Context in pragmatic inference

Judith Degen

09/12/2015

Institute of Cognitive Science, University of Osnabrück
The linguistic signal is rampantly underspecified.
The linguistic signal is rampantly **underspecified**.
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The linguistic signal is rampantly underspecified.

How do listeners deal with this underspecification?
0, 1, 2, 3, ..., A

ANN FOUND SOME OF THE MARBLES
ANN FOUND SOME OF THE MARBLES

speaker
0, 1, 2, 3, ..., \( \forall \)

ANN FOUND SOME OF THE MARBLES

underspecified utterances

speaker
Speaker: 0, 1, 2, 3, ..., \(\forall\)

Listener: ANN FOUND SOME OF THE MARBLES

underspecified utterances
pragmatic inferences about speaker meaning

0, 1, 2, 3, ..., \( \forall \)

underspecified utterances

ANN FOUND SOME OF THE MARBLES

listener

speaker
Outline

1. Underspecification in language
   1. Scalar implicature
   2. Two solutions to the underspecification problem
      1. The default solution
      2. The contextualist solution

2. The role of context
   1. **Strength** of inference
   2. **Speed** of processing quantifiers
   3. **Distribution** of inferences in spontaneous speech

3. Summary, conclusion
Outline

1. Underspecification in language
   1. Scalar implicature
   2. Two solutions to the underspecification problem
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2. The role of context
   1. **Strength** of inference
   2. **Speed** of processing quantifiers
   3. **Distribution** of inferences in spontaneous speech

3. Summary, conclusion

4. Efficient use of context: probabilistic pragmatics
Scalar implicature

1. John: Was the exam easy?
   Mary: Some of the students failed.
   **Inference**: Some, but not all of the students failed.
Scalar implicature

(1) John: Was the exam easy?
    Mary: Some of the students failed.
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(2) John: Who came to the party?
    Mary: Ann or Greg.
    **Inference**: Either Ann or Greg came, but not both.
Scalar implicature

(1) John: Was the exam easy?
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(2) John: Who came to the party?
    Mary: Ann or Greg.
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(3) John: How was your date?
    Mary: It was OK.
    **Inference**: The date was OK, but not great.
Scalar implicature

(1) John: Was the exam easy?
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**Inference**: Some, but not all of the students failed.

**Generalization** Grice 1975; Horn 1972, 2004
By uttering the weaker alternative from a scale of a weaker and a stronger alternative, the speaker implicates the negation of the stronger alternative.
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**Pragmatic interpretation**
...some, but not all...

**Literal interpretation**
...some, and possibly all...
Scalar implicature

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**Pragmatic interpretation**
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Why study scalar implicature?

(1) John: Was the exam easy?
    Mary: Some of the students failed.

**Inference**: Some, but not all of the students failed.

**Inference**: The exam was not easy.
Why study scalar implicature?

(1) John: Was the exam easy?
Mary: Some of the students failed.
Inference: Some, but not all of the students failed.
Inference: The exam was not easy.

(1) John: Is the teacher doing a good job?
Mary: Some of the students failed.
Inference: Some, but not all of the students failed.
Inference: The exam was hard.
Inference: The teacher isn’t doing a good job.
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Why study scalar implicature?
Why study scalar implicature?
Test bed for accounts of the underspecification problem
Why study scalar implicature?
Test bed for accounts of the underspecification problem

The default account
Levinson 2000

Basic assumptions:
• context is hard to integrate

Solution: two types of inferences
• fast, automatic, context-independent inferences
• slow, effortful, context-dependent inferences
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The contextualist account
Degen & Tanenhaus 2015a
Basic assumptions:
• context is easy to integrate
Solution: efficient use of context
• listeners acquire a context-dependent speaker model: \[ P(\text{utterance} \mid \text{context, meaning}) \]
• listeners use available contextual cues to infer speaker meaning: \[ P(\text{meaning} \mid \text{utterance, context}) \]
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P(utterance | context, meaning)
• listeners use available contextual cues to infer speaker meaning:
P(meaning | utterance, context)
Two solutions to underspecification

Default
- regular
- automatic
- fast

Contextualist
- irregular
- effortful
- slow
Two solutions to underspecification

Default

SI

regular
automatic
fast

irregular
effortful
slow

Contextualist


Two solutions to underspecification

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Two solutions to underspecification

Default

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Notions of “context”

• **utterance alternatives** that the speaker could have used, but didn’t \cite{Katzir2007, FoxKatzir2011}

• conversational goal or Question Under Discussion (**QU**D) \cite{Roberts1996, Roberts2012}
Alternatives and the QUD

**Question Under Discussion** (explicit or implicit)
(1) What does she look like?
(2) What are some features of Sally?
Harry: She has a good personality.

**Alternatives**
Jess: So which one is she?
Harry: Attractive.
Jess’s inference: Sally is **attractive**, but not **beautiful**.
QUD effects on scalar implicature

Does the QUD modulate scalar implicature strength?

Implicit QUD
QUD effects on scalar implicature

Does the QUD modulate scalar implicature strength?

Implicit QUD

**all?** Did the speaker find all of the marbles?
QUD effects on scalar implicature

Degen & Goodman 2014

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**any?** Did the speaker find any of the marbles?
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**all?** Did the speaker find all of the marbles?
I found **all** / **some** of the marbles.

**any?** Did the speaker find any of the marbles?
I found **all** / **some** of the marbles.
Predictions

Default

• no effect of QUD

• strong scalar inferences in both cases

Contextualist

• effect of QUD

• stronger inferences under all?-QUD
Task and results

48 participants on Mechanical Turk
Task and results

48 participants on Mechanical Turk
Task and results

48 participants on Mechanical Turk
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The QUD modulates scalar inference strength
Task and results

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The QUD modulates scalar inference strength
see also Zondervan 2010; Degen 2013
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Number alternatives in processing “some”
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Subitizing Kaufman et al. 1949
Number alternatives in processing “some”

Subitizing Kaufman et al. 1949
Number alternatives in processing “some”

You got some/two/eight of the gumballs.

Subitizing Kaufman et al. 1949
Number alternatives in processing “some”

You got some/two/eight of the gumballs.

1. Naturalness ratings
   - Do listeners have expectations about use of some? P(some | M)
   - Do expectations depend on the contextual availability of number alternatives? P(some | M, C)

Subitizing Kaufman et al. 1949
Number alternatives in processing “some”

You got some/two/eight of the gumballs.

1. Naturalness ratings
   - Do listeners have expectations about use of some? $P(\text{some} | M)$
   - Do expectations depend on the contextual availability of number alternatives? $P(\text{some} | M, C)$

2. Response times
   - Are listeners’ expectations of use reflected in online processing of some?
The gumball paradigm
Degen & Tanenhaus 2015a
The gumball paradigm
Degen & Tanenhaus 2015a
The gumball paradigm

Degen & Tanenhaus 2015a

You got some of the gumballs

How natural was the statement as a description of the scene?

Very unnatural

1    2    3    4    5    6    7  Very natural

360 participants on MTurk

Independent variables:
• set size in lower chamber: 0 - 13
• quantifier: some, all, none, (one, two, …)
• presence of number terms
Expectations of use for some

some is a dispreferred alternative for small sets (p < .0001)
Expectations of use for *some*

*some* is a dispreferred alternative for small sets ($p < .0001$) especially when numbers are available alternatives ($p < .01$)
Expectations in online processing

Are these expectations of use reflected in online processing? What is the speed of processing literal vs. pragmatic interpretation?

- 48 participants
- set sizes: 0 - 13
- **button press task:**
  - yes (agree) vs. no (disagree)
- included number terms
- **8 critical trials (complete set with *some*):**
  - yes = literal; no = pragmatic

Noveck & Posada 2003; Bott & Noveck 2004
Response time predictions

**Default**
- no effect of expectations
- literal slower than pragmatic

**Contextualist**
- effect of expectations
- SI speed context-dependent

![Graph showing response time predictions](image)
Response time results

![Graph showing response time results. The x-axis represents the number of gumballs, and the y-axis represents mean response time in milliseconds. The graph shows a trend with a peak at 13 gumballs and a trough between 4 and 6 gumballs. There are two response categories: no and yes. The no response has a higher mean response time at 13 gumballs, while the yes response shows a more fluctuating trend with a lower mean response time at 4 to 6 gumballs.](image-url)
Response time results

responses slower where some less expected
Response time results

responses slower where some less expected
Response time results

responses slower where *some* less expected pragmatic responses slower than literal responses
Response time results

responses slower where *some* less expected

pragmatic responses slower than literal responses
Possible explanations for the “delayed implicature” effect I
Two-stage, literal-first process? Huang & Sneaker 2009; 2011
Unlikely for independent reasons. Grodner et al. 2010; Breheny et al. 2013; Degen & Tanenhaus 2015b
Possible explanations for the “delayed implicature” effect I

Two-stage, literal-first process? Huang & Sneaker 2009; 2011

Unlikely for independent reasons. Grodner et al. 2010; Breheny et al. 2013; Degen & Tanenhaus 2015b

You got some of the orange gumballs
Possible explanations for the “delayed implicature” effect II

QUD makes the stronger alternative *all* irrelevant.
Possible explanations for the “delayed implicature” effect II

QUD makes the stronger alternative all irrelevant.

Support:
only 29% pragmatic responses
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Scalar implicatures in the wild

1. I like *some country music*.

2. It would certainly help them to appreciate *some of the things we have here*.

3. You sound like you have *some small ones* in the background.
Combining corpora & the web

Degen 2015

1. extracted all 1390 utterances containing \textit{some} from the Switchboard corpus of spoken American English

2. collected implicature strength ratings for each item on MTurk
Speaker A: i mean, they just have beautiful, beautiful homes and they have everything. the kids only wear name brand things to school and it's one of these things,

Speaker B: oh me. well that makes it hard for you, doesn't it.

Speaker A: well it does, you know. it really does because i'm a single mom and i have a thirteen year old now and uh, you know, it does.

Speaker B: oh, me.

Speaker A: i mean, we do it to a point but uh, not to where she feels different ,

Speaker B: yeah.

Speaker A: but some of them are very rich

---

**but some, but not all of them are very rich**

How similar is the statement with 'some, but not all' (green) to the statement with 'some' (red)?

Very different meaning  
1  2  3  4  5  6  7  Same meaning

[9-1=8]
Default prediction
Variation in implicature strength

large amount of variation between items
Just noise?

No. Inference strength systematically context-dependent.
Just noise?

No. Inference strength systematically context-dependent.

**Partitivity**
Modification
Grammatical function
Linguistic mention
Determiner strength
Just noise?

No. Inference strength systematically context-dependent.

**Partitivity**
Modification
Grammatical function
Linguistic mention
Determiner strength

**Simple *some***
I ate *some* cookies.

**Partitive *some***
I ate *some of the* cookies.
Just noise?

No. Inference strength systematically context-dependent.

**Partitivity**
Modification
Grammatical function
Linguistic mention
Determiner strength

**Simple some**
I ate **some** cookies.

**Partitive some**
I ate **some of the** cookies.

Utterances with partitive **some** give rise to stronger implicatures.
Empirical rating
by-participant intercepts only

Model fit

Empirical rating

Predicted rating

$r = .16$

by-participant intercepts only
Model fit
after adding fixed effects of context
Model fit
Model fit

after adding by-item random effects
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Conclusion

/b/  /g/

Mary hit the man with a stick

p(∀) = 0.1

Ann found some of the marbles

p(∀) = 0.8
Conclusion

How do listeners deal with this underspecification?
How do listeners deal with this underspecification?

By making **efficient** use of **context**.
Thank you

**Collaborators**
Michael Franke
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Efficient use of context

Probabilistic pragmatics  Franke & Jäger 2015

- **probabilistic**: speakers and listeners are uncertain
- **interactive**: explicit representation of speakers and listeners
- **rationalistic**: pragmatic behavior is approximately rational
- **Bayesian**: optimal behavior is given by Bayes’ rule
- **computational**: predictions derived from implemented models
- **data-oriented**: model predictions are tested empirically

Franke 2009; Frank & Goodman 2012; Russell 2012; Degen, Franke, & Jäger 2013; Goodman & Stuhlmüller 2013; Degen, Tessler, & Goodman 2015; Kao, Bergen, & Goodman 2014; Potts, Lassiter, Levy, & Frank, in press
Probabilistic pragmatics

Rational Speech Act (RSA) models

Pragmatic listener

\[ \Pr_{L_1}(s|u) \propto \Pr_{S_1}(u|s) \cdot \Pr(s) \]
Probabilistic pragmatics

Rational Speech Act (RSA) models

Pragmatic listener

\[ P_{L_1}(s|u) \propto P_{S_1}(u|s) \cdot P(s) \]
Probabilistic pragmatics

Rational Speech Act (RSA) models

pragmatic listener

\[ P_{L_1}(s|u) \propto P_{S_1}(u|s) \cdot P(s) \]
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Probabilistic pragmatics

Rational Speech Act (RSA) models

Pragmatic listener

\[ P_{L_1}(s|u) \propto P_{S_1}(u|s) \cdot P(s) \]

Pragmatic speaker

\[ P_{S_1}(u|s) \propto \exp(\lambda \ln P_{L_0}(s|u)) \]
Probabilistic pragmatics

Rational Speech Act (RSA) models

**pragmatic listener**

\[ P_{L_1}(s|u) \propto P_{S_1}(u|s) \cdot P(s) \]

**pragmatic speaker**

\[ P_{S_1}(u|s) \propto \exp(\lambda \ln P_{L_0}(s|u)) \]

**literal listener**

\[ P_{L_0}(s|u) \propto \delta[[u]](s) \cdot P(s) \]
Pragmatic listener

\[ P_{L_1}(s|u) \propto P_{S_1}(u|s) \cdot P(s) \]

"Some of the people drank beer."
Pragmatic listener

$$PL_1(s|u) \propto PS_1(u|s) \cdot P(s)$$

"Some of the people drank beer."

\[
\begin{align*}
\text{State} & \quad \text{Probability} \\
0 & \quad 1 \\
1 & \quad 0.3 \\
2 & \quad 0.3 \\
3 & \quad 0.3 \\
4 & \quad 0.1 \\
\end{align*}
\]

$\lambda = 1$
Implicit QUD manipulation

Ann's five-year-old nephew loves playing with marbles. For when he comes to visit, Ann keeps a set of 4 marbles in a drawer. Yesterday, he...

Ann is really into collecting marbles. Recently, her friends gave her a special edition of 4 marbles, which she loves. Yesterday, her five-year-old nephew...

came to visit and found her marbles in a drawer. He also found some shoe boxes. He played with the marbles for a long time and moved them from one box to another until they were all hidden and he did not remember where he put them.