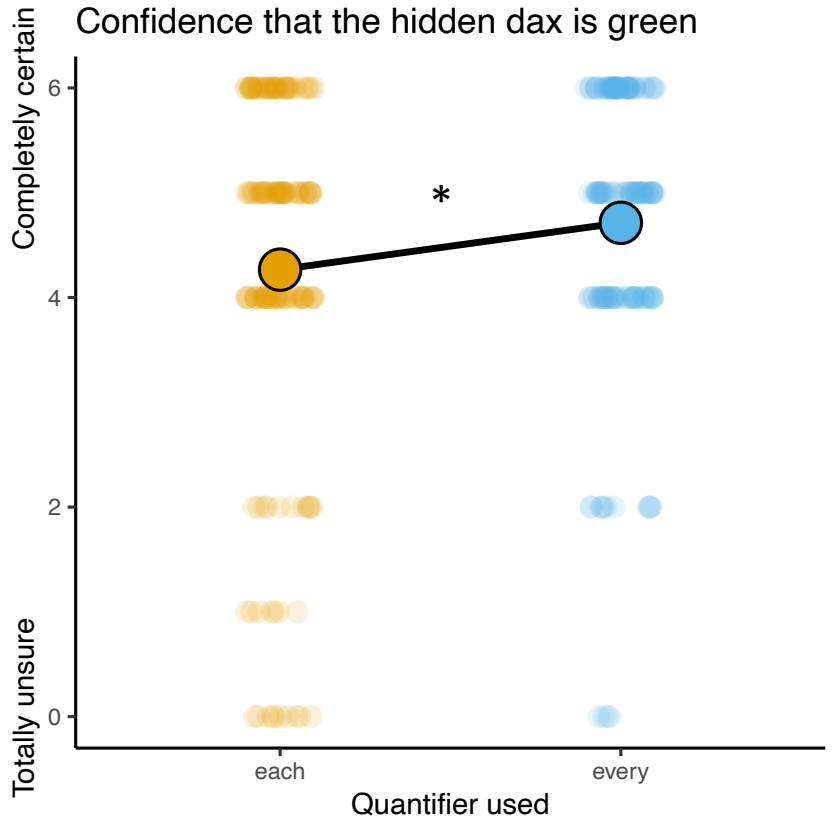

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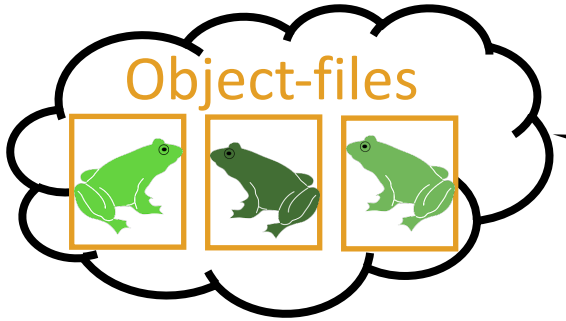
✓ Quantifying over local domains vs. generalizing

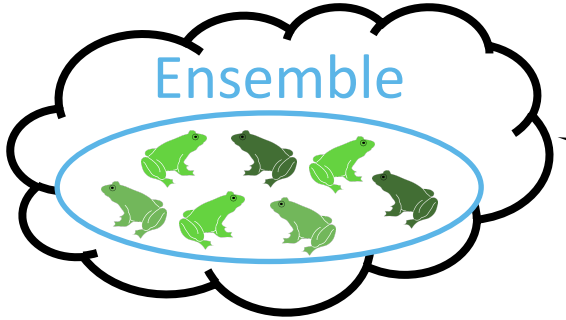
Conclusions

∀x:Frog(x)[Green(x)]



Each frog is green
(small, local domain)

TheF:Frog(F)
[∀x:F(x)[Green(x)]]



Every frog is green
(large, global domain)

➥ Formal semantic differences

➥ distinct non-linguistic cognitive systems

➥ predictions about pragmatic preferences

Thanks (to each & every one of you) for listening!

Special thanks to these helpful discussants:

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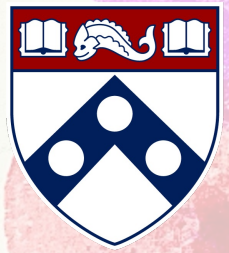
Liz Brannon
Dan Swingley
Charles Yang
Sandy LaTourrette
Ellen Lau
Ugurcan Vurgun
Sarah Lee



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Language and Cognition Lab

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Center for Outreach, Research, and Education