

A psycho-semantic explanation *of each and every* quantifier use

Tyler Knowlton, John Trueswell, Anna Papafragou

University of Pennsylvania

ELM 2 - 5.20.22

Each is more individualistic than *every*

Each is more individualistic than *every*

- (1) Which book did you loan to **each** student?
- a. ✓ *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani

Each is more individualistic than *every*

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

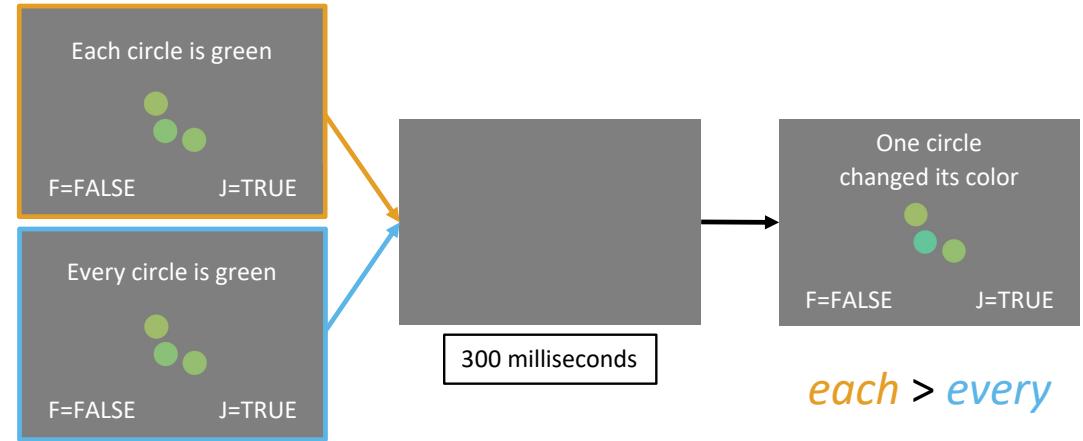
- a. ✓ *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani

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

- a. # *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani
- b. ✓ There's no one book I loaned to every student

Each is more individualistic than *every*

- (1) Which book did you loan to **each** student?
- ✓ *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani

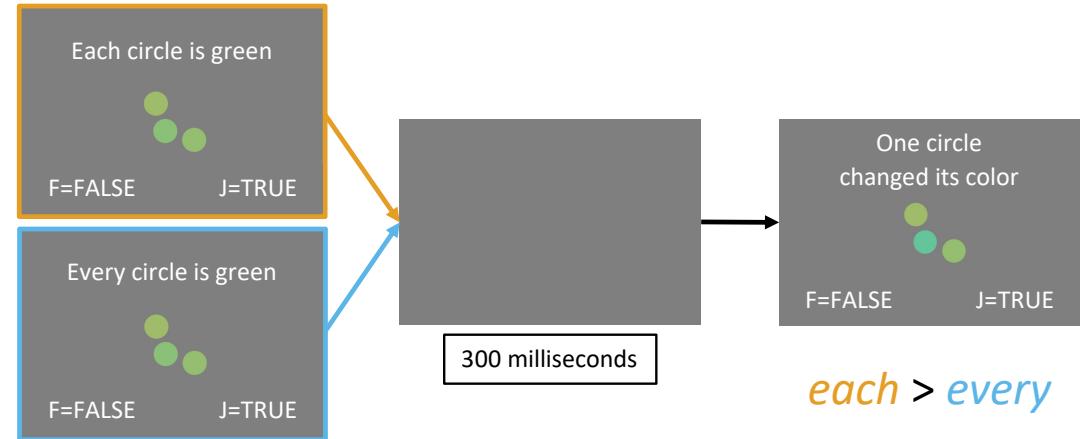


- (2) Which book did you loan to **every** student?
- # *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani
 - ✓ There's no one book I loaned to every student

Each is more individualistic than *every*

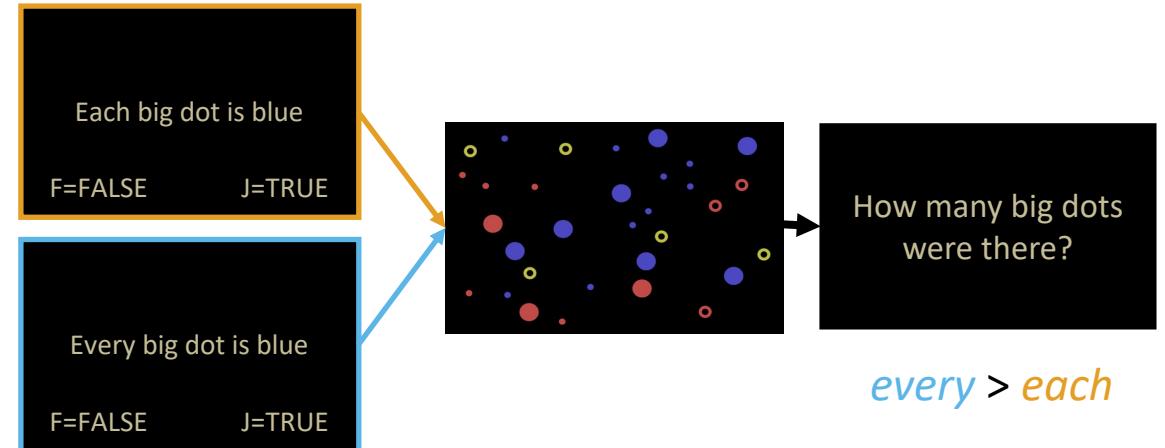
(1) Which book did you loan to **each** student?

- a. ✓ *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani



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

- a. # *Frankenstein* to Frank, *Persuasion* to Paula,
and *Dune* to Dani
- b. ✓ There's no one book I loaned to **every** student



Psycho-semantic proposal

“**Each** frog is green”

$\forall x:\text{Frog}(x)[\text{Green}(x)]$

Individuate the frogs

Psycho-semantic proposal

“**Each** frog is green”

$\forall x:\text{Frog}(x)[\text{Green}(x)]$

Individuate the frogs

“**Every** frog is green”

The **F**: $\text{Frog}(F)[\forall x:F(x)[\text{Green}(x)]]$

Group the frogs

Psycho-semantic proposal

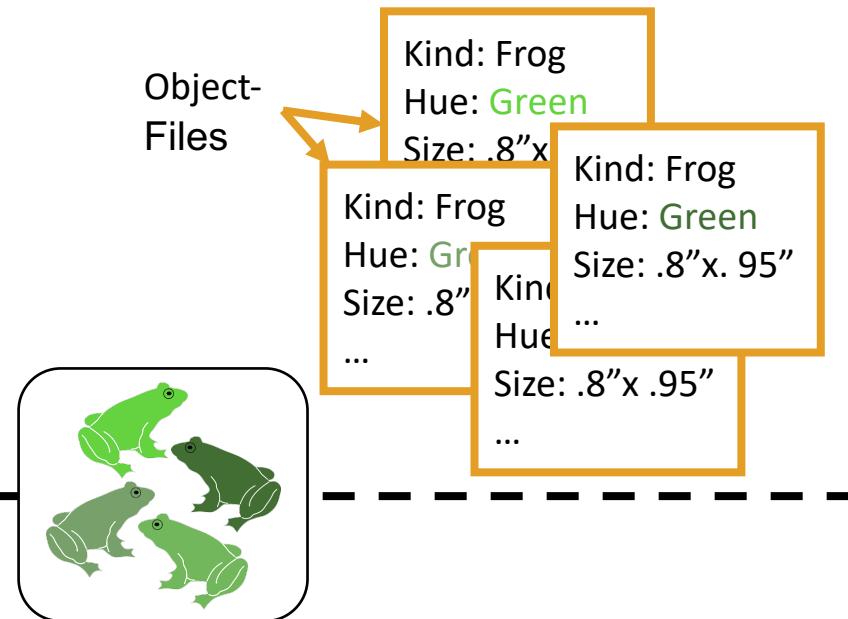
“**Each** frog is green”

$\forall x:\text{Frog}(x)[\text{Green}(x)]$

Individuate the frogs

“**Every** frog is green”

$\text{The } F:\text{Frog}(F)[\forall x:F(x)[\text{Green}(x)]]$



Group the frogs

Psycho-semantic proposal

“Each frog is green”

$\forall x: \text{Frog}(x)[\text{Green}(x)]$

Individuate the frogs

“Every frog is green”

$\text{The } F: \text{Frog}(F)[\forall x: F(x)[\text{Green}(x)]]$

Group the frogs

Object-
Files

Kind: Frog

Hue: Green

Size: .8"x

Kind: Frog

Hue: Gr

Size: .8"

...

...

Kind: Frog

Hue: Green

Size: .8"x. 95"

Kind: ...

Hue: ...

Size: .8"x .95"

...

Kind: Frogs

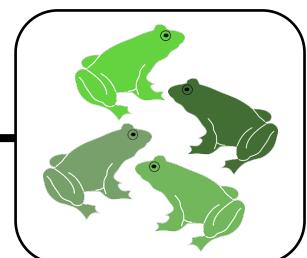
Average Hue: Green

Average Size: .8" x .95"

Cardinality: 4

...

Ensemble

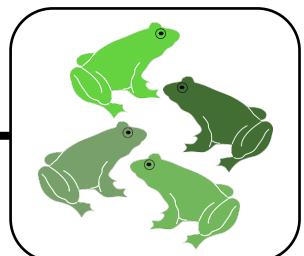


Psycho-semantic proposal

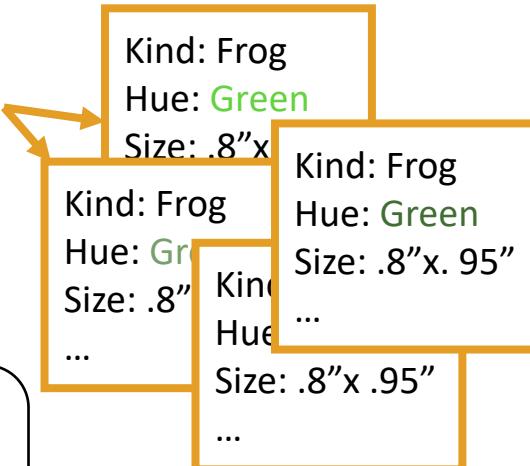
“Each frog is green”

$\forall x: \text{Frog}(x)[\text{Green}(x)]$

Individuate the frogs



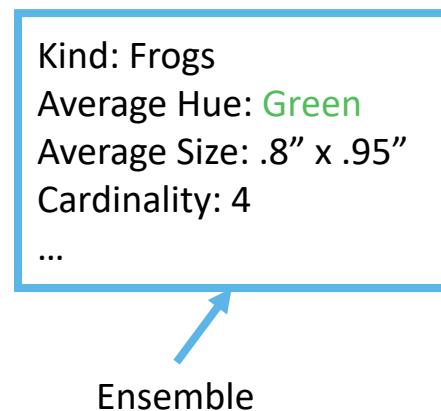
Object-
Files



“Every frog is green”

$\text{The } F: \text{Frog}(F)[\forall x: F(x)[\text{Green}(x)]]$

Group the frogs



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)

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

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

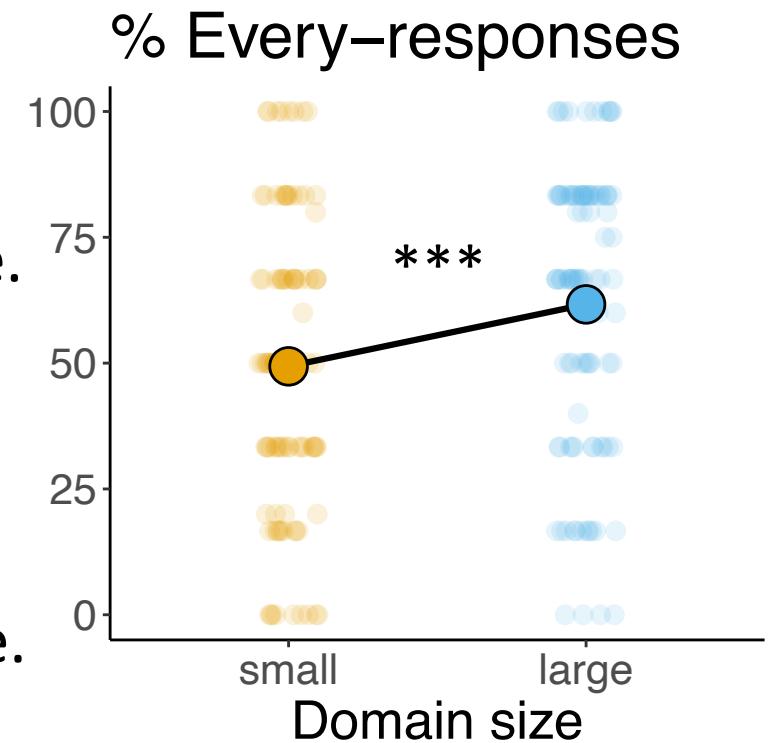
Every is better for larger domains

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

Every is better for larger domains

If someone said

Each martini needs an olive

how many martinis would you guess they have in mind?

1 item; n=198

Every is better for larger domains

If someone said

Each/Every martini needs an olive

how many martinis would you guess they have in mind?

% responses below “4”:

Each: 67%

Every: 30%

1 item; n=198

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.

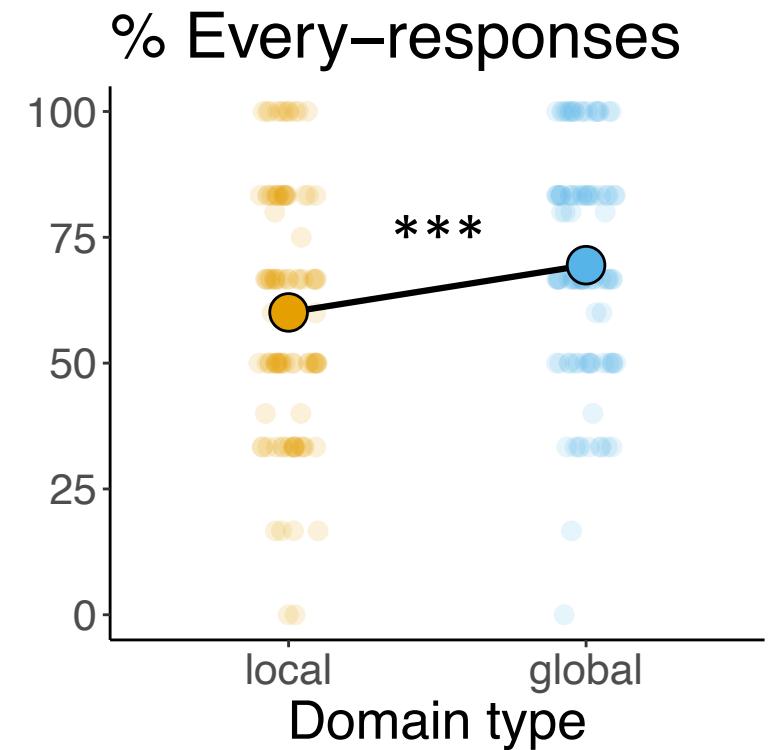
12 items; within-subjects; n=100

Every is better for generalizing

The bartender at the local tavern made a few martinis.

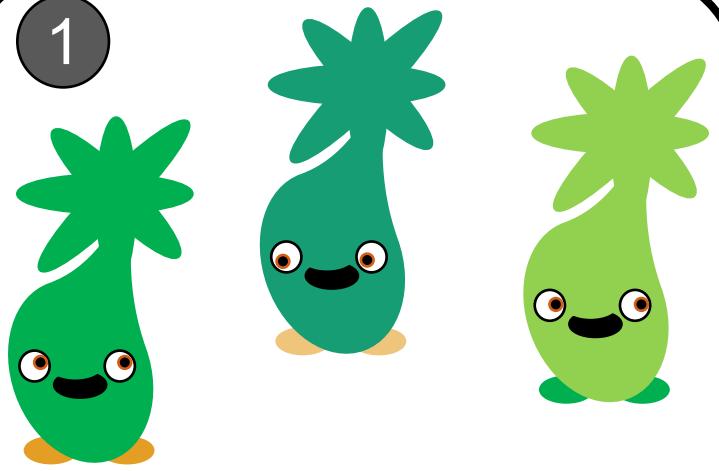
He said that {each/every} martini **that he made** has an olive.

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



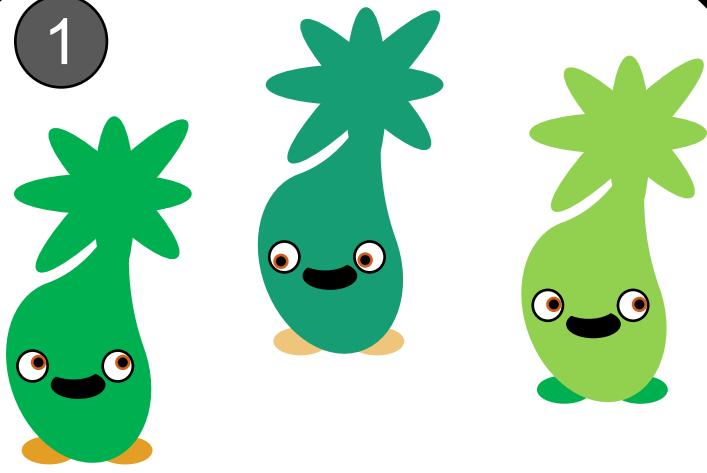
12 items; within-subjects; n=100

1



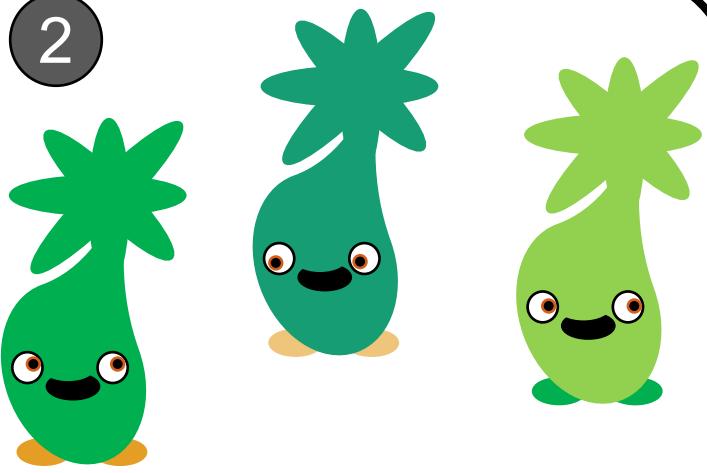
Look at these three daxes.

1



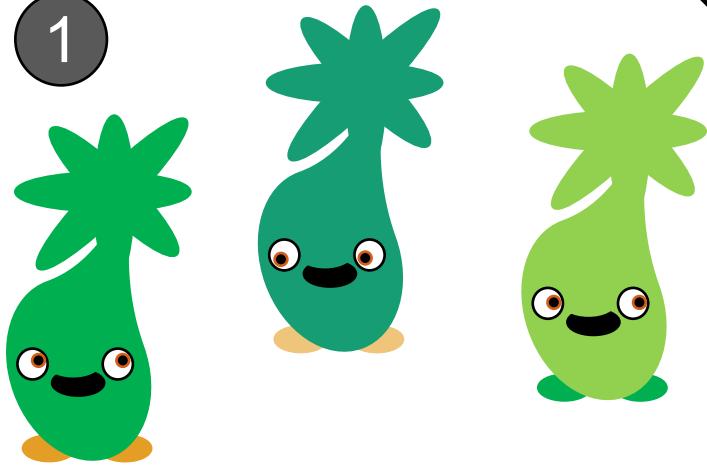
Look at these three daxes.

2



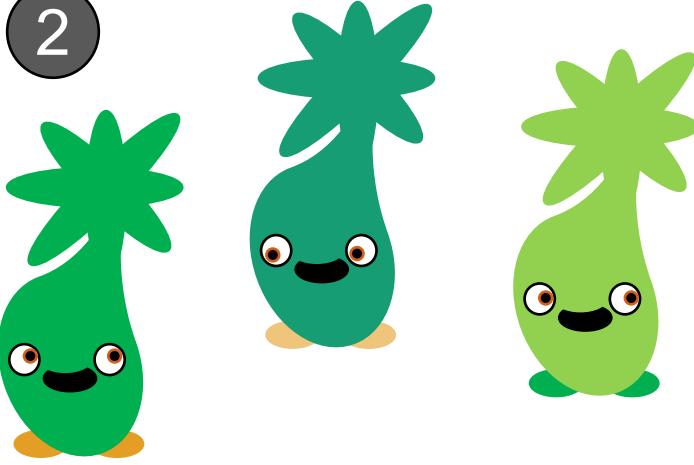
Each/Every dax is green.

1



Look at these three daxes.

2



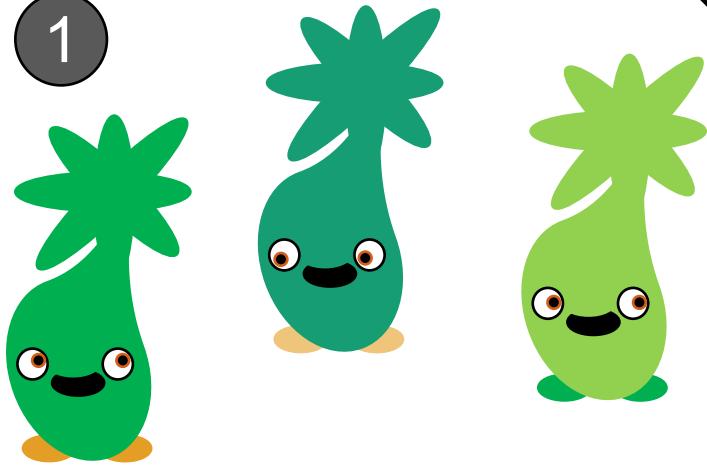
Each/Every dax is green.

3



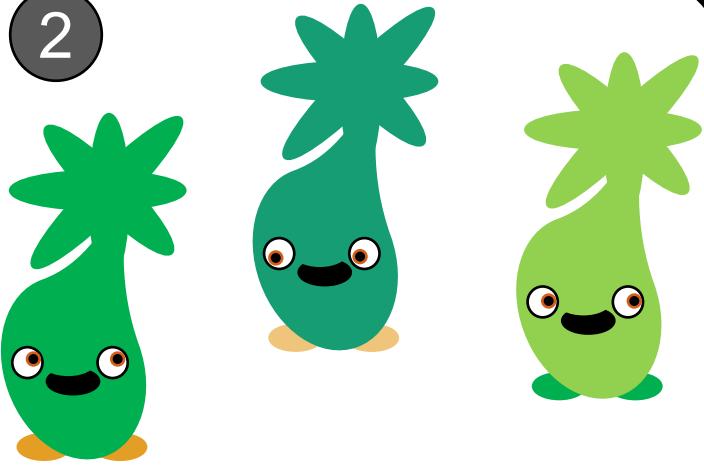
There's another dax under that tree, hidden by the shadow.

1



Look at these three daxes.

2



Each/Every dax is green.

3

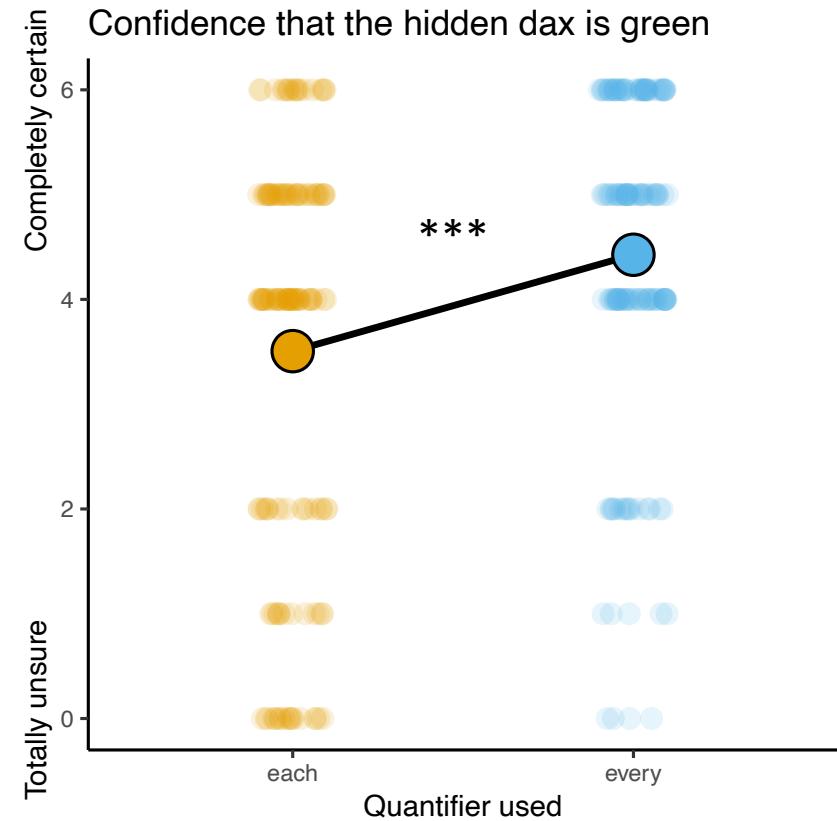
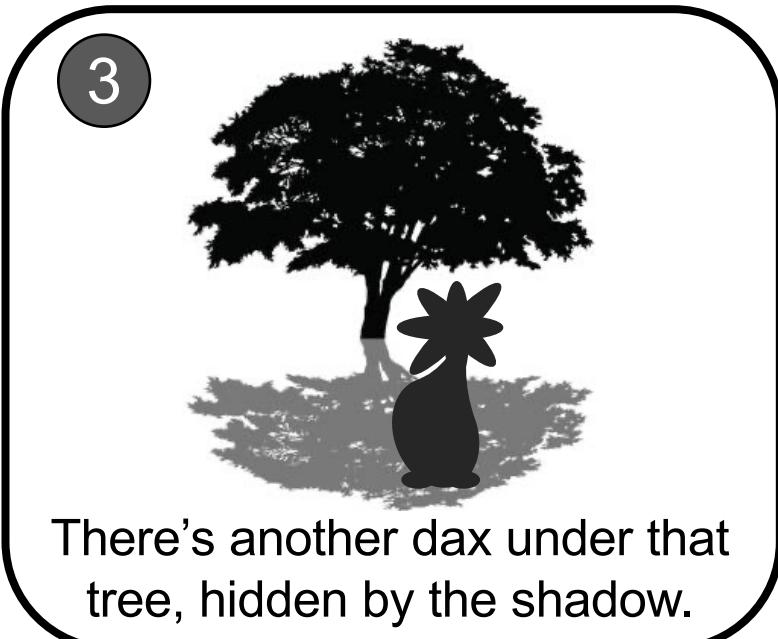
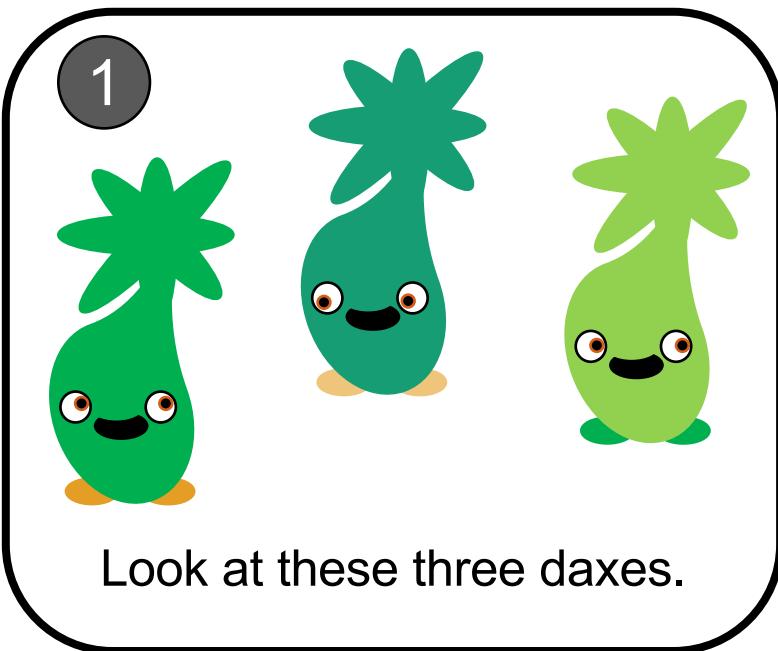


There's another dax under that tree, hidden by the shadow.

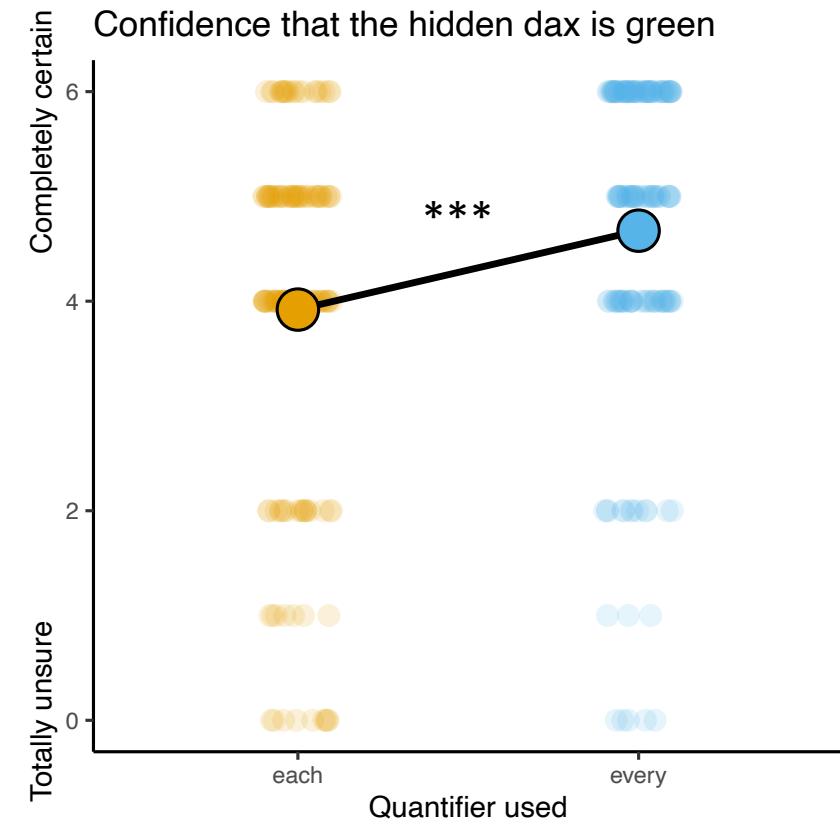
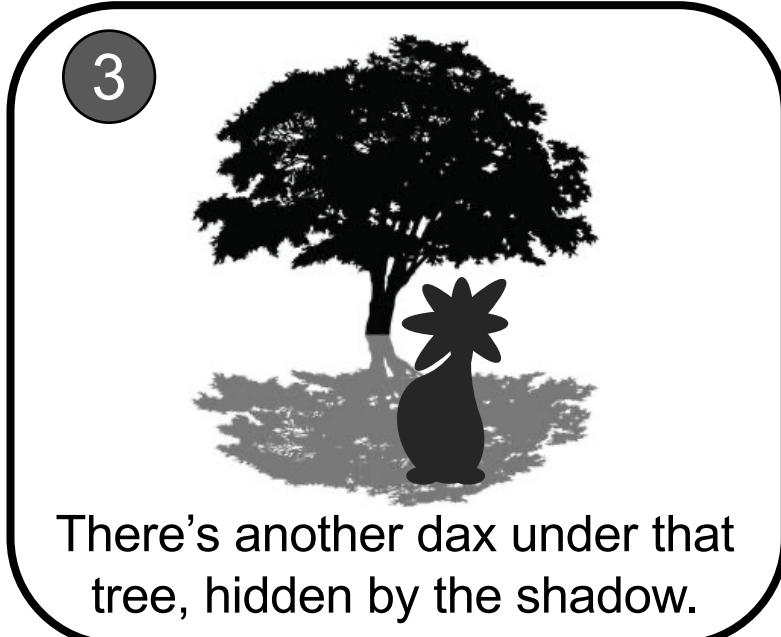
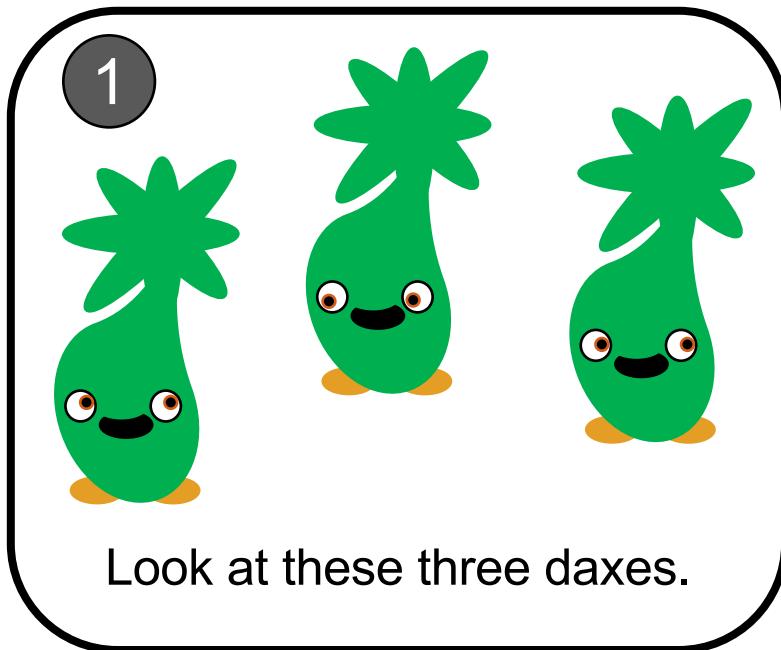
4



How confident are you that this dax is green?



1 item; n=300



1 item; n=300

Conclusions

Narrow:

- first-order *each* connected to object-files vs.
second-order *every* connected to ensembles

Broad:

- Mentalistic semantics
- + Non-linguistic cognitive systems
- = Predictions about pragmatic preferences

Thanks!

Special thanks to:

Jeff Lidz

Paul Pietroski

Justin Halberda

Alexander Williams

Florian Schwarz

Victor Gomes

Nicolò Cesana-Arlotti

Liz Brannon

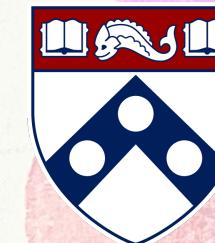
Dan Swingley

Charles Yang

Sandy LaTourrette

Zoe Ovans

Ellen Lau



Penn
UNIVERSITY of PENNSYLVANIA



The Language Learning Lab



Language and Cognition Lab

mindCORE

Center for Outreach, Research, and Education