Set Selection and Storage Reflect Differences in Quantifier Meanings

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Meanings, Representational Formats, and Verification

Big Picture: What Representational Formats do Speakers use to Encode Quantifier Meanings?

- What is the logical vocabulary of meaning representations?
- How can truth-conditionally equivalent meanings be teased apart experimentally?
- Does each learner acquire only one meaning for a given quantifier?
- Does everyone acquire the same meaning for a given quantifier?

Current Research Questions:

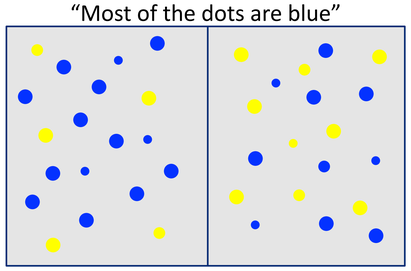
- Are the lexical specifications of *more* and *most* detectable by probing set memory?
- Can quantifier complexity more generally be diagnosed the same way?

Previous Findings

- A one-to-one strategy isn't used to evaluate *most*-statements even when it's available and would be more accurate [1]
- **Interface Transparency Thesis**: People are biased to use verification strategies that transparently reflect the meaning under evaluation [2]

#(dot & blue) > #(dot & ¬blue)
↔ OneToOnePlus[(dot & blue), (dot & ¬blue)]
↔ #(dot & blue) / #(dot) > .5
↔ #(dot & blue) > #(dot) - #(dot & blue)
↔ $\frac{\#(\text{dot \& blue})}{\#(\text{dot})} > \frac{\#(\text{dot}) - \#(\text{dot \& blue})}{\#(\text{dot})}$
↔ …

"Most of the dots are blue"



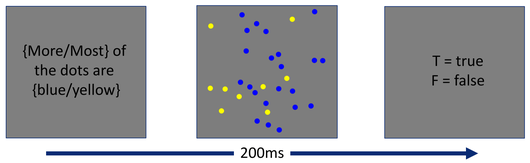
More v. Most

Background: Direct v. Proportional Comparisons

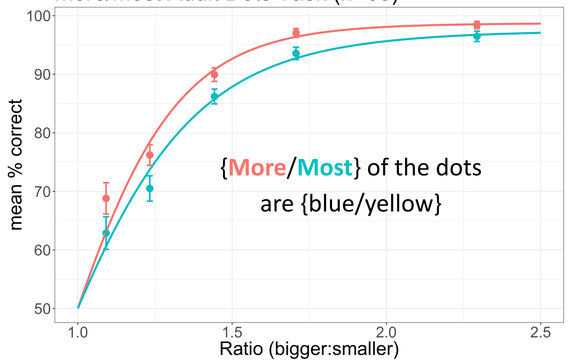
- *More*: compare focused & **non-focused** sets (e.g., blue & yellow)
- *Most*: compare focused & **superset** (e.g., blue & total)

***Experiment 1*: Adult Dots Task**

- #(superset) > #(non-focused set)
  - More noise in superset estimates → Superior performance evaluating *more*-statements

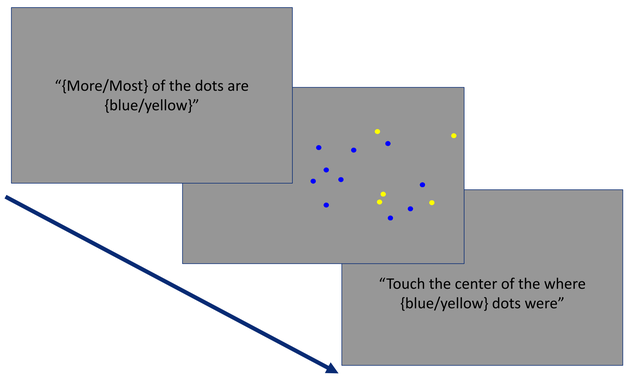


More/Most Adult Dots Task (n=68)

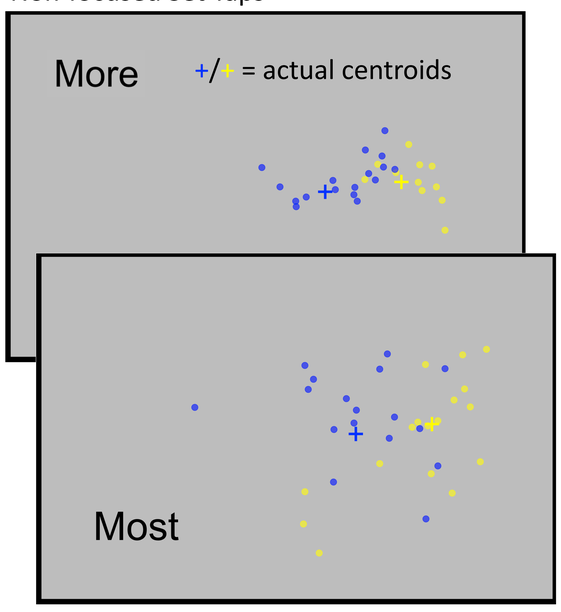


***Experiment 2*: Centroid Selection**

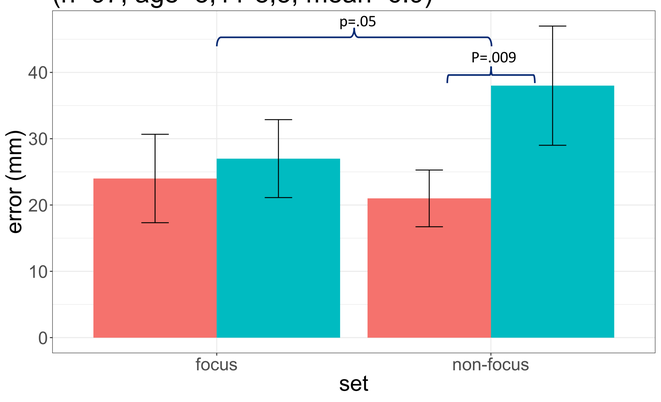
- Attending to a set → better estimate of its center [3]
  - *More*: good performance on both sets
  - *Most*: poor performance on non-focused set



Non-focused Set Taps



Distance from true center
(n=97; age=3;11-8;3, mean=6.9)



1st- v. 2nd-order Quantifiers

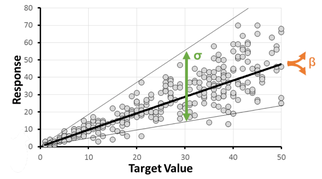
Background: Quantifier Complexity

- *Most* must be 2nd-order [4]; *All*/*Every*/*Each* could be 1st- or 2nd-order
  - Quantifying over individuals or sets? Fa → ∃x(Fx) vs. Fa → ∃X(Xa)
- 2nd-order strategy: **set**-based; 1st-order strategy: **individual**-based
  - Attending to a set → better estimate of its cardinality

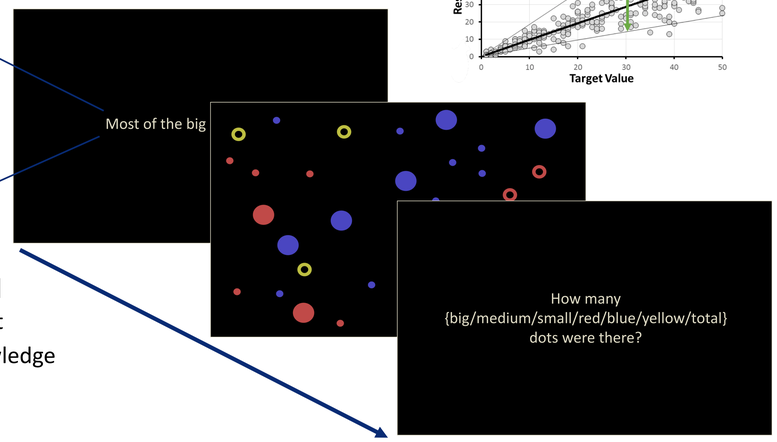
"Every dot is blue"
∀x (dot(x) → blue(x))
↔ {x : dot(x)} ⊆ {x: blue(x)}
↔ #(dot & blue) = #(dot)
↔ …

***Experiments 3 & 4*: Most of the v. There is a / All of the v. Every**

- Fit to model: underestimation (≈ bias) (β) and variability (≈ precision) (σ) [6]

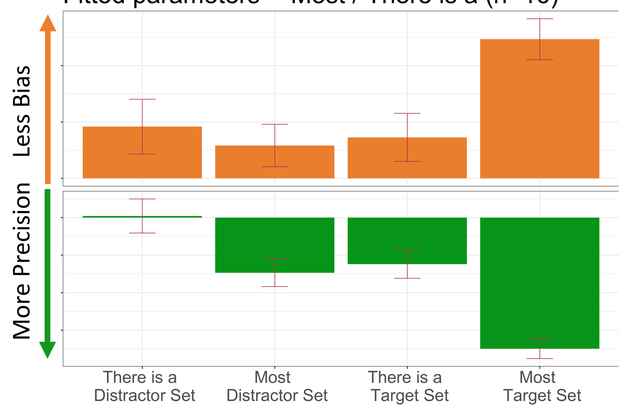


Example Sentences
Most of the big dots are blue
There is a big dot that's blue
All of the big dots are blue
Every big dot is blue
∅



- Establish cardinality knowledge baseline [5]
- *Most of the* → Highlights internal argument
- *There is a* → No enhanced cardinality knowledge
- *All of the* & *Every* → Pattern like *Most*

Fitted parameters -- Most / There is a (n=16)



Fitted parameters -- All / Every (n=18)

Meaning differences are reflected in memory for incidentally encoded properties of sets
(exp. 1 & 2) *More*'s meaning is comparative, *Most*'s meaning is proportional
Cardinality knowledge can serve as 1st- / 2nd-order diagnostic
(exp. 4) *Every* and *All* seem to be represented as 2nd-order, despite the fact that they are both 1st-orderizable

References: [1] Pietroski et al. 2009, *Mind & Language* [2] Lidz et al. 2011, *Nat. Language Semantics* [3] Alvarez & Oliva 2008, *Psych. Sci.* [4] Barwise & Cooper 1981, *Linguistics & Philosophy* [5] Halberda et al. 2006, *Psych. Sci.* [6] Odic et al. 2015 *Behav. Research Methods* **Contact: tzknowlton@gmail.com**