# Memory for cardinality supports a non-relational account of conservativity

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ELM 1 @ UPenn

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The conservativity constraint

Three potential explanations

Testing their predictions

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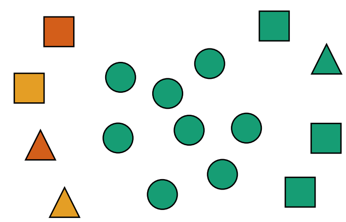
# Natural language determiners are "conservative"

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

***every*** *circle is green ==*

***every*** *circle is a circle that is green*



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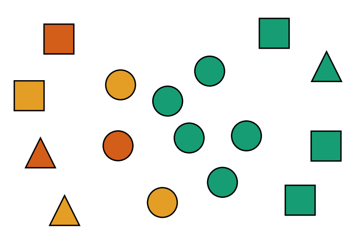

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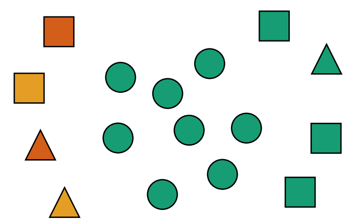

A determiner **DET** is conservative iff

(1) [[**DET** N(P)] PRED] ==

(2) [[**DET** N(P)] [be N(P) that PRED]]

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## We can imagine **DET**s that are not conservative

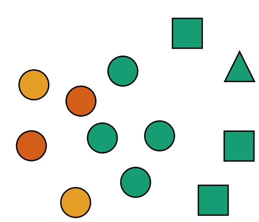
***equi*** *circles are green*

≈ *the circles are equinumerous with the green things* (TRUE; 8=8)

=/=

***equi*** *circles are circles that are green*

≈ *the circles are equinumerous with the circles that are green* (FALSE; 8≠4)



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## We can imagine **DET**s that are not conservative

***yreve*** *circles are green*

*≈ the circles include all green things*

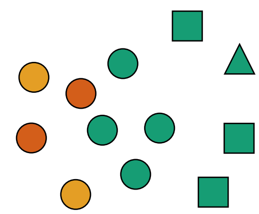
(FALSE; green non-circles)

*=/=*

***yreve*** *circles are circles that are green*

*≈ the circles include all circles that are green*

(TRUE; only circles are green circles)



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## The conservativity constraint

[[**DET** N(P)] PRED] ==
[[**DET** N(P)] [be N(P) that PRED]]

*every, most, …*

*yreve, equi, …*

Three potential explanations

Testing their predictions

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## Three views of conservativity

Meaning of [[**every** N(P)] predicate]

relational

non-relational

Lexical restriction

$P \supseteq N$

$\supseteq$ $\not\subseteq$

Interface filtering

$P \cap N \supseteq N$

* trivial meanings

Ordered predication

$\forall x[\text{is-P}(x)] \upharpoonright N$

entails conservativity

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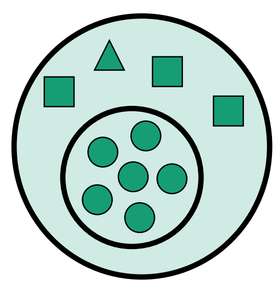
## Proposal 1: Lexical restriction

(Keenan & Stavi 1986)

Determiners express relations between sets

(Barwise & Cooper 1981)

***every*** *circle is green* ≡ GREEN-THINGS ⊇ CIRCLES



But only some relations make good **DET** meanings

⊇(PRED, NP)
**MOST**(PRED, NP)
**AT-LEAST-FOUR**(PRED, NP)
…

⊆(PRED, NP) ←Meaning of ***yreve***
=(PRED, NP)
**EQUAL-IN-NUMBER**(PRED, NP)
…

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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]] (QR & Trace conversion)

≈ GREEN-THINGS ∩ CIRCLES ⊇ CIRCLES

⟦**Equi** circles are green⟧

≈ |GREEN-THINGS ∩ CIRCLES| = |CIRCLES|

$_{TC}$= *every*!

⟦**Yreve** circle is green⟧

≈ GREEN-THINGS ∩ CIRCLES ⊆ CIRCLES

(always TRUE)

* Trivial meanings

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## Proposal 3: Ordered predication

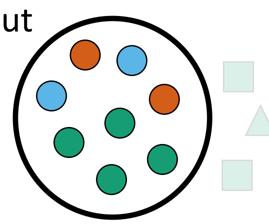
(Pietroski, 2005; 2018)

⟦**Every** circle is green⟧

$=_{LF}$ [**every** circle [~~every circle~~ is green]] (QR)

≈ ∀x[is-green(x)] ↾ CIRCLES (First argument sets domain)

All conservative determiners stateable in this way, but non-conservative determiners are not (Westerståhl, 2019)



⟦**Equi** circle is green⟧

≈ ??x[green(x)] ↾ CIRCLES

(intended: |CIRCLES| = |GREEN-THINGS|)

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## The conservativity constraint

[[**DET** N(P)] PRED] ==
[[**DET** N(P)] [be N(P) that PRED]]

✓ *every, most, …*

✗ *yreve, equi, …*

## Three potential explanations

| Lexical restriction | Interface filtering | Ordered predication |
|---|---|---|
| P ⊇ N | P ∩ N ⊇ N | ∀x[is-P(x)] ↾ N |

## Testing their predictions

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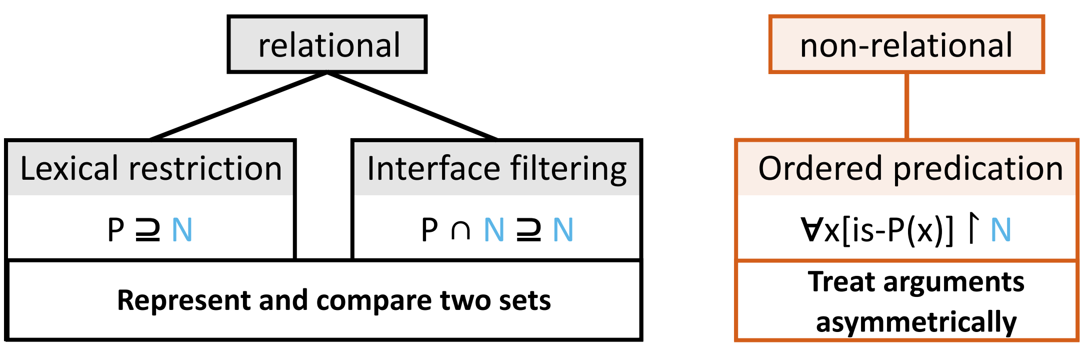
## Testing predictions of the three views

**Linking hypothesis**: in understanding a declarative sentence, people are biased toward verification strategies that directly compute the relations & operations expressed by the semantic representation under evaluation (Lidz et al. 2011)

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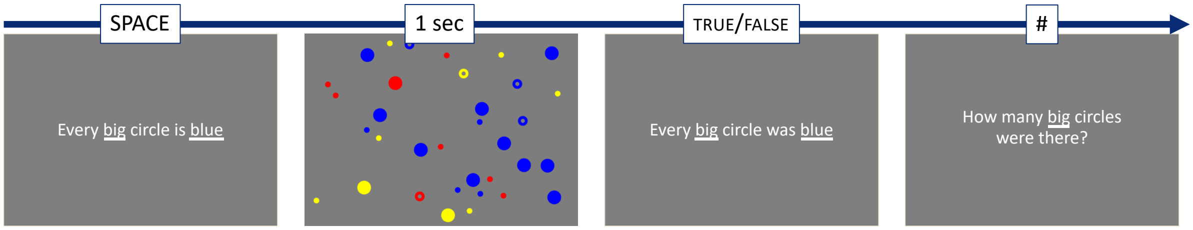
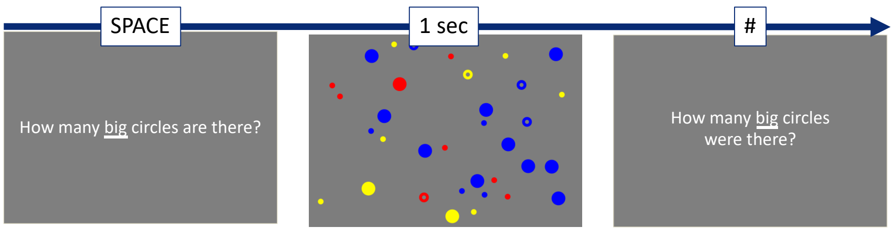
# Which set(s) do participants represent?




**#-knowledge on T/F task**

**#-knowledge on baseline task**

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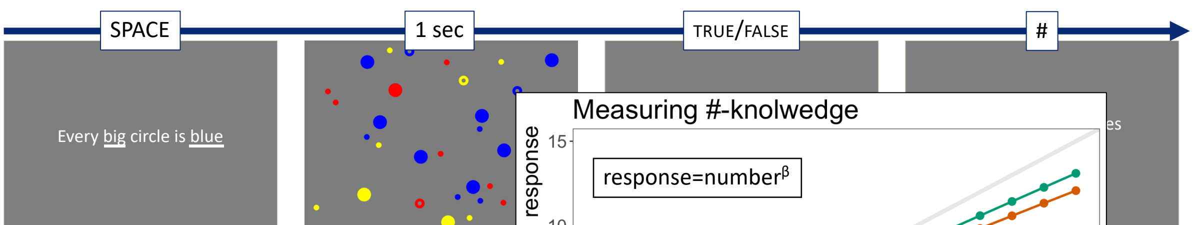


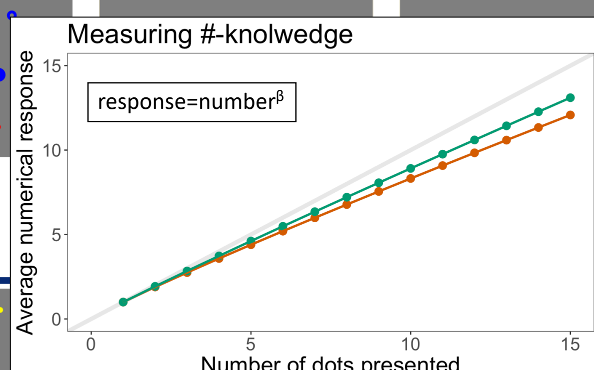


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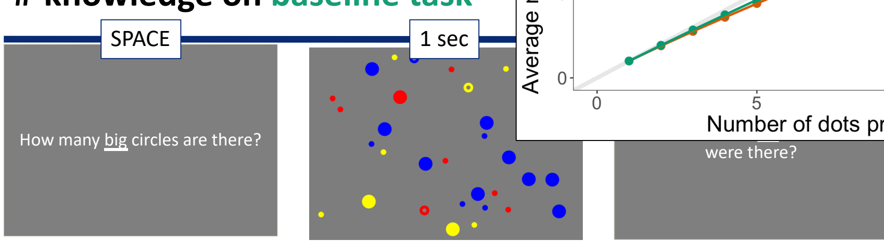


(Stevens 1964; Krueger 1984; Odic et al. 2016)

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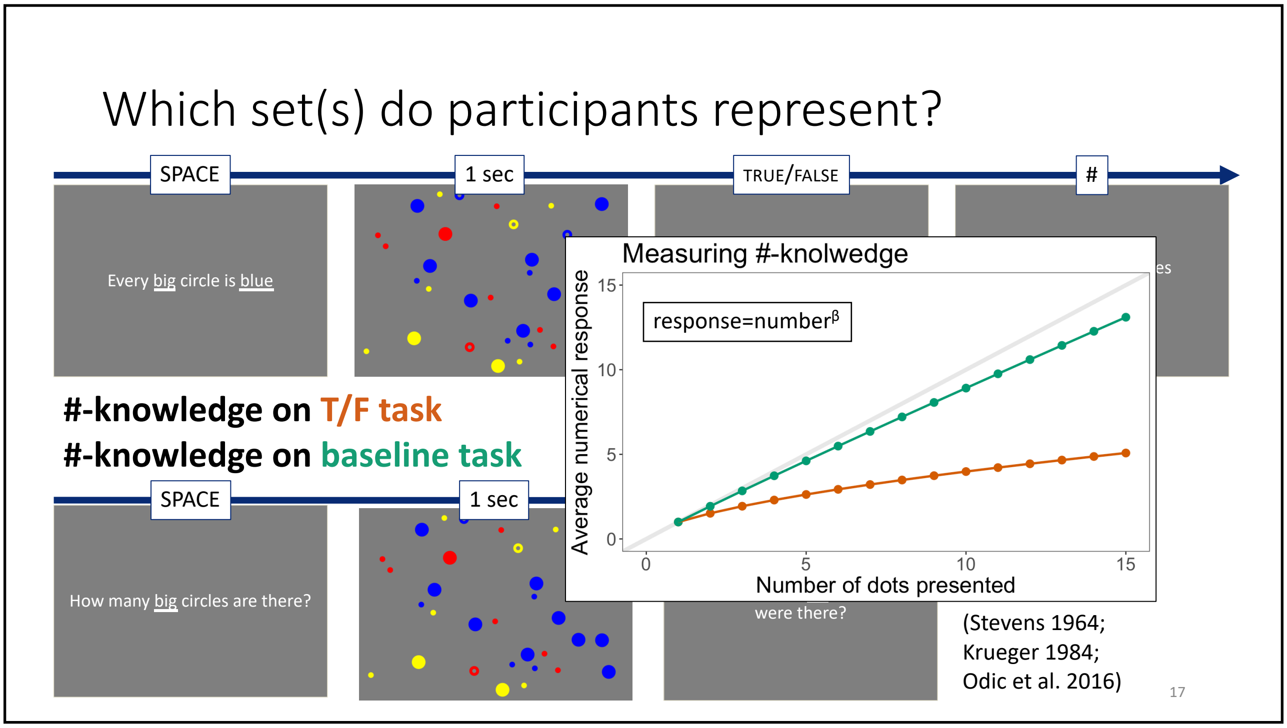

Which set(s) do participants represent?
SPACE
1 sec
TRUE/FALSE
#
Every big circle is blue
#-knowledge on T/F task
#-knowledge on baseline task
SPACE
1 sec
How many big circles are there?
were there?
Measuring #-knolwedge
response=number$^\beta$
Average numerical response
Number of dots presented
(Stevens 1964; Krueger 1984; Odic et al. 2016)
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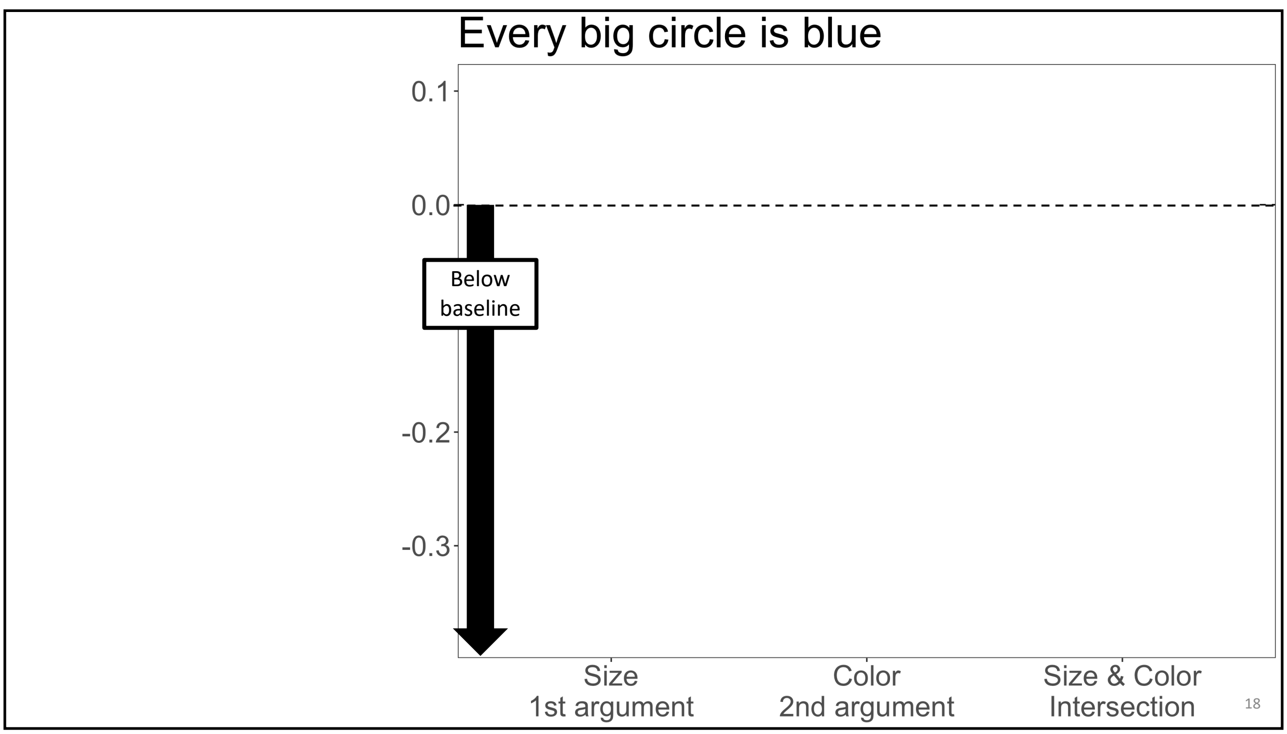

Every big circle is blue
0.1
0.0
-0.2
-0.3
Below baseline
Size
1st argument
Color
2nd argument
Size & Color
Intersection
18


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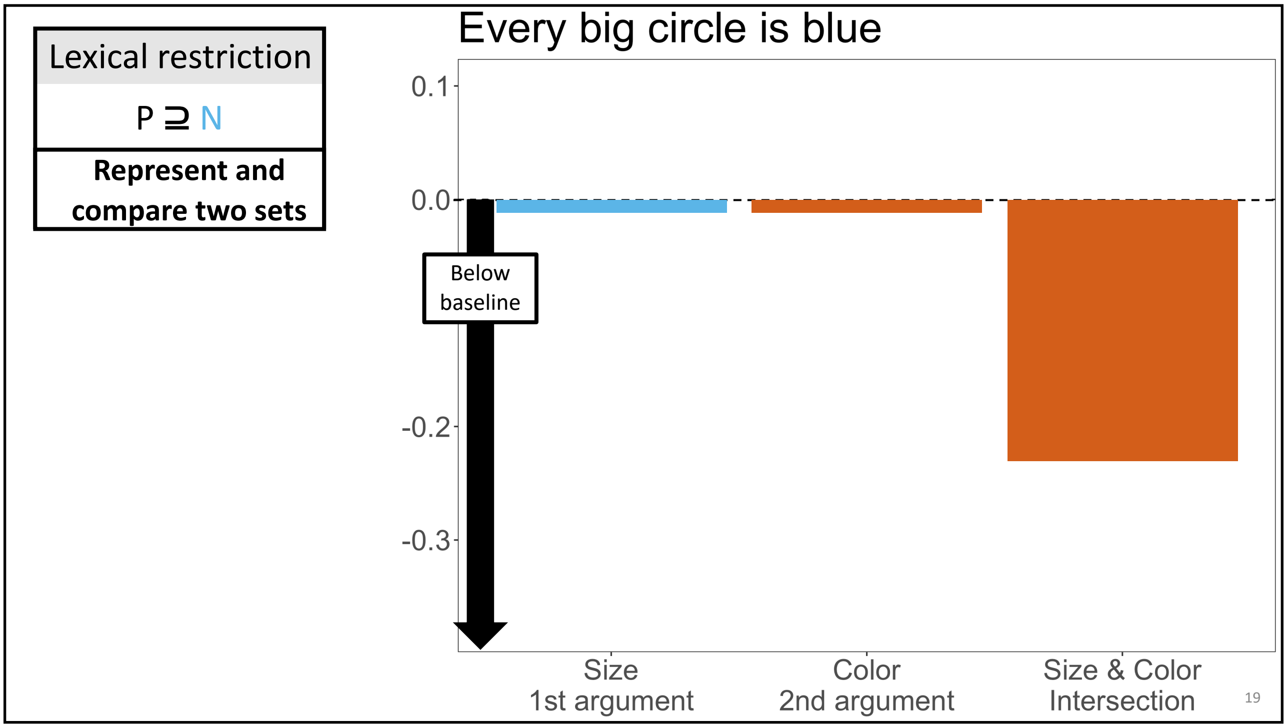
Lexical restriction
P ⊇ N
Represent and compare two sets
Every big circle is blue
0.1
0.0
-0.2
-0.3
Below baseline
Size
1st argument
Color
2nd argument
Size & Color
Intersection
19

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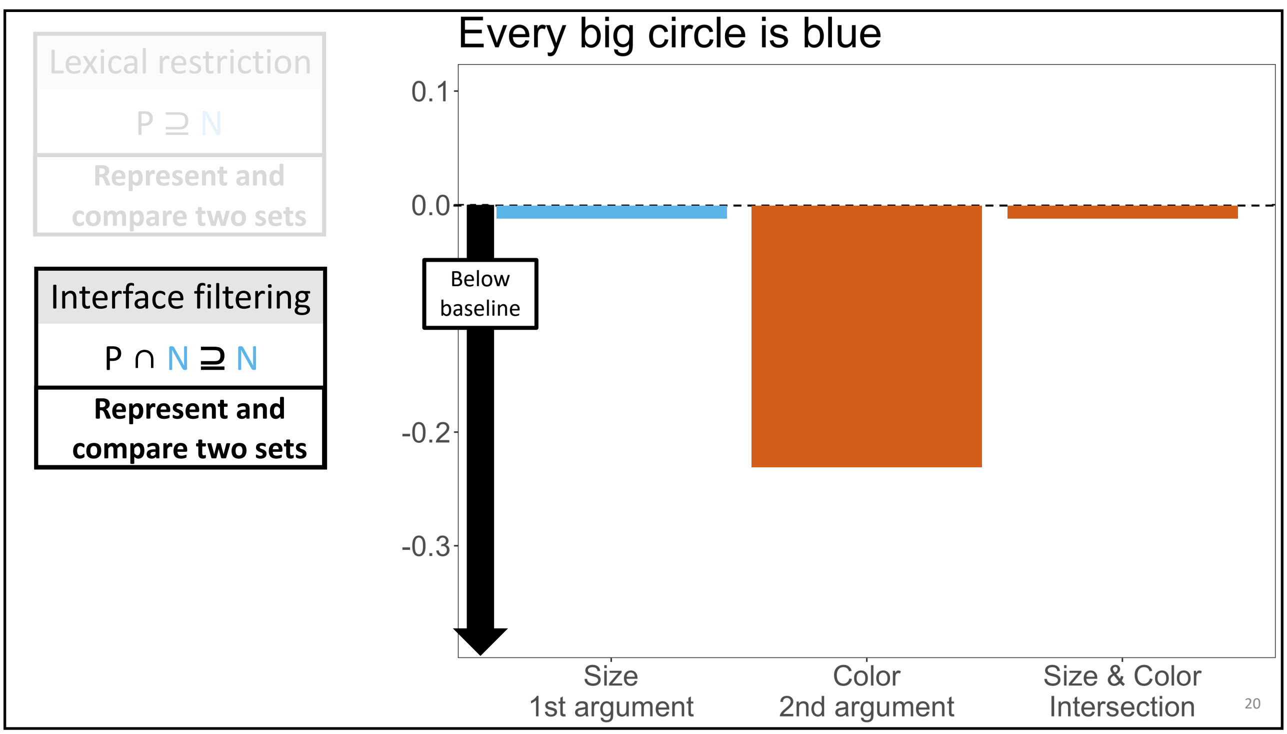
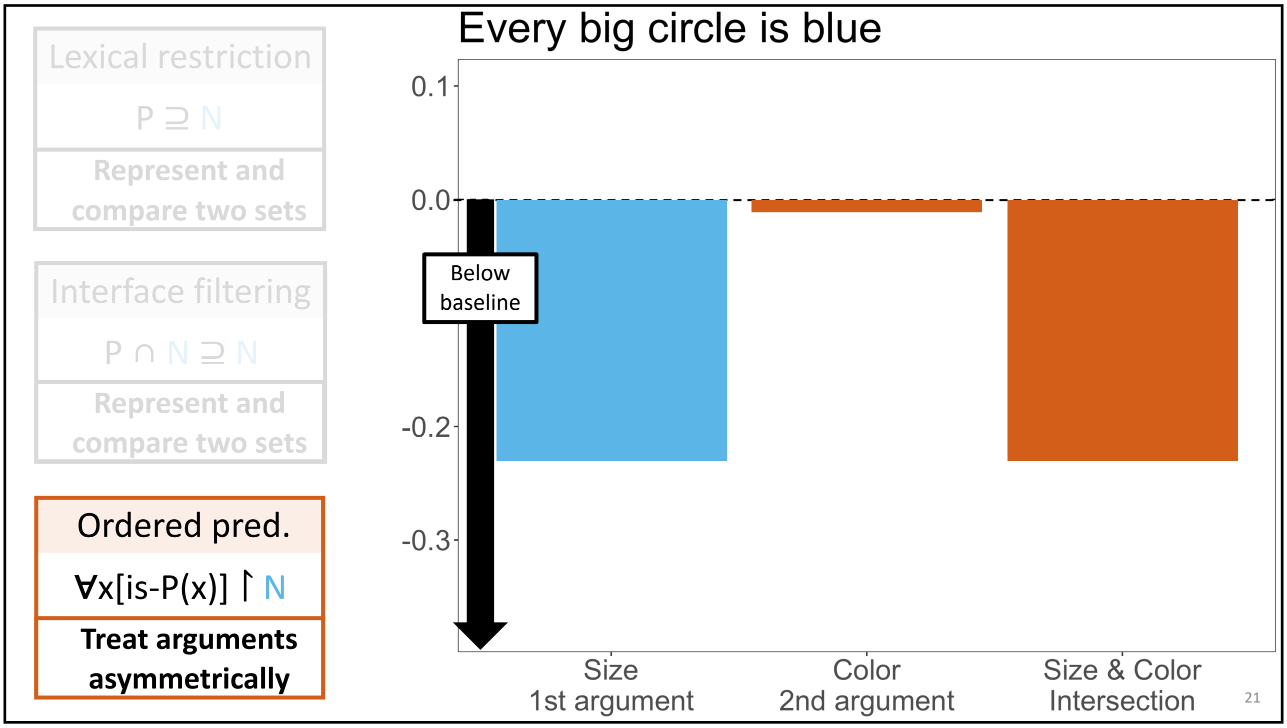

Lexical restriction
P ⊇ N
Represent and compare two sets
Interface filtering
P ∩ N ⊇ N
Represent and compare two sets
Every big circle is blue
0.1
0.0
-0.2
-0.3
Below baseline
Size
1st argument
Color
2nd argument
Size & Color
Intersection
20

20


Lexical restriction
P ⊒ N
Represent and compare two sets
Interface filtering
P ∩ N ⊒ N
Represent and compare two sets
Ordered pred.
∀x[is-P(x)] ↾ N
Treat arguments asymmetrically
Every big circle is blue
0.1
0.0
-0.2
-0.3
Below baseline
Size
1st argument
Color
2nd argument
Size & Color
Intersection
21

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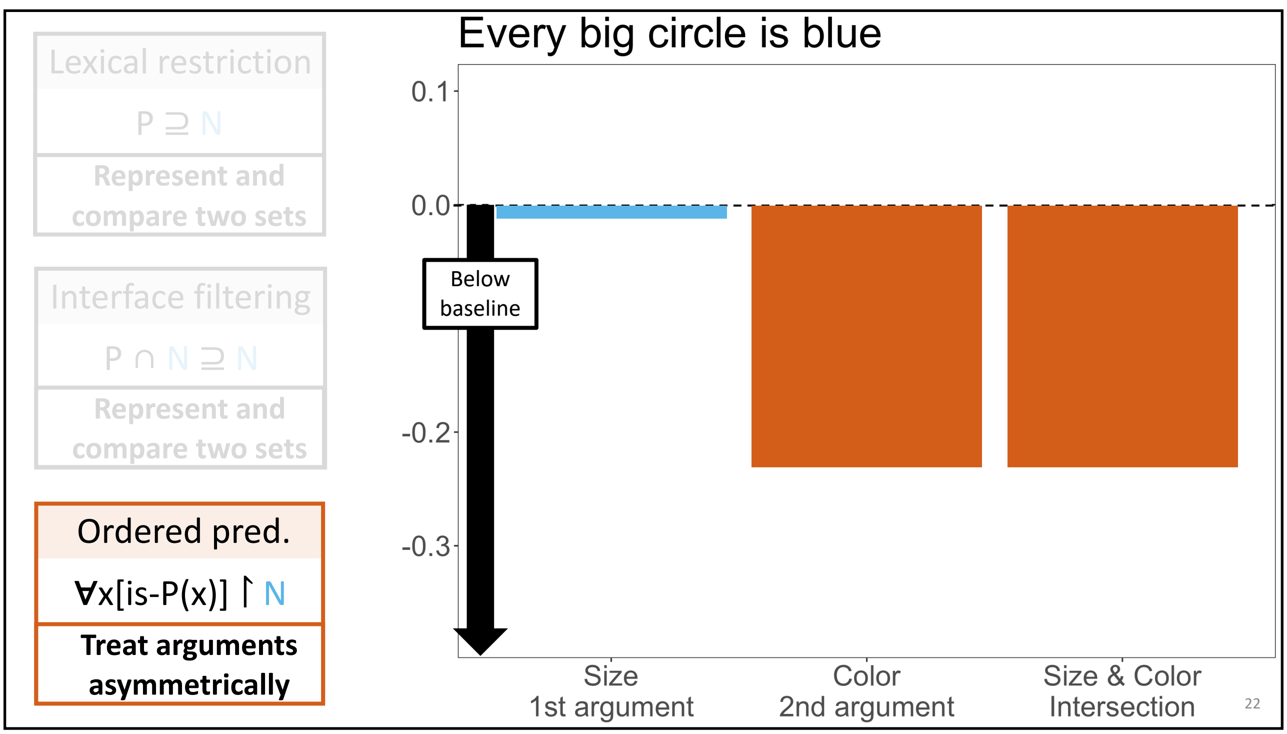
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0.1
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Below baseline
Size
1st argument
Color
2nd argument
Size & Color
Intersection
22

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Lexical restriction

$P \supseteq N$

**Represent and compare two sets**

Interface filtering

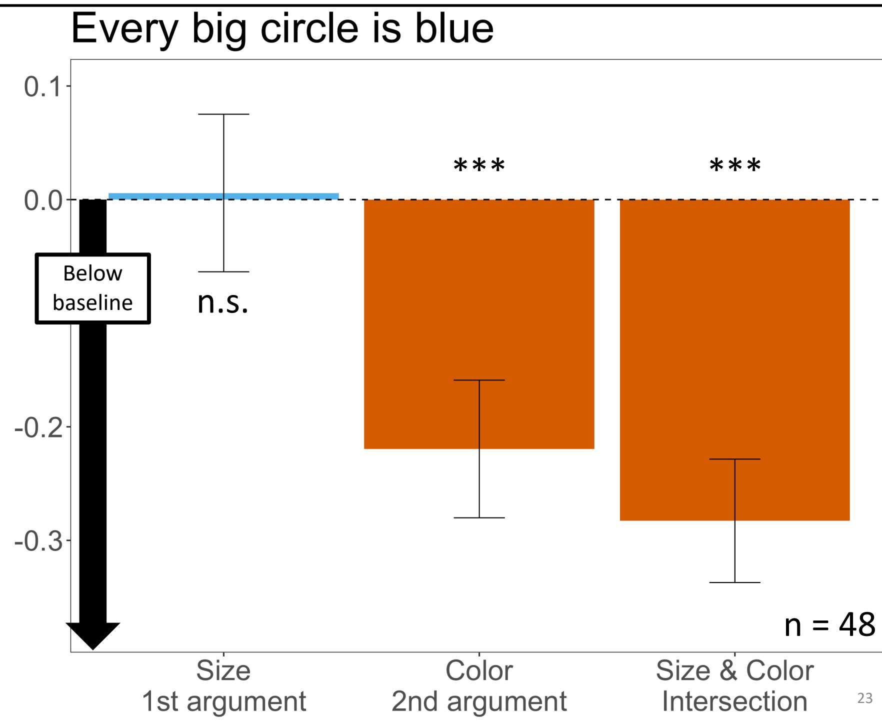
$P \cap N \supseteq N$

**Represent and compare two sets**

Ordered pred.

$\forall x[\text{is-P}(x)] \restriction N$

**Treat arguments asymmetrically**

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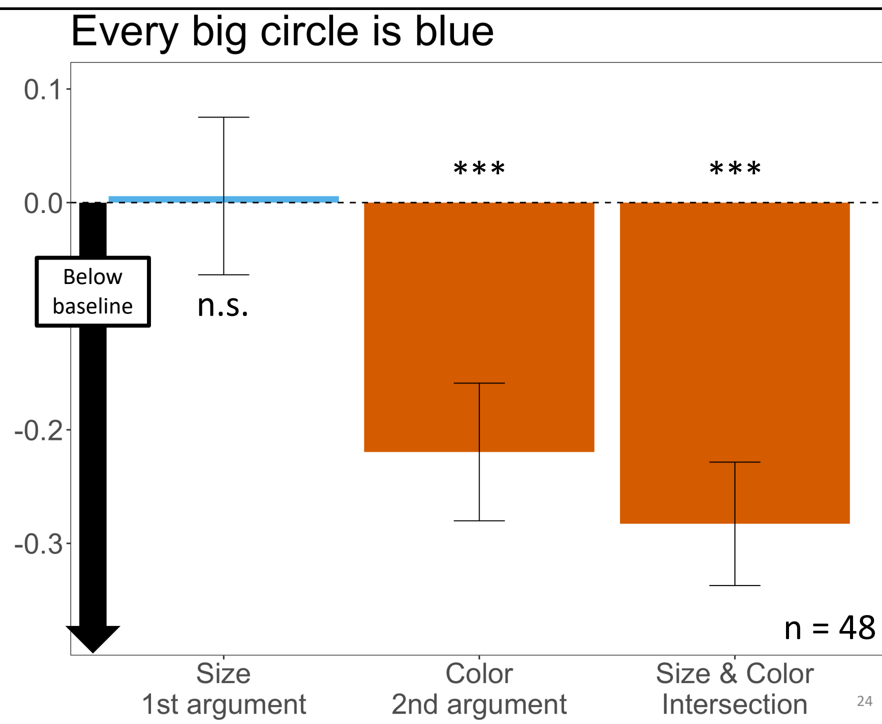
Is there something special about size?

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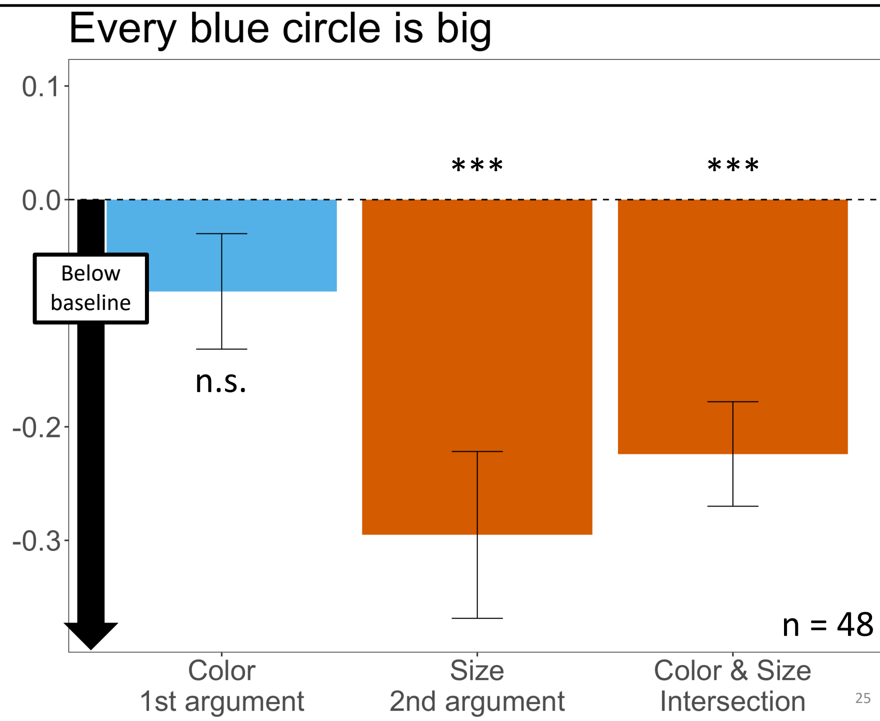
Is there something special about size?

No:
swap arguments,
same result!

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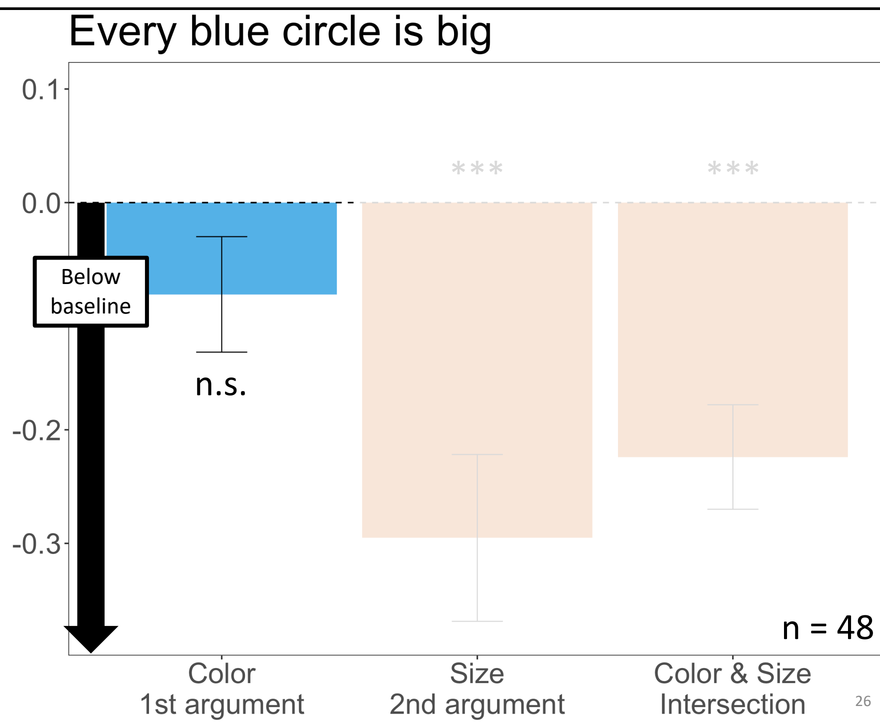
Is the extension of the NP always mentally grouped?

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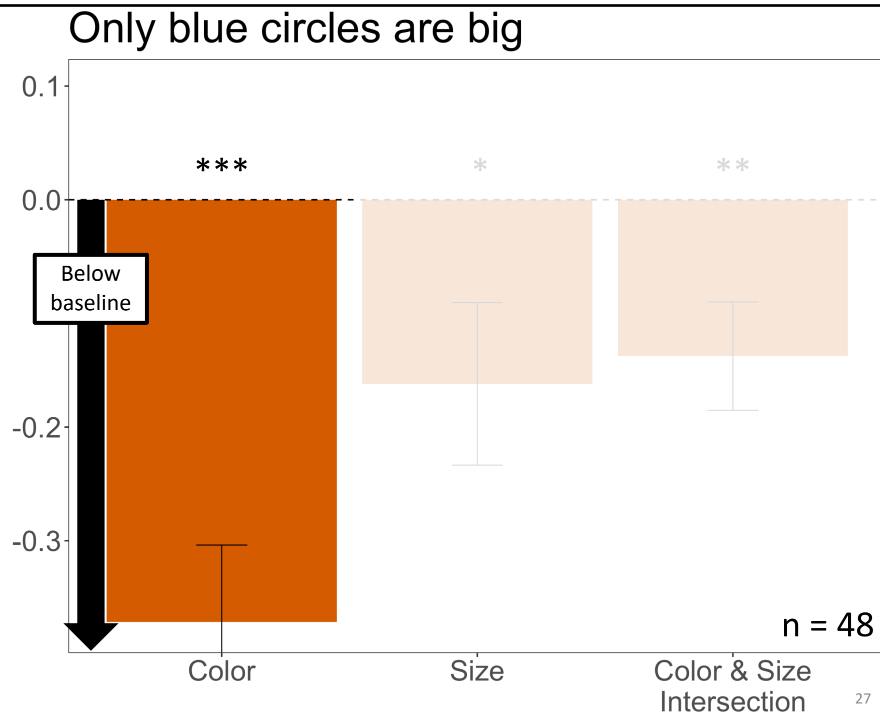
Is the extension of the NP always mentally grouped?

No:
not with *only*!

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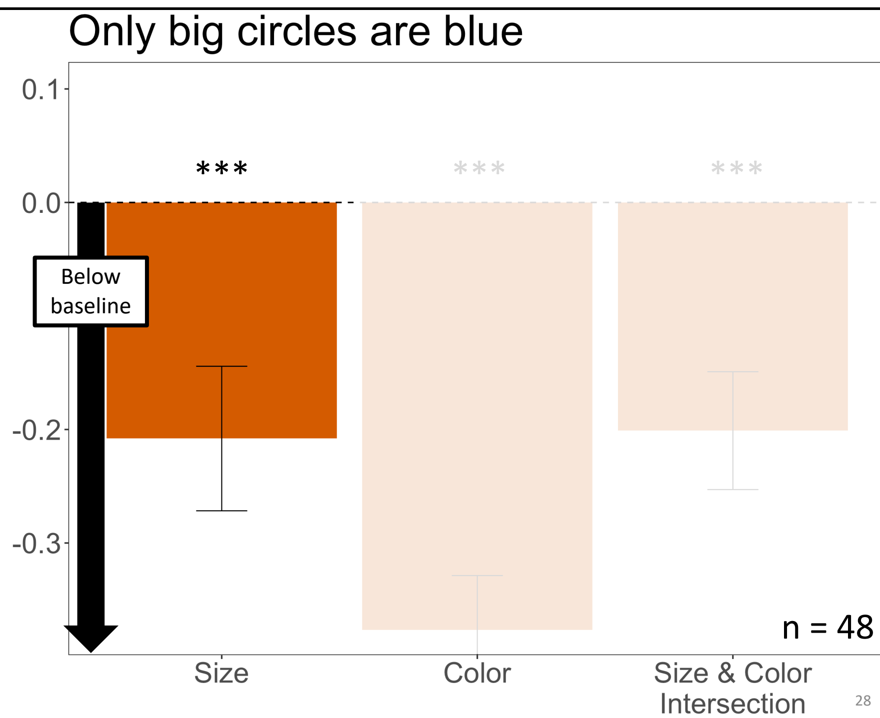


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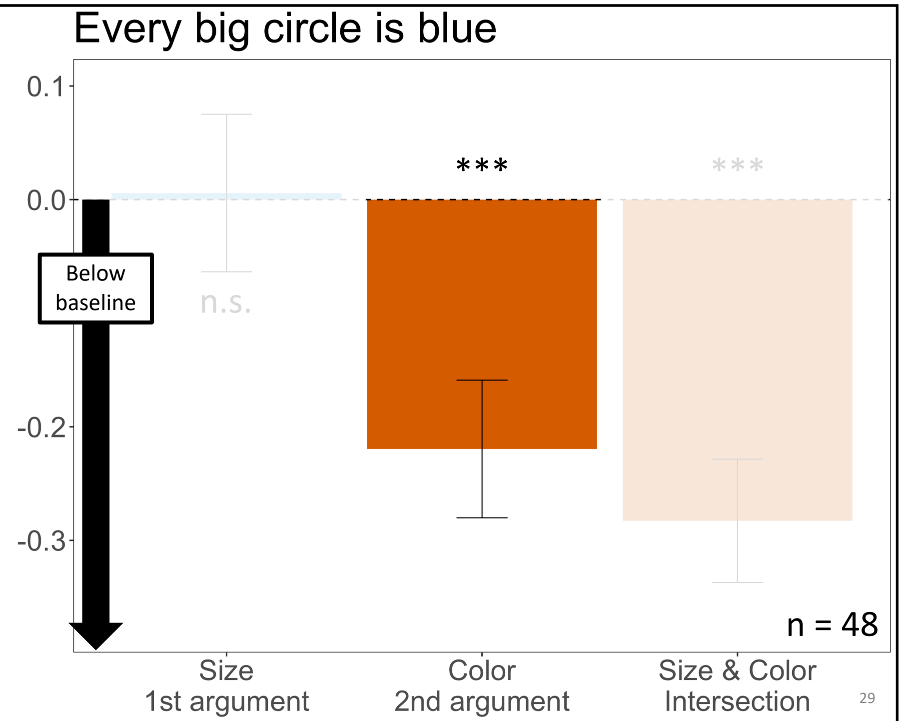
Are they failing to represent color b/c of wm limit (3)?

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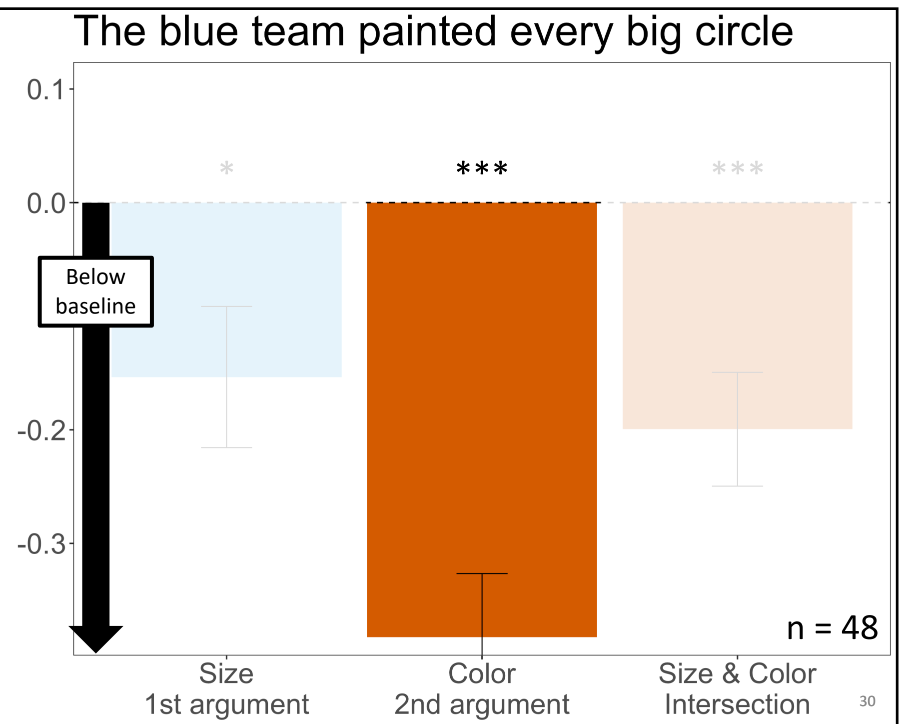
Are they failing to represent color b/c of wm limit (3)?

No:
they still fail when color named first!

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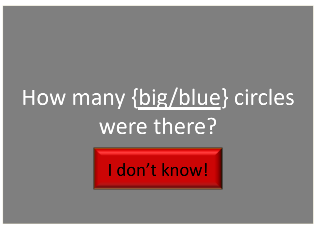
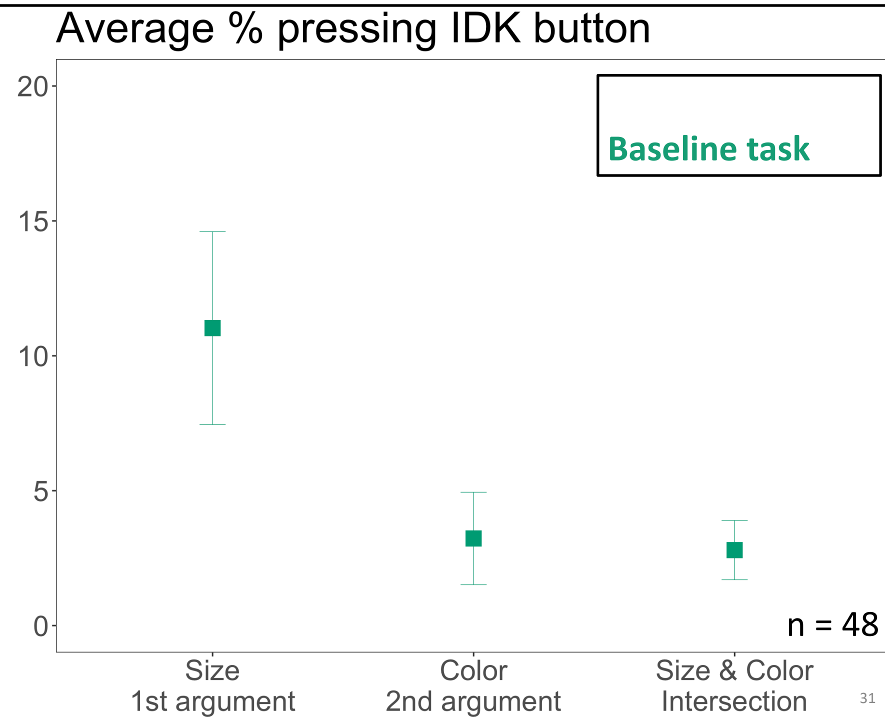
Is there another signature of the asymmetry?

Yes:
rate of opting not to answer

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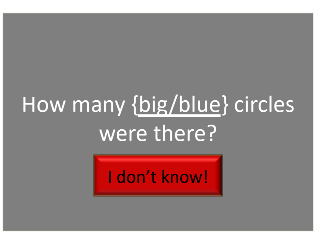


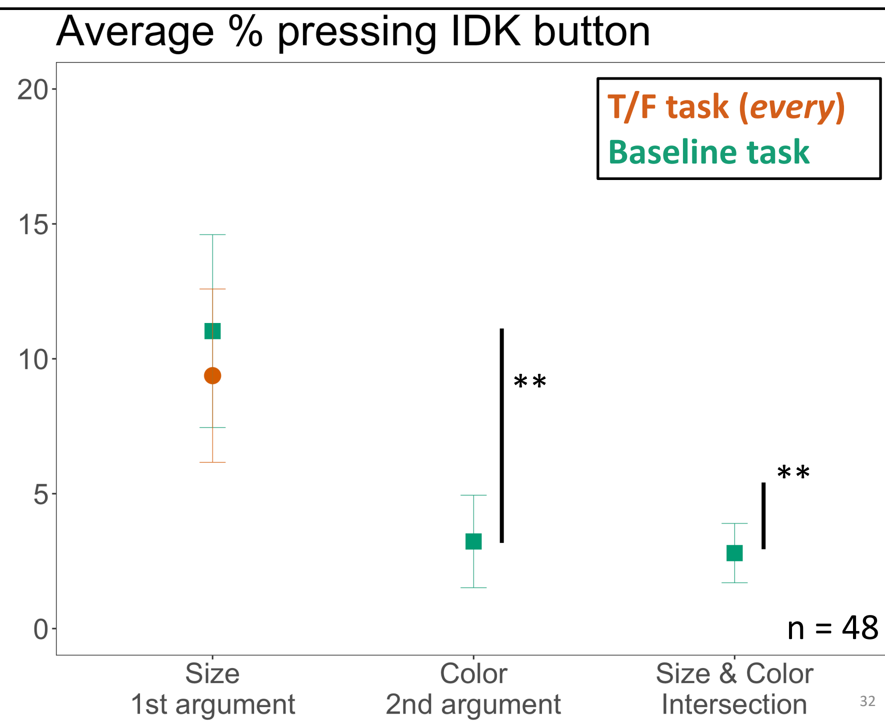


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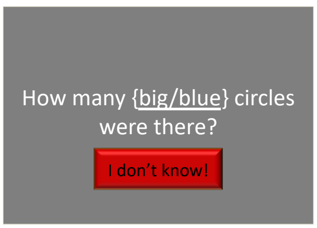
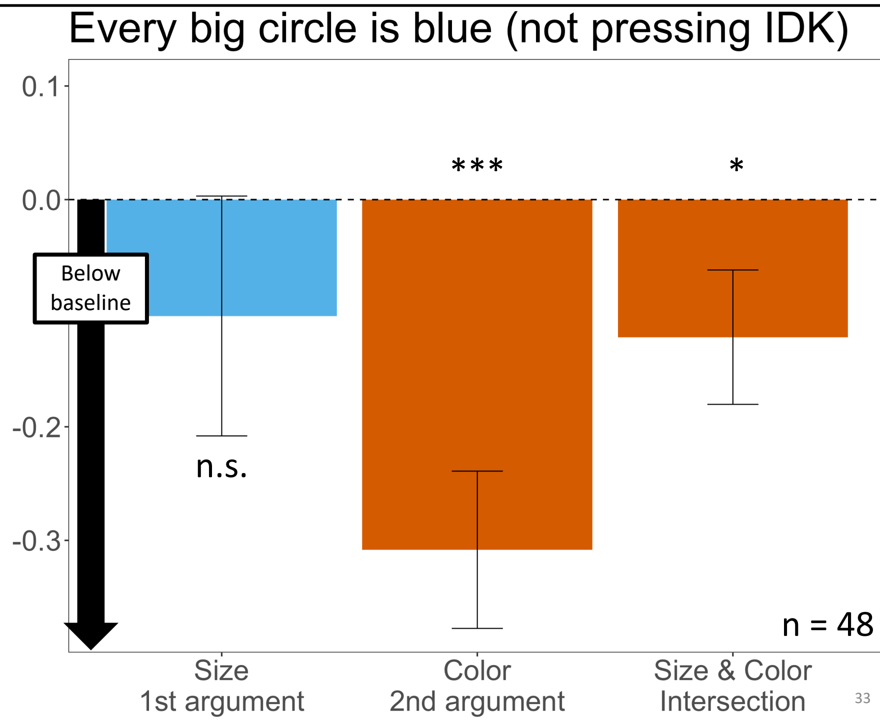
Are participants fully conscious of not knowing #?

No:
same result when they did respond

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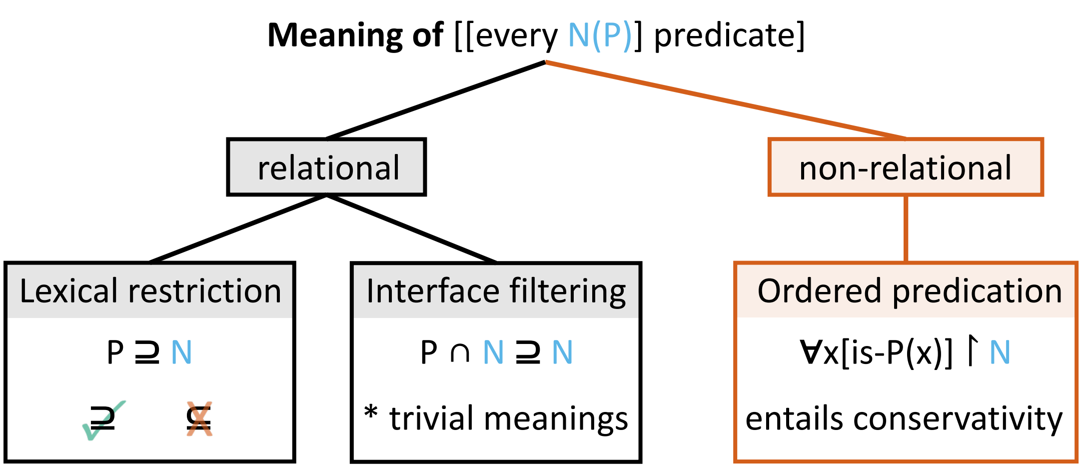
## Three views of conservativity

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## Three views of conservativity

**Meaning of** [[every N(P)] predicate]

**Takeaway:**
Participants only mentally group the extension of *every*'s first argument
→ *every*'s meaning does not express a relation b/t sets, in line with ordered predication

non-relational

Ordered predication

∀x[is-P(x)] ↾ N

entails conservativity

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## Thanks!

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Language at Maryland

NSF

James S. McDonnell Foundation

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