The role of numerical cognition in signalling Question Under Discussion

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Implicatures from numerical expressions

Quantity implicatures arise when the utterance of an informationally weaker expression conveys the falsity of a stronger alternative:

I saw some of your children today +> It is not the case that I saw all of your children today

These seem to arise from expressions of the form "more than *n*", where *n* is a large, round number (Cummins, Sauerland and Solt, 2012)

More than 100 people were present +> Not more than 1000/200/$^?$150/$^?$125 people were present

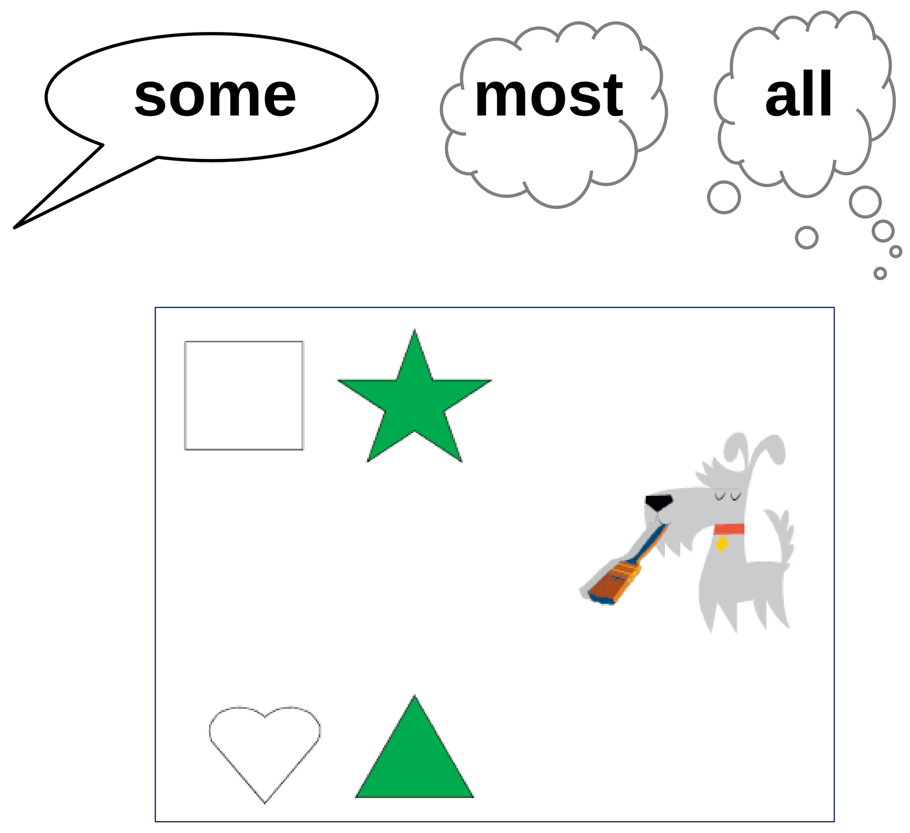
However, they don't arise when *n* is a small integer (in cardinal contexts), as observed by Fox and Hackl (2006).

John has more than two children !+> John has not more than three children

How do we account for this pattern in a psychologically plausible way?

General question: what implicatures are conveyed by a given utterance?

Utterances don't simply convey the negation of all stronger alternatives:
for instance, *p* does not generally implicate the falsity of *p & q*.
In the case of **scalar implicature**, the use of a weaker term implicates the negation of stronger alternatives, suggesting that there's a strong conceptual link between the scalemates.
However, we can also have so-called **ad hoc implicatures**,
in which the relation between the possible utterances is entirely context-specific:
as in the example on the right from Katsos and Bishop (2011).



Here, participants who hear the question — *What did the dog paint?*
tend to reject the response — *The dog painted the triangle*
apparently due to the erroneous implicature it conveys: *The dog didn't paint the star*

Appealing to Question Under Discussion (QUD) to constrain alternatives

A possible limitation on the set of implicature-relevant alternatives is that they must be a better answer to the QUD (Roberts 1996).
The idea would then be that stronger scalar alternatives, by definition, answer the same QUDs as their weaker scalemates;
similarly for the more informative options in the case of ad hoc implicatures (in the above example, exhaustive answers).
However, QUDs are not always explicit, so the question then arises: ***how can we identify QUDs*** in a principled way?

Utterance as a clue to the QUD?

Some utterances appear to hint at their own QUD: e.g.
Obama can win more than 269 electoral college votes.
Here, the question is not "how many?" but "is it more than 269?" – hearer infers that 269 is a critical threshold value.
Given that specific QUD, more information ("more than 300") is not necessarily "better" – hence, no implicature should arise.
Could that be true for "more than two", etc., as actually used?
If so, this could explain the lack of implicature for such items.

Experiment: reasoning about choice of number

12 items based on (cardinal) sentences from the BNC: *n* either *small* (1, 2, 3, 4), *round* (60, 70, 80, 90) or *neither* (58, 77, 86, 93).
Small *n* used with "more than", others with "more than"/"at least".
Participants asked to judge each sentence according to four separate criteria, each on a 5-point Likert scale:

(i) whether the actual number under discussion was less than *m* (where *m* was the next scale point; cf. Cummins et al. 2012)
(ii) whether the statement was the most informative possible
(iii) whether the statement was a convenient approximation
(iv) whether the specific number *n* was important for any reason.

Implementation

31 participants recruited via Amazon Mechanical Turk.
Balanced design: each participant judged 12 items with distinct numbers (8 "more than", 4 "at least"). Results pooled here.

Results

	(i)	(ii)	(iii)	(iv)
More than				
Round	3.46 (1.30)	3.44 (1.15)	4.08 (1.06)	2.98 (1.09)
Small	2.02 (1.27)	3.43 (1.13)	3.29 (1.20)	3.58 (1.24)
Neither	3.63 (1.12)	3.68 (1.04)	3.29 (1.23)	3.11 (1.27)
At least				
Round	3.37 (1.41)	3.67 (1.04)	3.90 (0.94)	3.10 (1.16)
Neither	3.27 (1.38)	3.87 (1.09)	3.21 (1.33)	3.27 (1.26)

Mean ratings (SDs) for each quantifier and number condition

Planned t-tests for the "more than" conditions showed ($p < 0.01$):

- responses to (i) lower for small numbers than other categories
- responses to (iv) higher for small numbers than others.

For the mean responses by item, strong negative correlation between the judgments for (i) and (iv), Pearson's r = -0.67.

Discussion

Participants in this study infer that the use of a specific small number is likely to reflect the importance of that particular number.
Across conditions, when they draw that inference, they are also less willing to endorse implicatures.
The results support the idea that implicatures can be suppressed when hearers infer that a particular number was especially relevant to the discourse purpose (which can naturally be encompassed within something like a QUD-based account).

References

Cummins, C., Sauerland, U., and Solt, S. (2012). Granularity and scalar implicature in numerical expressions. *Linguistics and Philosophy*, 35, 135–169.
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AMLaP XX, University of Edinburgh, 4 September 2014