# Conservative meanings with only one set:
## evidence from verification

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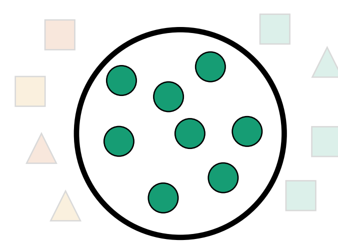
# Relating processing strategies & semantic theory

"Every circle is green"



**Verification strategy**:
only represent one set (CIRCLES)

Default strategy = implement meaning

Pietroski et al. (2009)
Lidz et al. (2011)
Odic et al. (2018)
Knowlton et al. *under review*

**Meaning representation**:
implicates only one set

If *every*'s meaning generalizes

**Conservativity universal**:
follows from one-set meanings

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## All quantifiers are conservative!

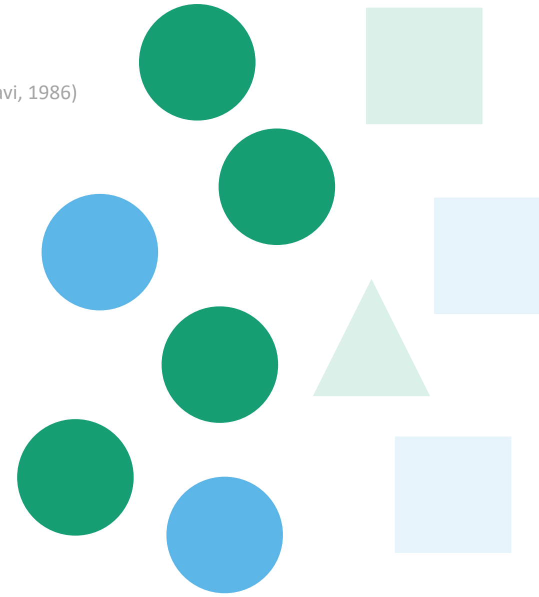
(Barwise & Cooper, 1981; Higginbotham & May, 1981; Keenan & Stavi, 1986)

Some **circles** are green

Most **circles** are green

Every **circle** is green

____ **circles** are green



3

## All quantifiers are conservative!

(Barwise & Cooper, 1981; Higginbotham & May, 1981; Keenan & Stavi, 1986)

A quantifier Q is conservative iff
$Q(X, Y) \leftrightarrow Q(X, X \cap Y)$

Some **circles** are green ⟷ Some **circles** are green **circles**

Most **circles** are green ⟷ Most **circles** are green **circles**

Every **circle** is green ⟷ Every **circle** is a green **circle**

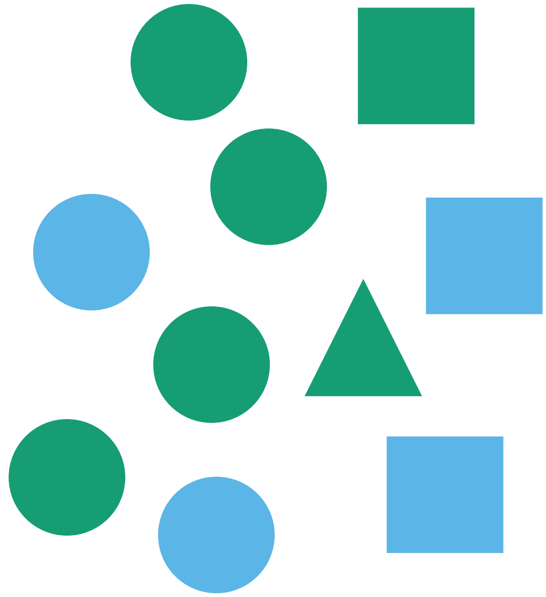
____ **circles** are green ⟷ ____ **circles** are green **circles**

4

## Made up
## non-conservative quantifiers

Equi circles are green

≈ *the circles are the green things*



5

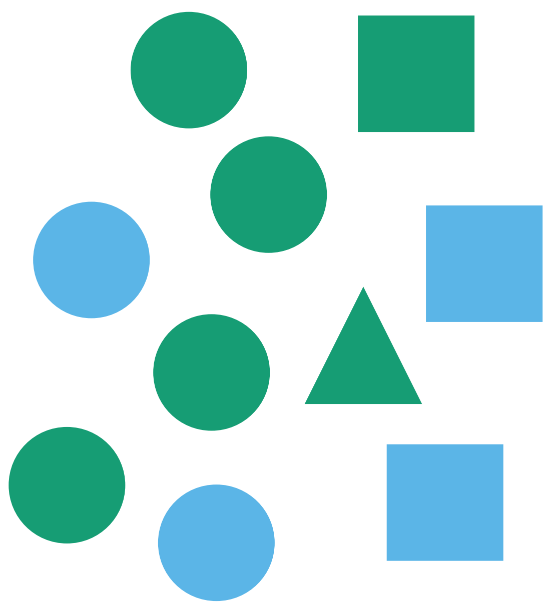
## Made up
## non-conservative quantifiers

Equi circles are green

≈ *the circles are the green things*

Yreve circle is green

≈ *the circles include all green things*



6

## Made up
## non-conservative quantifiers

Equi circles are green

≈ *the circles are the green things*

Yreve circle is green

≈ *the circles include all green things*

Everynon circle is green

≈ *every non-circle is green*

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## Made up
## non-conservative quantifiers

A quantifier Q is conservative iff
$Q(X, Y) \leftrightarrow Q(X, X \cap Y)$

Equi circles are green

≈ *the circles are the green things* ↮ *the* ***circles*** *are the green* ***circles***

Yreve circle is green

≈ *the circles include all green things* ↮ *the* ***circles*** *include all green* ***circles***

Everynon circle is green

≈ *eve*

A deep fact about the language faculty: 5 year-olds can't learn novel non-conservative determiners! (Hunter & Lidz, 2012)

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Our semantic theory should:

Let us state *Every*, *Most*, *Some*, …

But not *Equi*, *Yreve*, *Everynon*, …

**Three proposals**:

Lexical restriction

Interface filtering

One-set meanings

quantifier Q is conservative iff
$Q(X, Y) \longleftrightarrow Q(X, X \cap Y)$

*circles are the green circles*

*he circles include all green circles*

culty: 5 year-olds can't learn novel non-conservative determiners! (Hunter & Lidz, 2012)

9

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*circles are the green circles*

*he circles include all green circles*

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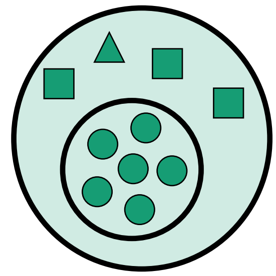
## Proposal 1: Lexical restriction

Quantifiers express relations between sets (Barwise & Cooper, 1981)

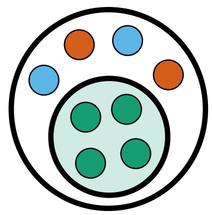
⟦**Every circle is green**⟧ ≈ CIRCLES ⊆ GREEN-THINGS

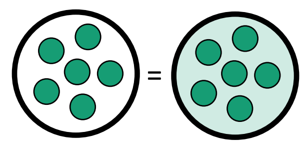


But only some relations make good meanings (Keenan & Stavi, 1986)

⟦**Yreve circle is green**⟧
≈ CIRCLES ⊇ GREEN-THINGS

⟦**Equi circles are green**⟧
≈ CIRCLES = GREEN-THINGS








Our semantic theory should:
Let us state *Every*, *Most*, *Some*, …
But not *Equi*, *Yreve*, *Everynon*, …

A quantifier Q is conservative iff
Q(X, Y) ⟷ Q(X, X∩Y)

**Three proposals**:

Lexical restriction Every(A, B) ≡ A ⊆ B

Interface filtering

One-set meanings

Our semantic theory should:
Let us state *Every*, *Most*, *Some*, …
But not *Equi*, *Yreve*, *Everynon*, …

A quantifier Q is conservative iff Q(X, Y) ⟷ Q(X, X∩Y)

**Three proposals**:

Lexical restriction Every(A, B) ≡ A ⊆ B

Interface filtering

One-set meanings

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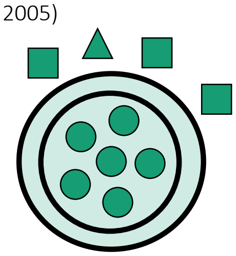
# Proposal 2: Interface filtering (Romoli, 2015; Chierchia, 1995; Fox, 2002; Sportiche, 2005)

⟦**Every circle is green**⟧

$=_{LF}$ [every circle [~~every circle~~ is green]]

≈ CIRCLES ⊆ CIRCLES ∩ GREEN-THINGS



⟦**Equi circles are green**⟧

≈ CIRCLES = CIRCLES ∩ GREEN-THINGS

= *every*!

⟦**Yreve circle is green**⟧

≈ CIRCLES ⊇ CIRCLES ∩ GREEN-THINGS

(always TRUE)

* Trivial meanings

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Our semantic theory should:

Let us state *Every*, *Most*, *Some*, …

But not *Equi*, *Yreve*, *Everynon*, …

A quantifier Q is conservative iff $Q(X, Y) \longleftrightarrow Q(X, X \cap Y)$

**Three proposals**:

Lexical restriction $Every(A, B) \equiv A \subseteq B$

Interface filtering $Every(A, B) \equiv A \subseteq A \cap B$

One-set meanings

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Our semantic theory should:

Let us state *Every*, *Most*, *Some*, …

But not *Equi*, *Yreve*, *Everynon*, …

A quantifier Q is conservative iff $Q(X, Y) \longleftrightarrow Q(X, X \cap Y)$

**Three proposals**:

Lexical restriction $Every(A, B) \equiv A \subseteq B$

Interface filtering $Every(A, B) \equiv A \subseteq A \cap B$

One-set meanings

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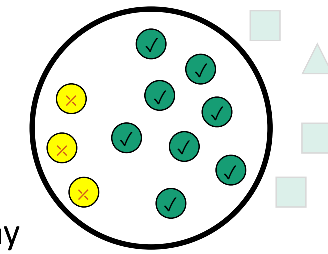
## Proposal 3: One-set meanings (Pietroski, 2005; 2018; Westerståhl, 2019)

⟦**Every circle is green**⟧

$=_{LF}$ [every circle [~~every circle~~ is green]]

≈ ∀x[green(x)] ↾ CIRCLES



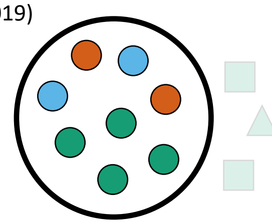
All conservative quantifiers stateable in this way

Non-conservative quantifiers are not (Westerståhl, 2019)

⟦**Equi circle is green**⟧

≈ ??x[green(x)] ↾ CIRCLES

(intended: CIRCLES = GREEN-THINGS)



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Our semantic theory should:

Let us state *Every*, *Most*, *Some*, …

But not *Equi*, *Yreve*, *Everynon*, …

**Linking Hypothesis**:
Sets implicated by meaning are represented during evaluation
(Pietroski et al., 2009; Lidz et al., 2011; Knowlton et al., *under review*)

**Three proposals**:

Lexical restriction Every(A, B) ≡ A ⊆ B — A, B

Interface filtering Every(A, B) ≡ A ⊆ A∩B — A, A ∩ B

One-set meanings Every(A, b) ≡ ∀x[bx] ↾ A — A

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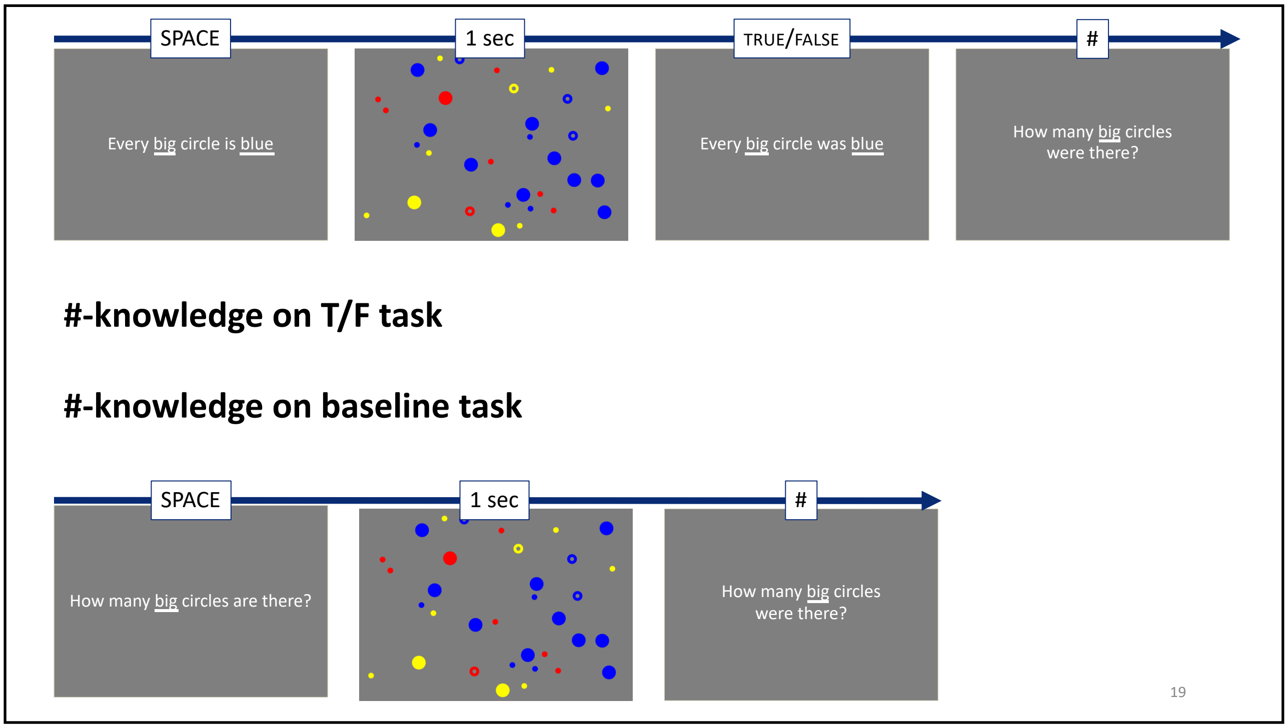
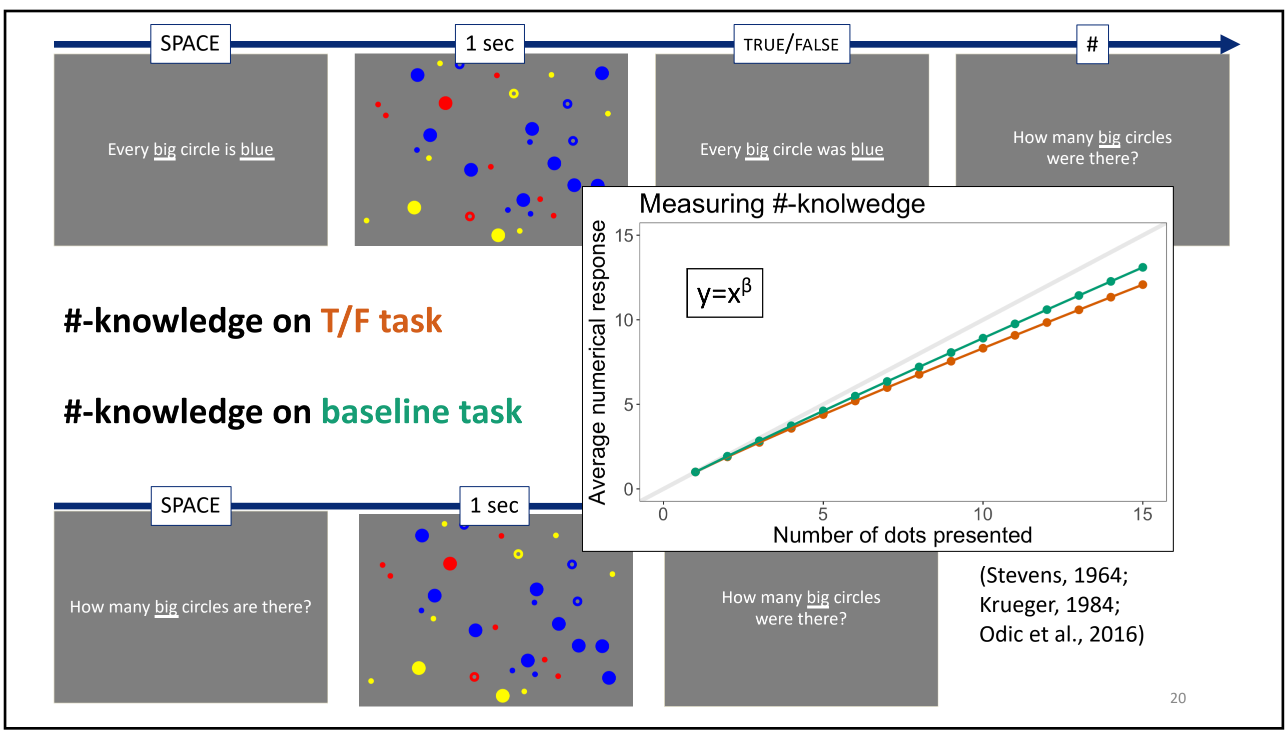
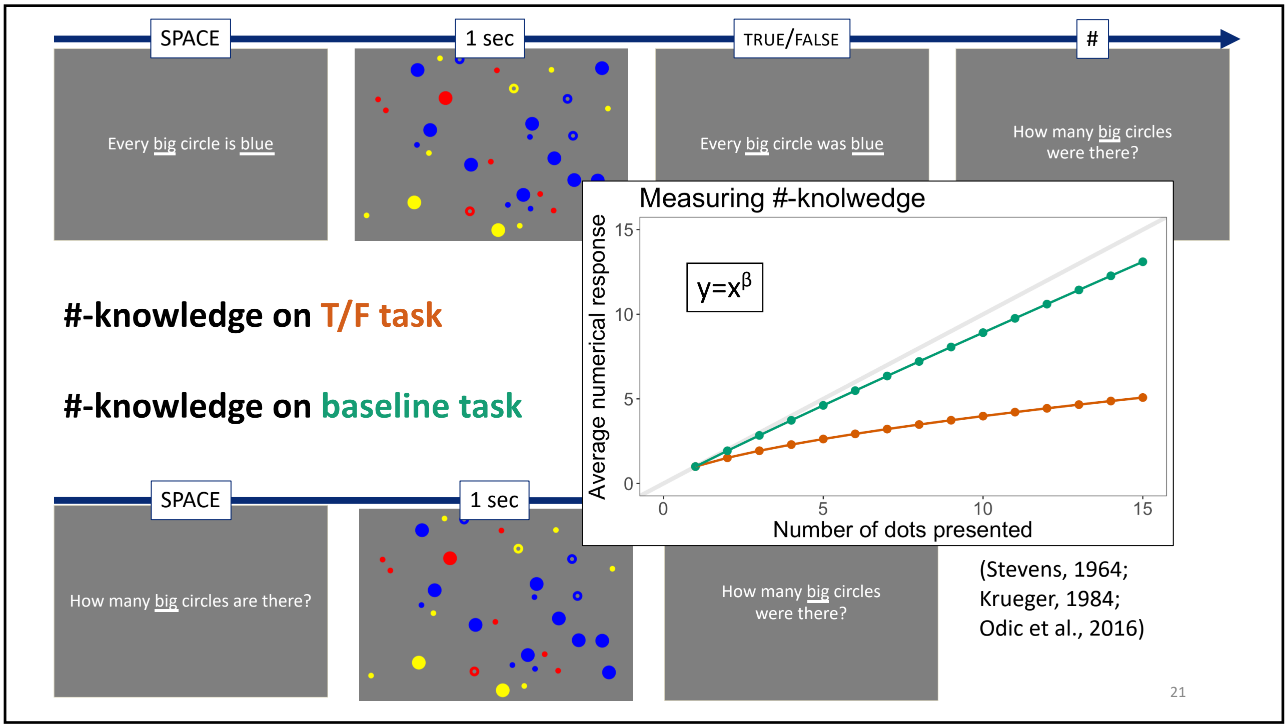
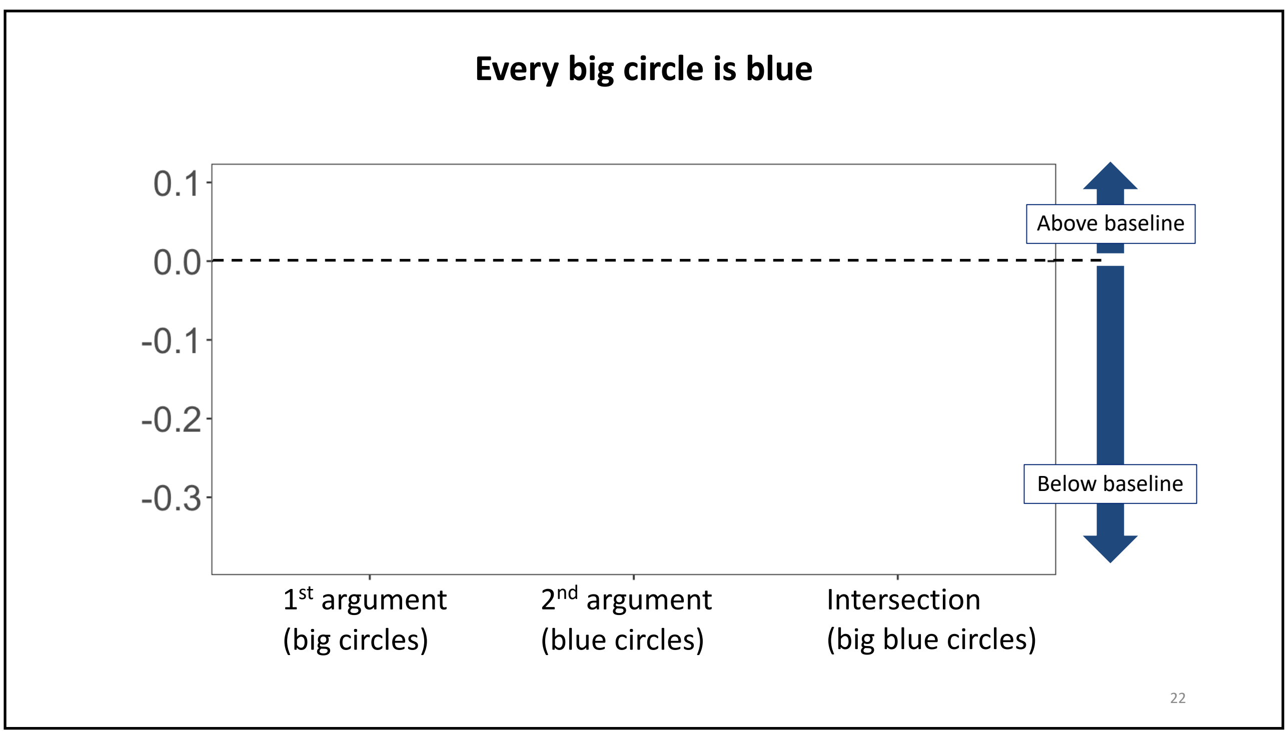
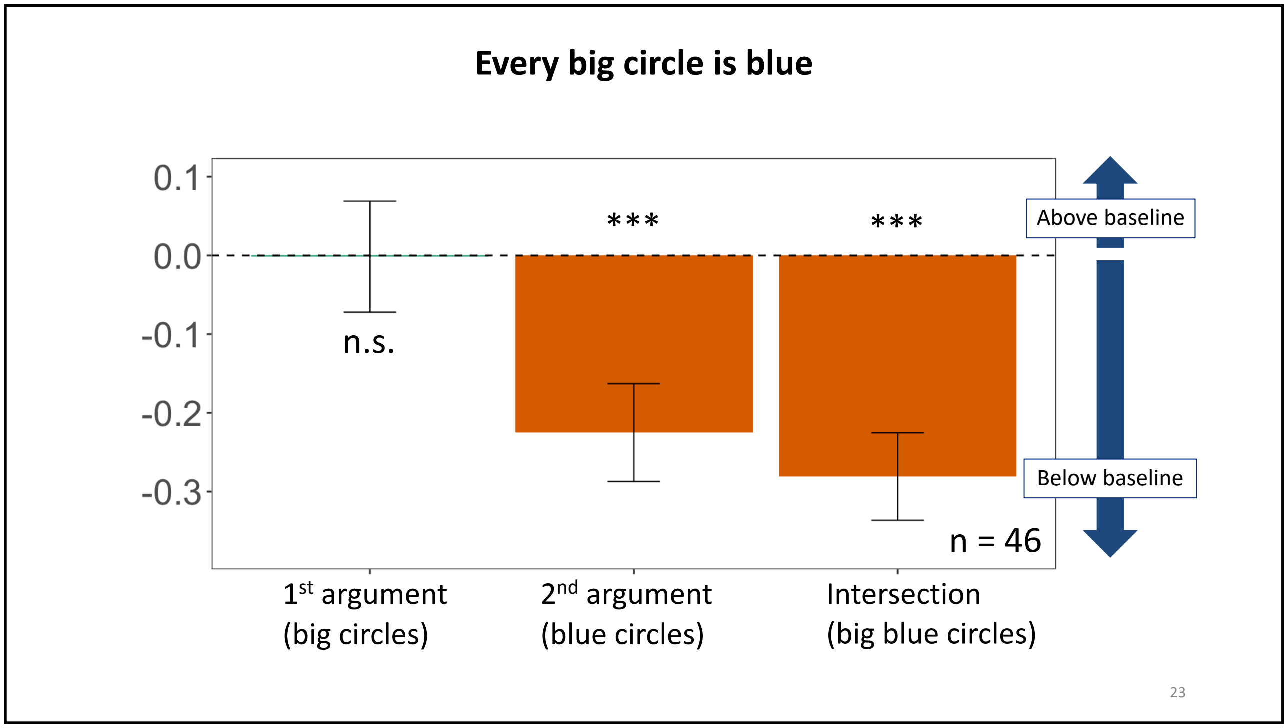

SPACE
1 sec
TRUE/FALSE
#
Every big circle is blue
Every big circle was blue
How many big circles were there?
#-knowledge on T/F task
#-knowledge on baseline task
SPACE
1 sec
#
How many big circles are there?
How many big circles were there?
19

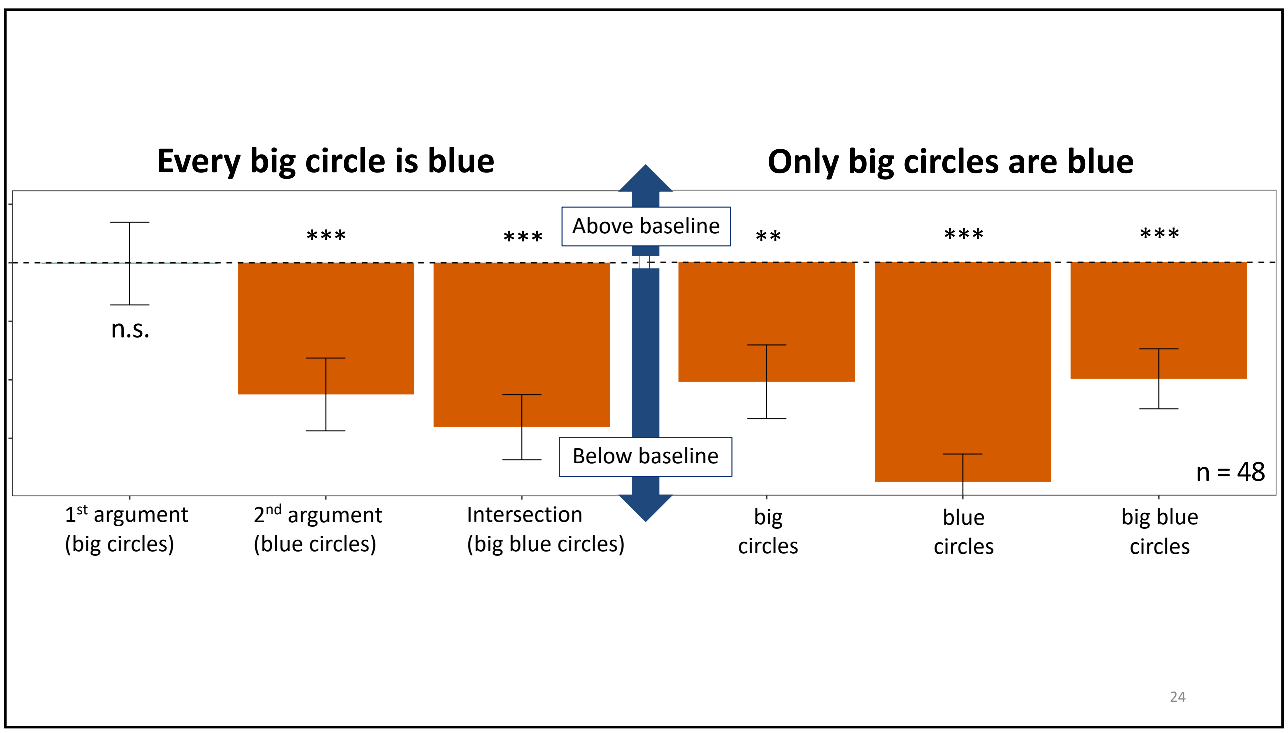

SPACE
1 sec
TRUE/FALSE
#
Every big circle is blue
Every big circle was blue
How many big circles were there?
#-knowledge on T/F task
#-knowledge on baseline task
Measuring #-knolwedge
y=x^β
Average numerical response
0
5
10
15
Number of dots presented
SPACE
1 sec
How many big circles are there?
How many big circles were there?
(Stevens, 1964;
Krueger, 1984;
Odic et al., 2016)
20


SPACE
1 sec
TRUE/FALSE
#
Every big circle is blue
Every big circle was blue
How many big circles were there?
#-knowledge on T/F task
#-knowledge on baseline task
SPACE
1 sec
How many big circles are there?
How many big circles were there?
Measuring #-knolwedge
y=x^β
Average numerical response
Number of dots presented
0
5
10
15
(Stevens, 1964; Krueger, 1984; Odic et al., 2016)
21

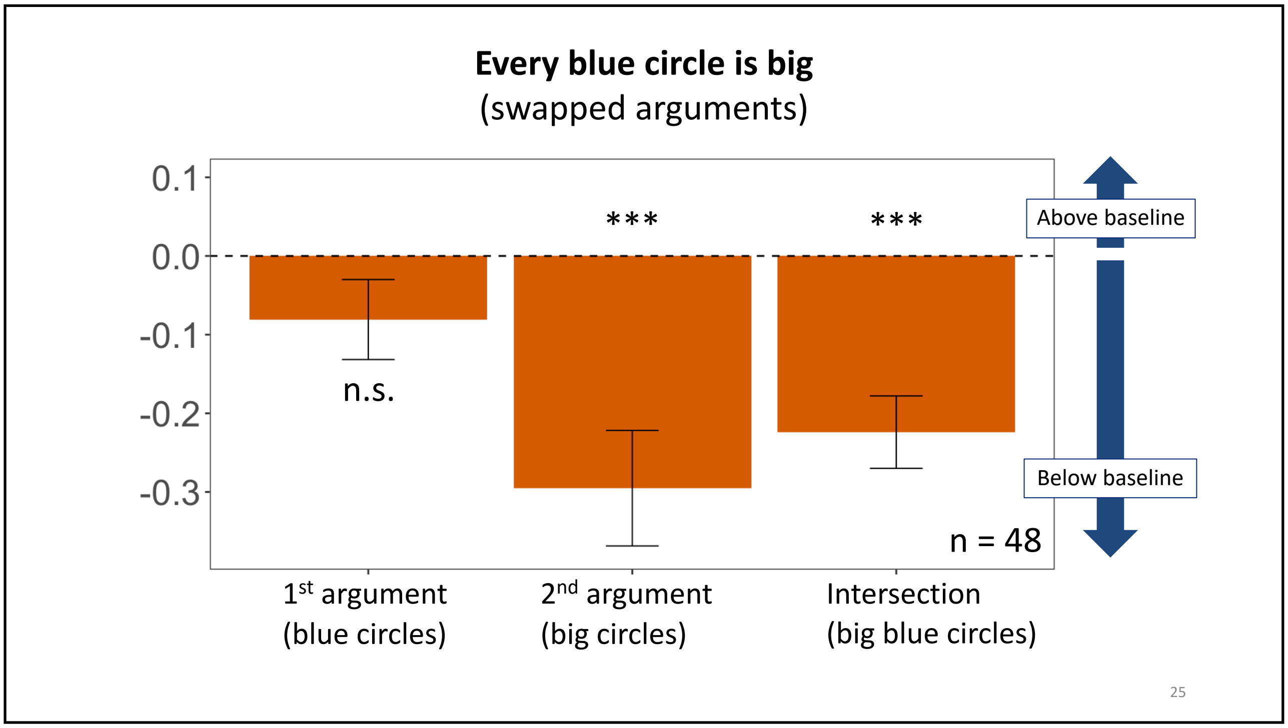

Every big circle is blue
0.1
0.0
-0.1
-0.2
-0.3
Above baseline
Below baseline
1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)
22

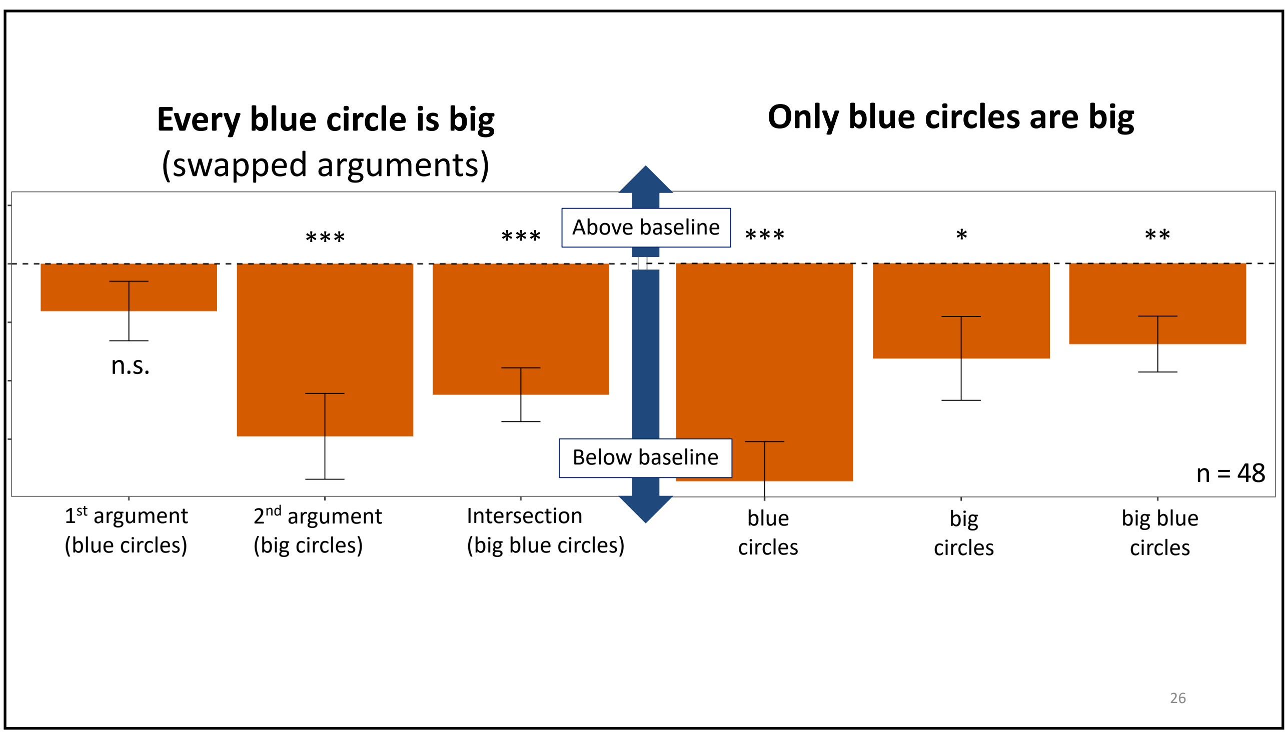


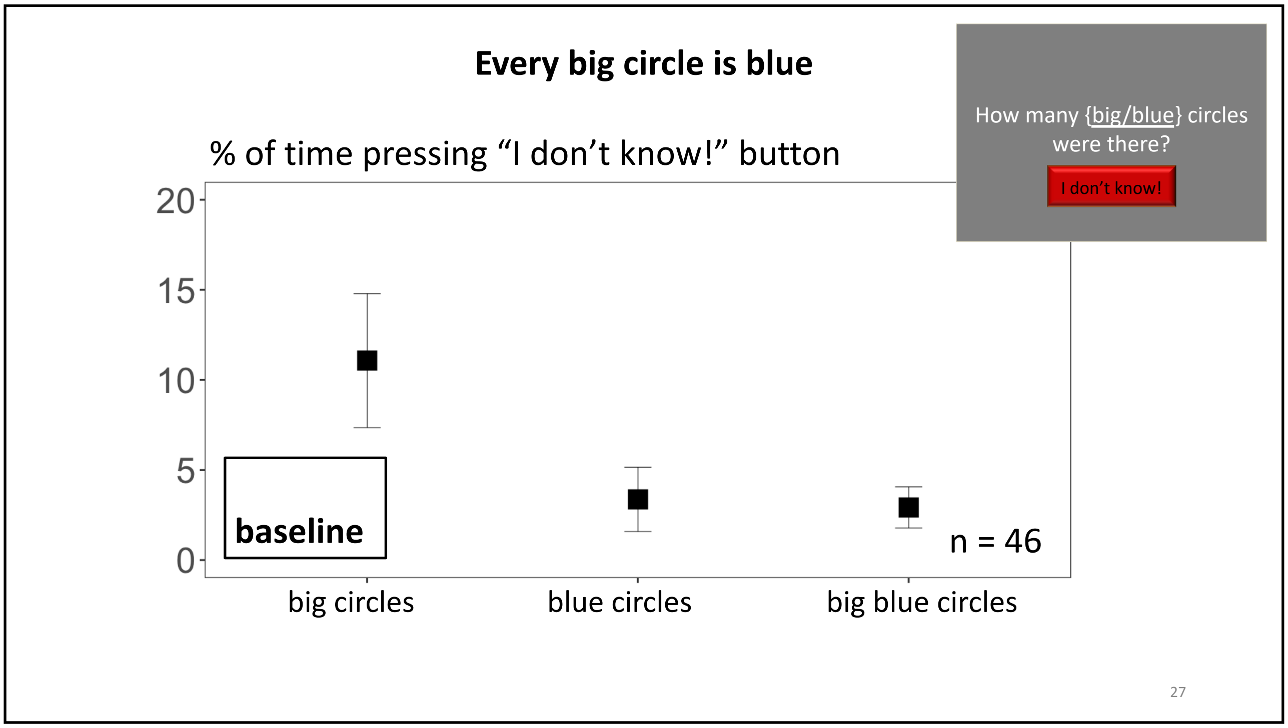
Every big circle is blue
0.1
0.0
-0.1
-0.2
-0.3
n.s.
***
***
Above baseline
Below baseline
n = 46
1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)
23

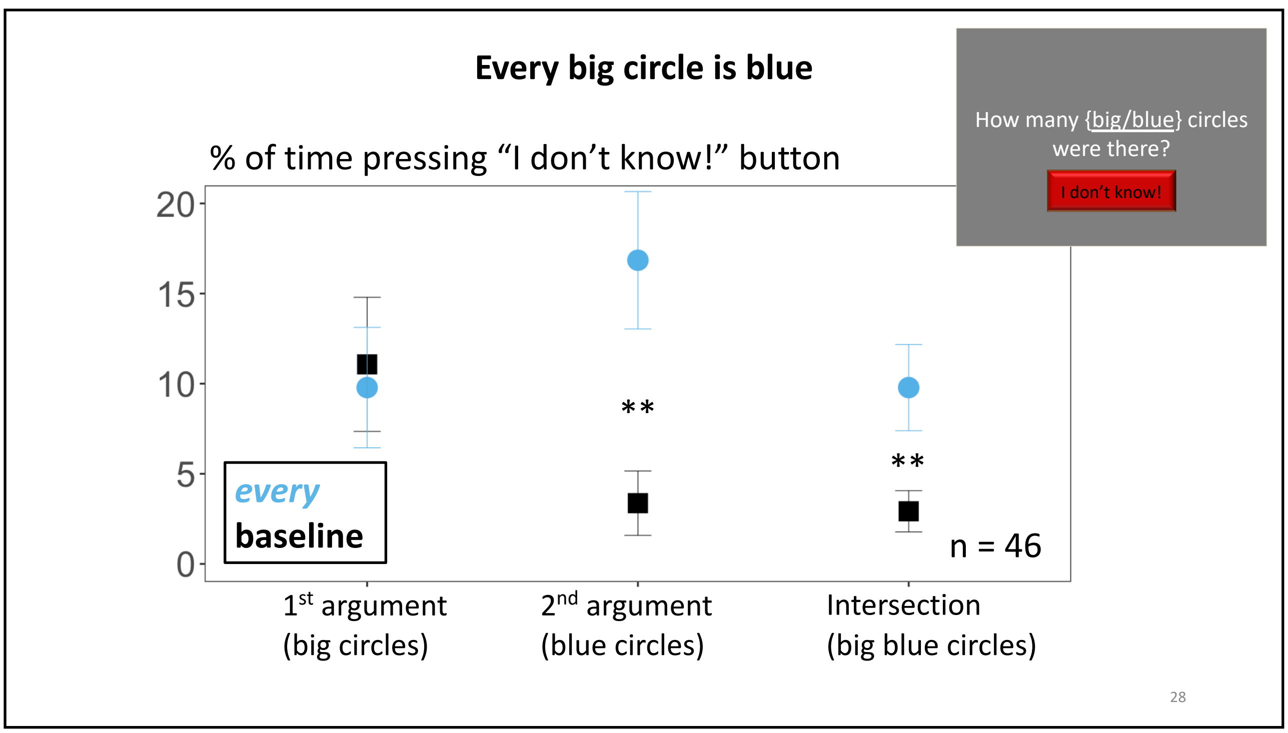



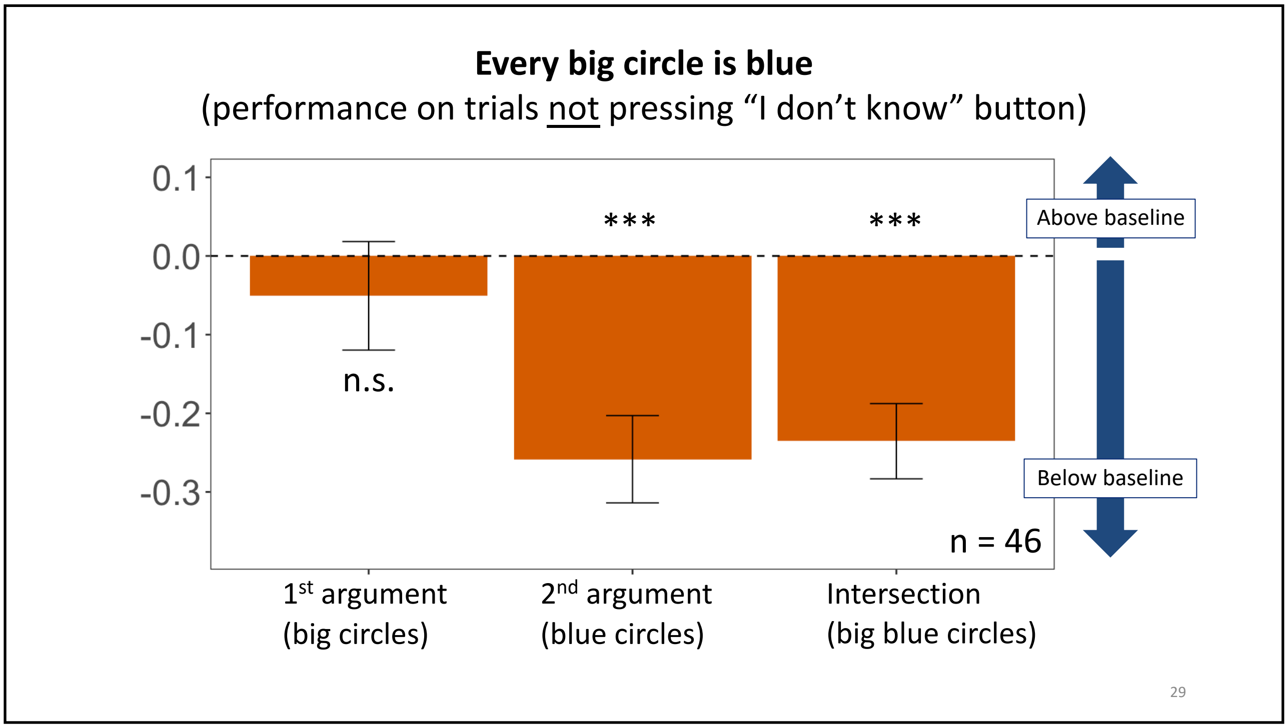
Every big circle is blue
Only big circles are blue
Above baseline
Below baseline
n.s.
***
***
**
***
***
n = 48
1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)
big circles
blue circles
big blue circles
24

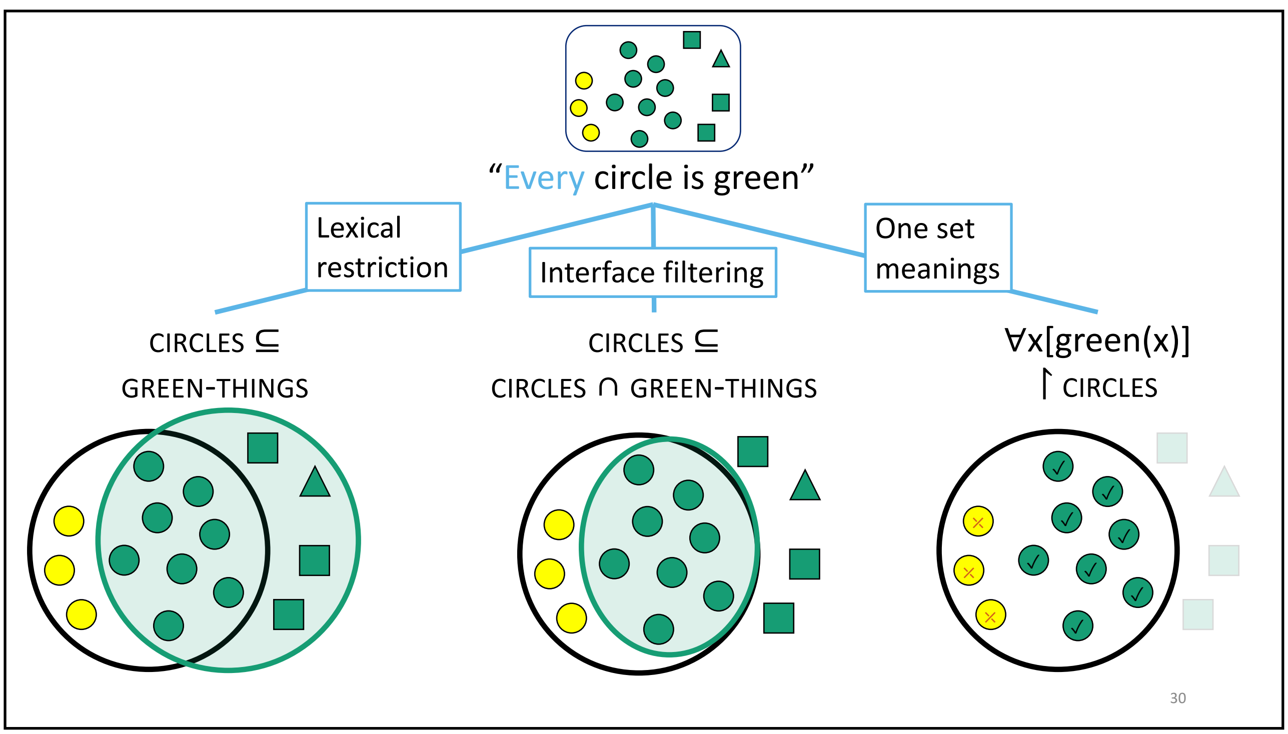

Every blue circle is big
(swapped arguments)
0.1
0.0
-0.1
-0.2
-0.3
***
***
n.s.
Above baseline
Below baseline
n = 48
1st argument
(blue circles)
2nd argument
(big circles)
Intersection
(big blue circles)
25

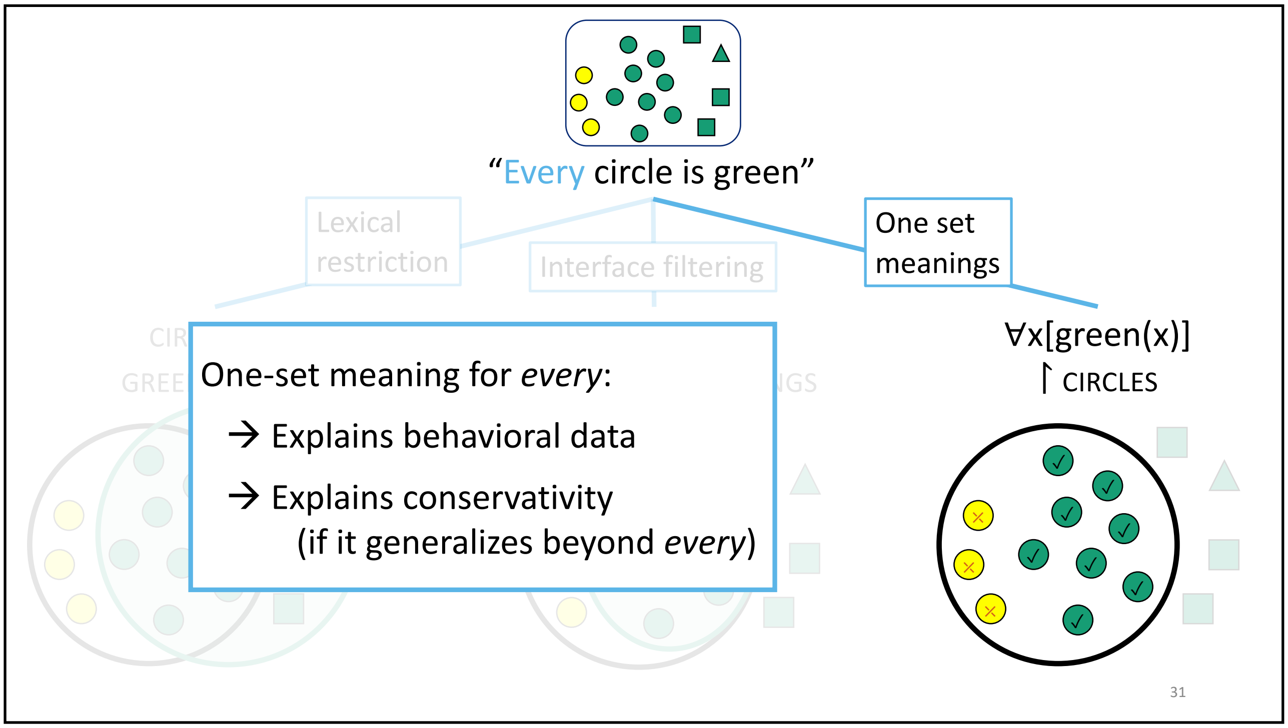

Every blue circle is big
(swapped arguments)
Only blue circles are big
***
***
***
*
**
n.s.
Above baseline
Below baseline
n = 48
1st argument
(blue circles)
2nd argument
(big circles)
Intersection
(big blue circles)
blue
circles
big
circles
big blue
circles
26


Every big circle is blue
How many {big/blue} circles were there?
I don't know!
% of time pressing "I don't know!" button
20
15
10
5
0
baseline
n = 46
big circles
blue circles
big blue circles
27


Every big circle is blue
How many {big/blue} circles were there?
I don't know!
% of time pressing "I don't know!" button
20
15
10
5
0
every
baseline
**
**
n = 46
1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)
28


Every big circle is blue
(performance on trials not pressing "I don't know" button)
0.1
0.0
-0.1
-0.2
-0.3
***
***
n.s.
Above baseline
Below baseline
n = 46
1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)
29


"Every circle is green"
Lexical restriction
Interface filtering
One set meanings
CIRCLES ⊆ GREEN-THINGS
CIRCLES ⊆ CIRCLES ∩ GREEN-THINGS
∀x[green(x)] ↾ CIRCLES
30




# Thanks!

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Audiences at UPenn's ILST Seminar & UMD's LSLT series

Language at Maryland

NSF

James S. McDonnell Foundation

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## Meaning or strategy?

$\forall x[\text{green}(x)] \upharpoonright$ CIRCLES → Implement meaning → People use one-set strategy

CIRCLES $\subseteq$ GREEN-THINGS → ??? → People use one-set strategy

Use best/easiest strategy available given context?

No: see other work on *more, most*, *each*, & *every*

(Pietroski et al., 2009; Lidz et al., 2011; Odic et al., 2018; Knowlton et al., *under review*; *in prep*)

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## Why isn't *only* a counter-example?

*Only* isn't a quantifier, it's a focus-operator

Students only ordered **coffee**$_{\mathbf{F}}$ (they didn't also order tea, soda, ...)

Students only **ordered**$_{\mathbf{F}}$ coffee (they didn't also make it, purchase it, …)

Every student ordered **coffee**$_{\mathbf{F}}$

Every student **ordered**$_{\mathbf{F}}$ coffee

Says nothing about whether alternatives are TRUE or FALSE

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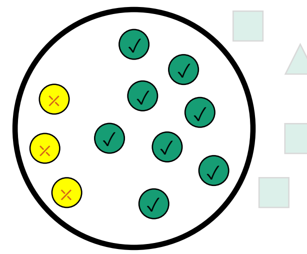
## What about *most*?

⟦**Every circle [~~every circle~~ is green]**⟧

≈ ∀x[green(x)] ↾ CIRCLES

≈ THE CIRCLES are s.t. every one of them is green



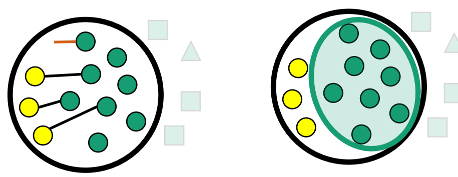
⟦**Most circles [~~most circles~~ are green]**⟧

≈ Mx[green(x)] ↾ CIRCLES

≈ THE CIRCLES are s.t. most of them are green

Decomposition of M?

See Pietroski et al. (2009); Lidz et al. (2011)



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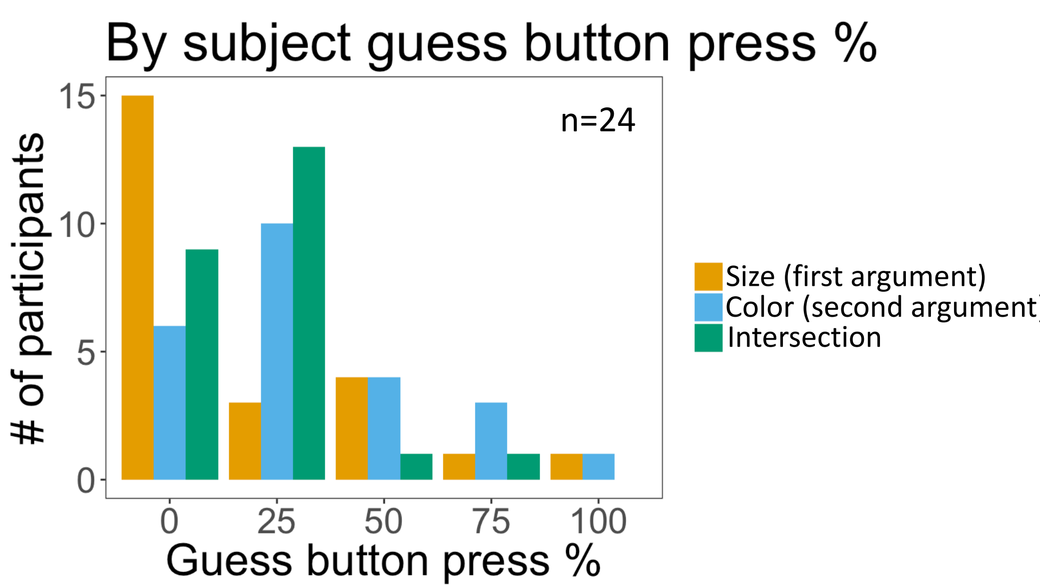


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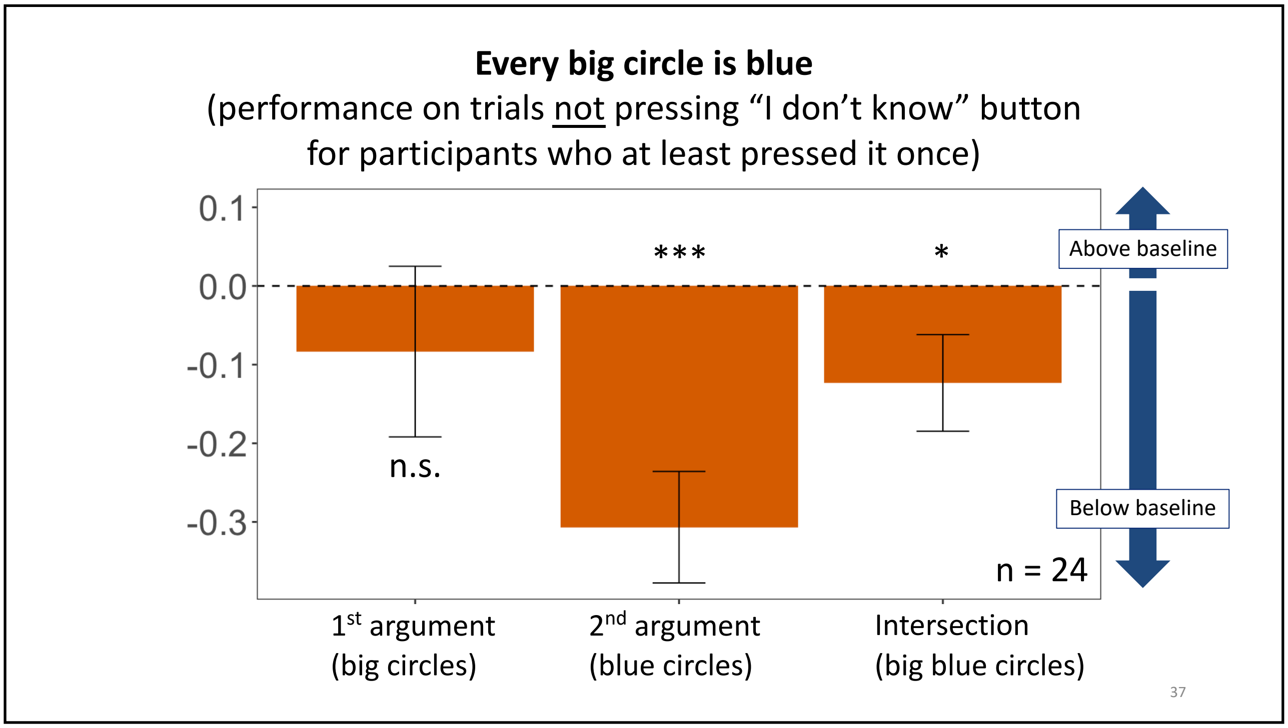

Every big circle is blue
(performance on trials not pressing "I don't know" button
for participants who at least pressed it once)
0.1
0.0
-0.1
-0.2
-0.3
***
*
n.s.
n = 24
Above baseline
Below baseline
1st argument
(big circles)
2nd argument
(blue circles)
Intersection
(big blue circles)
37