Conservative meanings with only one set: evidence from verification

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Relating processing strategies & semantic theory

Verification strategy: only represent one set (CIRCLES)

Default strategy = implement meaning

Meaning representation: implicates only one set

If every's meaning generalizes

Conservativity universal: follows from one-set meanings

"Every circle is green"

Pietroski et al. (2009)
Lidz et al. (2011)
Odic et al. (2018)
Knowlton et al. under review
Some circles are green
Most circles are green
Every circle is green

___ circles are green

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

All quantifiers are conservative!
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*
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

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

A deep fact about the language faculty: 5 year-olds can’t learn novel non-conservative determiners! (Hunter & Lidz, 2012)
A quantifier Q is conservative iff
\[ Q(X, Y) \iff Q(X, X \cap Y) \]

Made up non-conservative quantifiers

Equi circles are green ≈ the circles are the green things
\[ \negqv \] the circles are the green circles

Yreve circle is green ≈ the circles include all green things
\[ \negqv \] the circles include all green circles

Every non circle is green ≈ every non-circle is green
\[ \negqv \] every non-circle is a green circle

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

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

Three proposals:
- Lexical restriction
- Interface filtering
- One-set meanings

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Proposal 1: Lexical restriction

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

\[ \text{[Every circle is green]} \approx \text{CIRCLES} \subseteq \text{GREEN-THINGS} \]

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

\[ \text{[Yreve circle is green]} \approx \text{CIRCLES} \supseteq \text{GREEN-THINGS} \]
\[ \text{[Equi circles are green]} \approx \text{CIRCLES} = \text{GREEN-THINGS} \]

Our semantic theory should:
Let us state \textit{Every, Most, Some}, ...
But not \textit{Equi, Yreve, Everynon}, ...

Three proposals:
 Lexical restriction \textit{Every}(A, B) \equiv A \subseteq B
 Interface filtering
 One-set meanings
A quantifier $Q$ is conservative iff
$$Q(X, Y) \iff Q(X, X \cap Y).$$

Made up non-conservative quantifiers

Equi circles are green $\approx$ the circles are the green things $\not\approx$ the circles include all green circles

Yreve circle is green $\approx$ every non-circle is green $\not\approx$ every non-circle is a green circle

Our semantic theory should:
Let us state $\text{Every, Most, Some, \ldots}$
But not $\text{Equi, Yreve, Everynon, \ldots}$

Three proposals:

- Lexical restriction $\text{Every}(A, B) \equiv A \subseteq B$
- Interface filtering
- One-set meanings

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

- $[\text{Every circle is green}]$
  $\approx_{\text{LF}} [\text{every circle [every circle is green]}]$
  $\approx \text{CIRCLES} \subseteq \text{CIRCLES} \cap \text{GREEN-THINGS}$

- $[\text{Equi circles are green}]$
  $\approx \text{CIRCLES} = \text{CIRCLES} \cap \text{GREEN-THINGS}$

- $[\text{Yreve circle is green}]$
  $\approx \text{CIRCLES} \supseteq \text{CIRCLES} \cap \text{GREEN-THINGS}$
  (always TRUE)

* Trivial meanings
A quantifier $Q$ is conservative iff
$Q(X, Y) \iff Q(X, X \cap Y)$

Made up non-conservative quantifiers

Equi circles are green
$\approx$ the circles are the green things
$\not\approx$ the circles are the green circles

Every non circle is green
$\approx$ every non-circle is green
$\not\approx$ every non-circle is a green circle

Our semantic theory should:
Let us state $\text{Every, Most, Some, ...}$
But not $\text{Equi, Yreve, Everynon, ...}$

Three proposals:
Lexical restriction $\text{Every}(A, B) \equiv A \subseteq B$
Interface filtering $\text{Every}(A, B) \equiv A \subseteq A \cap B$

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

\[
\text{[Every circle is green]}
\approx _{LF} \forall x[\text{green}(x)] \uparrow \text{CIRCLES}
\]

All conservative quantifiers stateable in this way
Non-conservative quantifiers are not (Westerståhl, 2019)

\[
\text{[Equi circle is green]}
\approx \text{??x[green(x)]} \uparrow \text{CIRCLES}
\]
(intended: CIRCLES = GREEN-THINGS)

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

Three proposals:
- Lexical restriction Every(A, B) ≡ A ⊆ B
- Interface filtering Every(A, B) ≡ A ⊆ A ∩ B
- One-set meanings Every(A, b) ≡ ∀x[bx] \uparrow A

Linking Hypothesis:
Sets implicated by meaning are represented during evaluation
(Pietroski et al., 2009; Lidz et al., 2011; Knowlton et al., under review)
How many big circles were there? Every big circle is blue. How many big circles were there? Every big circle was blue. How many big circles were there?

#-knowledge on T/F task

#-knowledge on baseline task

How many big circles are there? How many big circles were there? 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

Using the equation $y = x^8$ (Stevens, 1964; Krueger, 1984; Odic et al., 2016)
How many big circles were there?

Every big circle is blue

How many big circles are there?

How many big circles were there?

Measuring #knowledge on T/F task

#-knowledge on baseline task

Every big circle was blue

How many big circles were there?

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

Every big circle is blue

1 st argument (big circles) 2 nd argument (blue circles) Intersection (big blue circles)

Above baseline

Below baseline
Every big circle is blue

1st argument (big circles)  2nd argument (blue circles)  Intersection (big blue circles)

n = 46

Above baseline  Below baseline

Every big circle is blue  Only big circles are blue

1st argument (big circles)  2nd argument (blue circles)  Intersection (big blue circles)  big circles  blue circles  big blue circles

n = 48

Above baseline  Below baseline
Every blue circle is big
(swapped arguments)

- 1st argument (blue circles)
- 2nd argument (big circles)
- Intersection (big blue circles)

n = 48

Only blue circles are big

- 1st argument (blue circles)
- 2nd argument (big circles)
- Intersection (big blue circles)
- blue circles
- big circles
- big blue circles

n = 48
Every big circle is blue

% of time pressing “I don’t know!” button

How many \{big/blue\} circles were there?

I don’t know!

n = 46
Every big circle is blue
(performance on trials not pressing “I don’t know” button)

1st argument (big circles)
2nd argument (blue circles)
Intersection (big blue circles)

n = 46

CIRCLES ⊆ GREEN-THINGS
CIRCLES ⊆ CIRCLES ∩ GREEN-THINGS
∀x[green(x)] ⊆ CIRCLES

Every circle is green

Lexical restriction
Interface filtering
One set meanings
“Every circle is green”

One set meaning for *every*:
- Explains behavioral data
- Explains conservativity (if it generalizes beyond *every*)

Thanks!

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Meaning or 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*)

Why isn’t *only* a counter-example?

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

Students only ordered *coffee* (they didn’t also order tea, soda, ...)
Students only *ordered* coffee (they didn’t also make it, purchase it, ...)

Every student ordered *coffee*  
Every student *ordered* coffee  
Says nothing about whether alternatives are TRUE OR FALSE
What about *most*?

[**Every circle [every circle is green]]**

\[ \forall x [\text{green}(x)] \upharpoonright \text{CIRCLES} \]
\[ \approx \text{THE CIRCLES are s.t. every one of them is green} \]

[**Most circles [most circles are green]]**

\[ M x [\text{green}(x)] \upharpoonright \text{CIRCLES} \]
\[ \approx \text{THE CIRCLES are s.t. most of them are green} \]

Decomposition of \( M \)?
See Pietroski et al. (2009); Lidz et al. (2011)

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**By subject guess button press %**

<table>
<thead>
<tr>
<th># of participants</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guess button press %</td>
<td>0</td>
<td>25</td>
<td>50</td>
<td>75</td>
</tr>
</tbody>
</table>

n=24

- Size (first argument)
- Color (second argument)
- Intersection
Every big circle is blue
(performance on trials not pressing “I don’t know” button for participants who at least pressed it once)

- First argument (big circles)
- Second argument (blue circles)
- Intersection (big blue circles)

Above baseline
Below baseline

n = 24

n.s. 
*** 
*

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