EXPERIMENTAL EVIDENCE FOR IMPLICATURES WITH MODIFIED NUMERALS
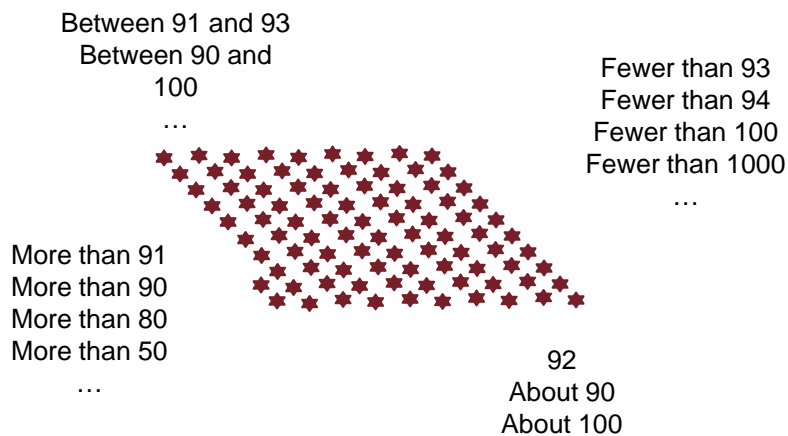
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85th LSA Annual Meeting, January 6-9, 2011

Motivation

Between 91 and 93
Between 90 and 100
…

Fewer than 93
Fewer than 94
Fewer than 100
Fewer than 1000
…

More than 91
More than 90
More than 80
More than 50
…

92
About 90
About 100

The Bigger Question

□ What factors govern speakers' choice between (infinitely) many truth-conditionally adequate alternatives?

❑ Today: A particular consequence of competition between alternatives

Scalar Implicature

The use a weaker term on an implicational scale implies that, as far as the speaker knows, stronger terms on the scale do not hold (Horn 1972)

Sue has read some of Jane Austen's novels   **<some,all>**
→ 'she hasn't read all of them'
Sue has 3 children   **<3,4,5,...>**
→ 'not 4, 5, etc.', i.e. exactly 3

▪ Has been observed that modified numerals do not give rise to scalar implicatures (Krifka 2002, Fox & Hackl 2006)
Sue has more than 3 children
↛ 'not more than 4', i.e. exactly 4

Main Claims

- Modified numerals of the form *more than n* and *at least n* **do** trigger scalar implicatures
- Such implicatures are constrained by (at least) two factors:
  - The granularity level of the numeral scale
  - The discourse salience of the numeral *n*

Pragmatic Strengthening

London has more than 1000 residents

London has more than 7000 residents

Granularity

*The distance between Amsterdam and Vienna is **one thousand kilometers***

*The distance between Amsterdam and Vienna is **nine hundred sixty-five kilometers***

- Krifka (2009): Granularity modelled via scales that differ in density of scale points:

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----------------------------------50---- … ----100-----
-------40--------------------------50---- … ----100-----
-------40------------45------------50---- … ----100-----
-38-39-40-41-42-43-44-45-46-47-48-49-50-51- … -99-100-101-
```

Granularity and modified numerals

☐ Granularity level contextually determined – bias towards coarse-grained representation (Krifka 2007) or contextual parameter of interpretation (Sauerland & Stateva 2007)

   ❑ Modified numerals should compete with alternatives matched in granularity

Prediction #1

- Expressions with modified numerals should give rise to Scalar Implicatures at the appropriate granularity level

  - E.g. 'more than *n*' should implicate 'not more than *m*', where *m* is a higher value on a scale of the same granularity as n

Experiment 1
Stimuli

A newspaper reported the following:

> **More than 100** people attended the public meeting about the new highway construction project'

Based on reading this, how many people do you think attended the meeting?

    A) Between _____ and _____ people attended.
    B) _____ people attended.

More than 100	**At least 100**
More than 110	**At least 110**
More than 93	**At least 93**

- Online survey via Amazon MTurk
- n= 100/condition

Experiment 1
Results

Median Estimates

n =	More than *n*		At least *n*	
	Upper bound	**Most Likely**	**Upper Bound**	**Most Likely**
100	150	110	126	103
110	130	113	135	110
93	100	94	100	94

Experiment 1
Results

Median Estimates – Relative to *n*
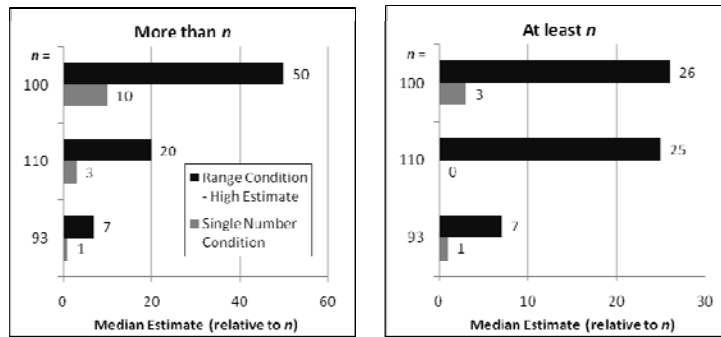
ANOVA	High Estimate	Most Likely
More than *n*	F=5.45, **p<.01**	F=5.81, **p<.01**
At least *n*	F=2.34, p=.099	F=3.99, **p<.05**

Experiment 1
Subject Comments

- 'More than 100' condition:
  - I feel that if there was more than 150, the newspaper would say more than 150.

  - I chose the above number because I felt had the numbers been higher the paper would have said more than 200.

  - I think 125 would be the next increment worthy of mentioning.

- 'More than 110' condition:
  - I chose 135 because I felt that a number higher than that would have been described as, "Close to 150 people attended...".

  - If it had been >120 it would have described them as such

  - If it was more than 115 the writer would have probably said "Almost 120 people attended the meeting"

Prediction #1

- Expressions with modified numerals should give rise to Scalar Implicatures at the appropriate granularity level

✓

  - Though assumed granularity level not consistent

However…

- Non-round numbers (e.g. 93) occur only on scale of granularity 1
  - Prediction: 'more than 93' should implicate 'not more than 94', i.e. 'exactly 94' ✖

- Use of modified numeral (e.g. *'more than n'*) for non-round *n* is odd in out-of-the-blue context
  - But felicitous when number is salient:
    U.S. coach Bob Bradley will call in more than 23 players when the Americans start their final training camp ahead of the World Cup.
    (http://soccernet.espn.go.com/world-cup/story/_/id/5096975/ce/us/bradley-call-more-23-training&cc=5739?ver=global)

Prediction #2

- Contextual activation of the numeral will weaken granularity-based scalar inference
  - Gives speaker a potential additional reason to (re-) use numeral, independent of granularity considerations
  - Hearer is aware of this, and moderates strength of inference from this numeral accordingly

Experiment 2
Stimuli

<u>Primed:</u>

    A: We need to sell 60 tickets to cover our costs. How
          are the ticket sales going?

    B: So far we've sold fewer than 60 tickets

<u>Unprimed:</u>

    A: We need to sell tickets to cover our costs. How are
          the ticket sales going?

    B: So far we've sold fewer than 60 tickets

How many tickets have been sold?

From _____ to _____, most likely _____.

- Paper and pencil
  questionnaire
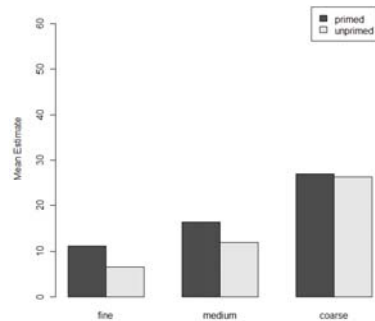- n=45

Experiment 2
Stimuli

- 3 levels of granularity
  - Coarse: Multiple of 100
  - Medium: Multiple of 10
  - Fine: non-round

- 2 numerical expressions:
  - *more than n*
  - *fewer than n*

- 2 levels of priming:
  - Unprimed
  - Primed

Experiment 2
Results

Most Likely Estimate (vs. *n*)

3 x 2 x 2 ANOVA – most likely estimate (relative to *n*)

Main effect of granularity:
$F=47.4$, **$p<.0001$**

Main effect of priming:
$F=8.1$, **$p<.01$**

Main effect of quantifier:
$F=8.9$, **$p<.01$**

Experiment 3
Stimuli

Primed:

Salesperson: This shelf unit is designed to hold 60 CDs. How many CDs do you own?

Customer: I have more than 60 CDs

Unprimed:

Salesperson: This shelf unit is designed to hold CDs. How many CDs do you own?

Customer: I have more than 60 CDs

How many CDs do you think the customer owns?
Between _____ and _____; most likely number _____

More than 60

Fewer than 60

-1-question MTurk survey
- n=100/condition
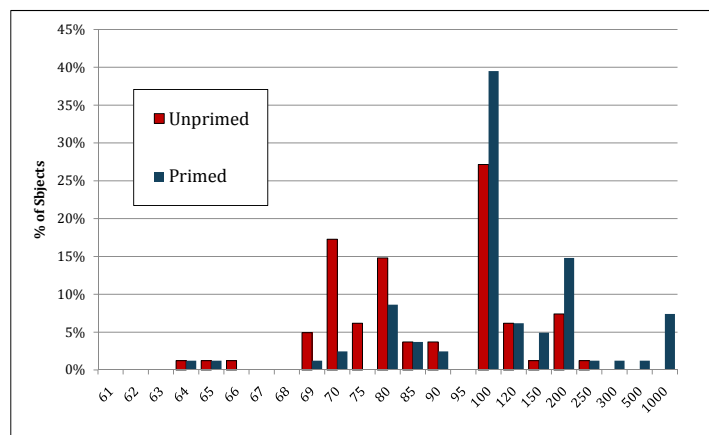
Experiment 3
Results

Median Estimates

	More than 60		Fewer than 60	
	Upper Bound	Most Likely	Lower Bound	Most Likely
Unprimed	85	70	40	55
Primed	100	80	30	110

2 x 2 ANOVA – most likely estimate (vs. *n*)
Main effect of priming: F=39.2, **p<.001**
Main effect of quantifier: F=33.9, **p<.001**
Interaction of quantifier and priming: F=8.5, **p<.01**

Experiment 3
Results

More than 60 – upper bound

Prediction #2

- Contextual activation of the numeral will weaken granularity-based scalar inference

✓

Conclusions

- Contrary to prior claims, modified numerals do trigger scalar implicatures
  - No need to account for gap in otherwise general pattern
- The implicatures in question are dependent on…
  - … the granularity of the numeral scale
  - … the discourse salience of the numeral

  hence the difficulty in detecting them without controlled experiments

Outlook

- Constraint Based Model of quantifier usage – choice among quantified expressions as output of multiple constraint satisfaction problem (Cummins ms.)
- Potential constraints:
  - Informativeness
  - Granularity
  - Contextual activation
  - Quantifier simplicity
  - Etc.
    - ➢ Potential to explain observed lack of implicatures with small numerals (e.g. *more than 3*)

Thank you!