A novel memory task reveals early understanding of quantifier meanings

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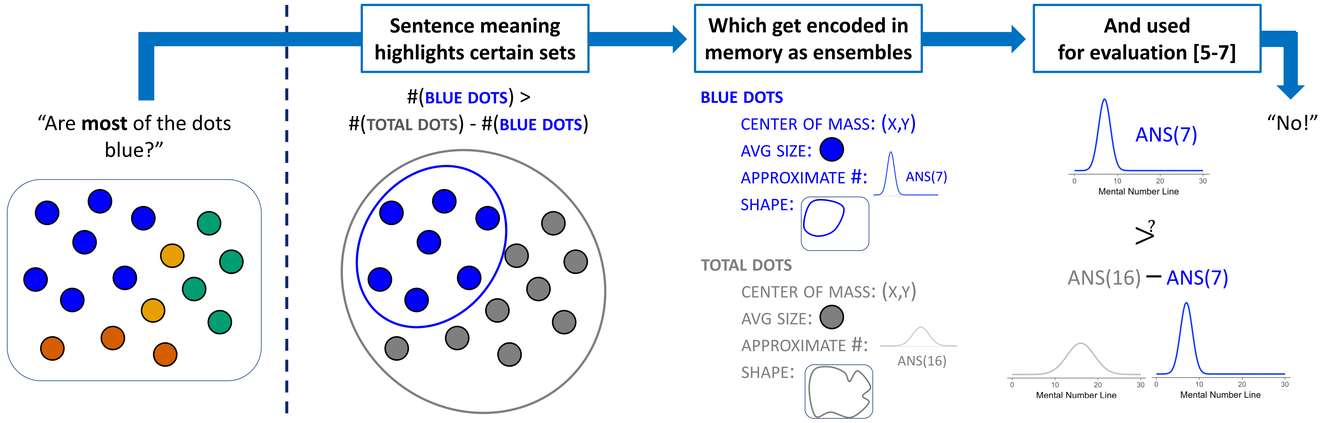
When do language learners acquire quantifier meanings?

Big Picture Question: How are quantifiers mentally represented and acquired?

- Methodological bottleneck: how to tell when learners have adult-like understanding of quantifiers?
  - Successes can be attributed to task effects [e.g., 1]
  - Failures can be attributed to performance limitations [e.g., 2]
  - This leads to disagreement in the literature about age of acquisition [e.g., 1,3]
- Novel method: probe memory for information gathered during evaluation to infer details of the meaning being represented [4]

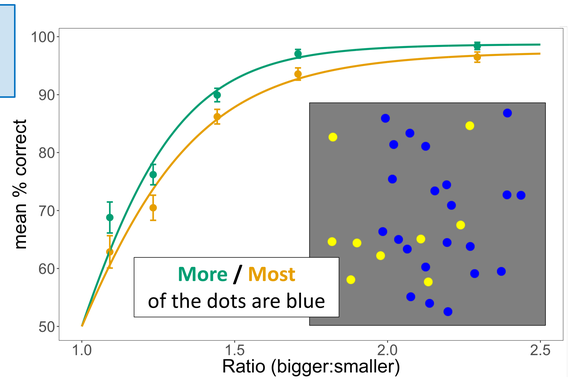
Linking Hypotheses:

- All else equal, people are biased toward verification strategies that transparently reflect the meaning under evaluation [5-7]
  - The meaning influences which aspects of the scene participants will attend to & encode
- If participants attend to a set, they should have a better estimate of its summary statistics [e.g., 8-11]
  - e.g., Approximate Cardinality, Average Size, **Center of Mass**



More & Most

More: Direct comparison (e.g., blue dots vs. **yellow** dots)
Most: Proportional comparison (e.g., blue dots vs. **total** dots)

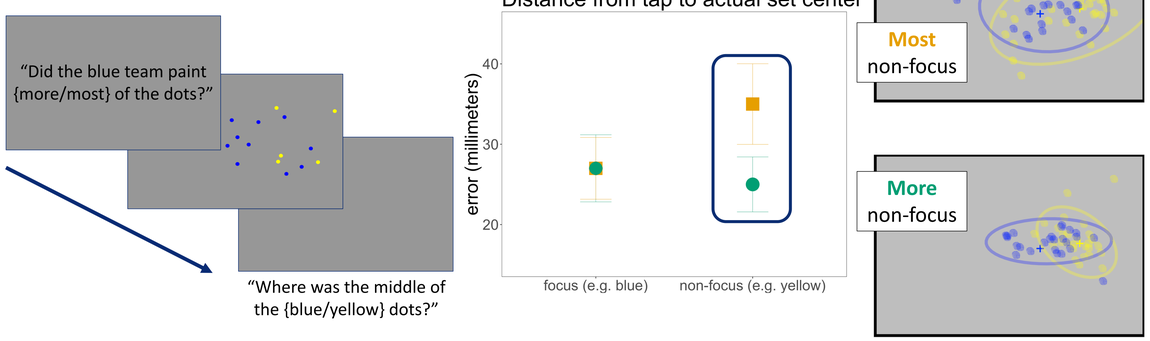


Adults: Speeded TRUE/FALSE Judgement Task

- n=68; 100 trials; 200ms display time
- ANS(total dots) is less precise than ANS(yellow dots) because #(total dots) > #(yellow dots)
  - Adults are better when evaluating a *more*-statement than a *most*-statement; even with identical scenes!

Kids: Center Selection Task (one-trial)

- n=213 (answering correctly); Ages: 3;11 - 8;3 (mean=6;6)
  - Focused set encoded after *more* or *most*
  - Non-focus set only encoded after *more*



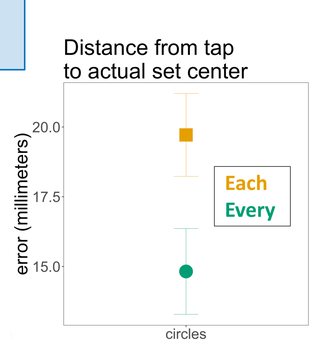
Result: Children have better memory representation of the non-mentioned set's center following a *more*-question →
Like adults, their representation of *More* invites direct comparisons; *Most* invites proportional comparisons

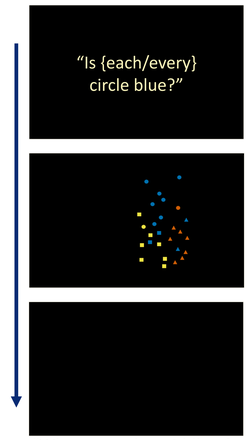
Each & Every

Every: Relate groups (e.g., the blue things include the circles)
Each: Relate individuals (e.g., any thing that's a circle is blue)

Adults: Center Selection Task

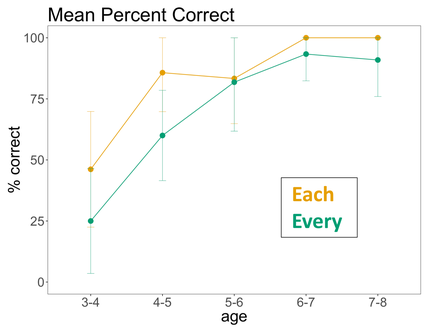
- n=18; 20 trials; 2s display time
- TRUE / FALSE (95% acc) followed by set center question
  - Adults know the center of the circles better after evaluating *every*-statements than *each*-statements; even with identical scenes!

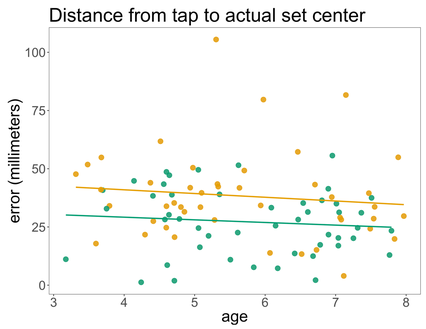


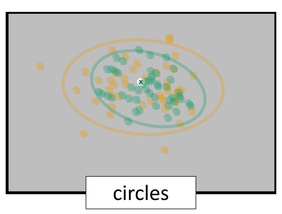


Kids: Center Selection Task (one-trial)

- n=93 (answering correctly); Ages: 3;2 - 7;11 (mean=5;9)
  - Individual circles encoded after *each*
  - Set of circles encoded after *every*







Result: Children have better memory representation of the set's center following an *every*-question →
Like adults, their representation of *Every* invites attending to groups; *Each* invites attending to individuals

[1] Sullivan, Bale & Barner (2018) Most preschoolers don't know *most* **[2]** Minai, Jincho, Yamane & Mazuka (2012) What hinders child semantic computation: children's universal quantification and the development of cognitive control **[3]** Halberda, Taing & Lidz (2008) The development of "most" comprehension and its potential dependence on counting ability in preschoolers **[4]** Knowlton, Pietroski, Halberda & Lidz (under review) The mental representation of universal quantifiers **[5]** Pietroski, Lidz, Hunter & Halberda (2009) The meaning of 'most': Semantics, numerosity and psychology **[6]** Lidz, Pietroski, Halberda & Hunter (2011) Interface transparency and the psychosemantics of *most* **[7]** Tomaszewicz (2011) Verification strategies for two majority quantifiers in polish **[8]** Ariely (2001) Seeing sets: Representation by statistical properties **[9]** Alvarez (2011) Representing multiple objects as an ensemble enhances visual cognition **[10]** Whitney & Leib (2018) Ensemble perception **[11]** Halberda, Sires & Feigenson (2006) Multiple spatially overlapping sets can be enumerated in parallel

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