Context in pragmatic inference

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The linguistic signal is rampantly **underspecified**.
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![Diagram](attachment:diagram.png)
The linguistic signal is rampantly **underspecified**.

![Diagram showing linguistic underspecification](image)

**p(∀) = 0.1**  **p(∀) = 0.8**
The linguistic signal is rampantly **underspecified**.

How do listeners deal with this underspecification?
Overview

1. Background
   - Scalar implicature (SI)
   - The default solution
   - A contextualist solution

2. Distributional properties of SI

3. Online processing of SI

4. Computational models of context in SI

5. Conclusion
Scalar implicature

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

~~~~ Some, but not all of the students failed.

Generalization (Grice, 1975; Horn, 1972)

By uttering the weaker alternative from a scale ⟨all, some⟩, the speaker implicates the negation of the stronger alternative.
Generalized vs. particularized conversational implicature

(Grice, 1975; Levinson, 2000)

(2) John: Was the exam easy?
Mary: Some of the students failed.
⇝ Some, but not all of the students failed. (GCI)
⇝ The exam was not easy. (PCI)
Generalized vs. particularized conversational implicature

(Grice, 1975; Levinson, 2000)

(2) John: Was the exam easy?
Mary: Some of the students failed.
⇝ Some, but not all of the students failed. (GCI)
⇝ The exam was not easy. (PCI)

(3) John: Is the teacher doing a good job?
Mary: Some of the students failed.
⇝ Some, but not all of the students failed. (GCI)
⇝ The exam was not easy.
⇝ The teacher is not doing a good job. (PCI)
Generalized vs. particularized conversational implicature

(Grice, 1975; Levinson, 2000)

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

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⇝ The exam was not easy. (PCI)

(3) John: Is the teacher doing a good job?
    Mary: Some of the students failed.

⇝ Some, but not all of the students failed. (GCI)
→ The exam was not easy.
⇝ The teacher is not doing a good job. (PCI)
Levinson’s solution: GCIs as default inferences

A solution to the underspecification problem: easy vs. hard inferences

**Generalized Conversational Implicature (GCI)**
Implicature arises by **default** and may be blocked by context.

**Particularized Conversational Implicature (PCI)**
Implicature arises in virtue of special features of the **context**.
Scalar implicatures from *some* to *not all* should be:

- frequent
- automatic
- context-independent
implicature strength and speed of computation depend on
probabilistic contextual support

assumptions:
implicature strength and speed of computation depend on probabilistic contextual support

assumptions:
  - context helps, not hinders
implicature strength and speed of computation depend on probabilistic contextual support

assumptions:
- context helps, not hinders
- listeners have a model of the utterances $U$ speakers are likely to produce in different (linguistic and extra-linguistic) contexts $C$ to convey a given meaning $M$: $p(U|C, M)$
implicature strength and speed of computation depend on **probabilistic contextual support**

assumptions:
- context helps, not hinders
- listeners have a model of the utterances $U$ speakers are likely to produce in different (linguistic and extra-linguistic) contexts $C$ to convey a given meaning $M$: $p(U|C, M)$
- listeners make use of available contextual cues to update their beliefs about the speaker’s **most likely intended meaning**: $p(M|U, C)$
implicature strength and speed of computation depend on 
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  produce in different (linguistic and extra-linguistic) contexts $C$ to 
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- listeners make use of available contextual cues to update their beliefs 
  about the speaker’s most likely intended meaning: $p(M|U, C)$

scalar implicature as a result of probabilistic belief update about likely 
states of the world upon observing utterance (see also Frank & Goodman, 
Differences between default and contextualist view

Default

GCI

PCI

Contextualist
Differences between default and contextualist view

Default

Contextualist

SI
GCI
PCI
Differences between default and contextualist view

**Default**
- GCI

**Contextualist**
- PCI
  - SI?
  - SI?
  - SI?
Scalar implicatures from *some* to *not all* are …

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Summary of predictions

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Collected implicature ratings on MTurk for 1390 items from Switchboard

(4) I like **some country music**.
(5) It would certainly help them to appreciate **some of the things we have here**.
(6) You sound like you have **some small ones** in the background.
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)?

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

Continue
Variation in implicature strength

- mean similarity rating: 3.9
- large variation between items
Effects of contextual cues

Implicature strength is greater when...

Partitive

...the *some*-NP is **partitive**

*Some of them are very rich*
Effects of contextual cues

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...the *some*-NP is **partitive**

*Some of them are very rich*

Previous mention

...the embedded NP referent was **previously mentioned**

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...the *some*-NP is **partitive**

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Grammatical function

... *some*-NP in **subject** position

*Some of them are very rich*
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Notions of ‘context’

- what the **alternative utterances** are that the speaker could have produced, but didn’t (Katzir, 2007; Fox & Katzir, 2011)
- what the focus of the conversation or the **Question Under Discussion** (QUD, Roberts, 1996) is
Alternatives and the QUD
(7) **Question Under Discussion** (explicit or implicit)

a. What does she look like?

b. What are features of Sally?

c. Harry: She has a good personality.
Alternatives and the QUD

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

(8) **Alternatives**
   Jess: So which one is she?
   Harry: **Attractive**.
   ⇒ Sally is attractive, but not **beautiful**.
You got some/two/eight of the gumballs.

Subitizing (Kaufman et al., 1949)
You got some/two/eight of the gumballs.

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

2. Response times
   - Are these expectations reflected in the online processing of some?

Subitizing (Kaufman et al., 1949)
The gumball paradigm (Degen & Tanenhaus, to appear)
The gumball paradigm  
(Degen & Tanenhaus, to appear)
You got some of the gumballs
The gumball paradigm

- You got some of the gumballs
- Task: rate naturalness of statement as a description of the scene
Exp. 2a: expectations of use for some

- 360 MTurk participants
- Independent variables:
  - set size in lower chamber: 0 - 13
  - quantifier: some, all, none, (one, two, ...)
  - presence of number terms

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

Very unnatural 1 2 3 4 5 6 7 Very natural

FALSE
some is a dispreferred alternative for small sets ($p < .0001$)
some is a dispreferred alternative for small sets ($p < .0001$) especially when number terms are available alternatives ($p < .01$)
Naturalness effects in online processing

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

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

Noveck and Posada (2003); Bott and Noveck (2004)
Predictions for online processing

Default
- no naturalness effect
- semantic slower than pragmatic

Contextualist
- naturalness effect
- SI speed context-dependent
Results: binary judgments & response times

**Judgments:** 71% semantic responses to *some* used with complete set

**Response times:**

Pragmatic responses slower than semantic responses
Responses slower for set sizes where *some* is less natural
Results: binary judgments & response times

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Pragmatic responses slower than semantic responses
Responses slower for set sizes where some is less natural
Possible explanations for the “delayed implicature” effect

- two-stage, literal-first process (Huang & Snedeker, 2009, 2011)
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- two-stage, literal-first process (Huang & Snedeker, 2009, 2011)
  - unlikely for independent reasons (Grodner et al., 2010; Breheny et al., 2013; Degen & Tanenhaus, under review)
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- two-stage, literal-first process (Huang & Snedeker, 2009, 2011)
  - unlikely for independent reasons (Grodner et al., 2010; Breheny et al., 2013; Degen & Tanenhaus, under review)
- QUD makes the stronger alternative *all* irrelevant
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QUD effects on scalar implicature (Degen & Goodman, under review)

Does the QUD modulate scalar implicature rates (via the relevance of the stronger alternative)?

- implicit QUD
  - **all?** Did the speaker find all of the marbles?
  - **any?** Did the speaker find at least one of the marbles?
Does the QUD modulate scalar implicature rates (via the relevance of the stronger alternative)?

- **implicit QUD**
  - **all?** Did the speaker find all of the marbles?
    - *I found all / some of the marbles.*
Does the QUD modulate scalar implicature rates (via the relevance of the stronger alternative)?

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    - *I found all / some of the marbles.*
  - **any?** Did the speaker find at least one of the marbles?
    - *I found all / some of the marbles.*

- prediction
  - more pragmatic responses when QUD is **all?** than when it is **any?**
QUD manipulation

- 48 participants on MTurk
- Independent variables
  - implicit **all?** or **any?** QUD via cover story
  - total number of contextual marbles (4 or 16)

She called out to her husband:
'I found some of the marbles!'

Is Ann's statement true?

Yes  No
The QUD modulates SIs ($p < .05$)
Knowledge of effort of establishing set size modulates SIs ($p < .05$)
Summary of predictions

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sentence verification widely used to probe implicature (Bott & Noveck, 2004; Degen & Tanenhaus, to appear; Geurts & Pouscoulous, 2009; Zondervan, 2010)

but: not a natural measure of interpretation

proposal: sentence verification is actually a production measure

predicts that we should find effect of QUD on production task
Dan found this box:

He called out to his wife:

'I found ______ of the marbles!'

For each of the following words, adjust the slider to indicate how likely you think it is that Dan used that word.

- four
- none
- some
- all
The expectation for *some* use is modulated by the QUD ($p < .05$).
After opening the first box, Ann called out to her husband:

'I found some of the marbles!'

Which of these boxes do you think Ann found?

Adjust the slider for each box to indicate how likely you think it is that Ann found that box.
No effect of the QUD on comprehension!
Summary

Does the QUD affect scalar implicature?

- sentence verification
- sentence completion
- sentence interpretation
Context affects some-not-all implicatures.
The dependent measure matters.
The end?
Context affects some-not-all implicatures.
The dependent measure matters.
The end?
\[ P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)} \]
\[ P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)} \]
Case study:

- measuring context effects with different dependent measures (Degen & Goodman, under review)
- builds on
  - rational speech act models (Frank & Goodman, 2012; Goodman & Stuhlmüller, 2013)
Probabilistic pragmatics

Meanings $M = \{m_0, m_1, m_2, \ldots, m_N\}$
Utterances $U = \{u_{\text{some}}, u_{\text{all}}, u_{\text{none}}, u_{\text{number}}\}$
QUD $Q = \{\text{qud}_{\text{all}}, \text{qud}_{\text{any}}\}$

$$P_{\text{listener}}(M|U, Q) \propto P_{\text{speaker}}(U|M, Q)P(M)$$

Franke (2009); Frank and Goodman (2012); Russell (2012)
Meanings $M = \{m_0, m_1, m_2, \ldots, m_\forall\}$
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obtained experimentally!

Franke (2009); Frank and Goodman (2012); Russell (2012)
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$$P_{\text{listener}}(M|U, Q) \propto P_{\text{speaker}}(U|M, Q)P(M)$$

simulate it!

Franke (2009); Frank and Goodman (2012); Russell (2012)
The importance of the prior

\[ P_{\text{listener}}(m\forall | u_{\text{some}}, Q) \propto P_{\text{speaker}}(u_{\text{some}} | m\forall, Q) P(m\forall) \]
The importance of the prior

\[ P_{\text{listener}}(m_\forall | u_{\text{some}}, Q) \propto P_{\text{speaker}}(u_{\text{some}} | m_\forall, Q) P(m_\forall) \]
The importance of the prior

\[ P_{\text{listener}}(m_{\forall} | u_{\text{some}}, Q) \propto P_{\text{speaker}}(u_{\text{some}} | m_{\forall}, Q) P(m_{\forall}) \]
The importance of the prior

\[ P_{\text{listener}}(m_\forall \mid u_{\text{some}}, Q) \propto P_{\text{speaker}}(u_{\text{some}} \mid m_\forall, Q)P(m_\forall) \]
The importance of the prior

\[ P_{\text{listener}}(m \forall | u_{\text{some}}, Q) \propto P_{\text{speaker}}(u_{\text{some}} | m \forall, Q) P(m \forall) \]
Summary

- **variation** and **context-dependence** in degree to which scalar implicatures from *some* to *not all* arise
- **online processing** of *some* and other quantifiers is dependent on expectations for alternative utterances
- developing **probabilistic models** of pragmatic inference that are explicit about speaker and listener beliefs is useful
  - rational interlocutor behavior (given a QUD, utterance cost)
  - dependent measures
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How do listeners deal with this underspecification?
How do listeners deal with this underspecification? By making **efficient** use of **context**!
Future directions

Extension of probabilistic models to incremental processing and acquisition

Development of a contextual theory of alternatives

Generalizability to other scales and inference types (Doran, Ward, Larson, McNabb, & Baker, 2012; van Tiel, van Miltenburg, Zevakhina, & Geurts, in prep.)

Fuller investigation of relevant contextual cues

- speaker knowledge (Bergen & Grodner, 2012; Goodman & Stuhlmüller, 2013)
- speaker variability (Yildirim, Degen, Tanenhaus, & Jaeger, 2013)
- information structure
- prosody
- ...

Judith Degen
Thank you!

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- Stanford: Erin Bennett, Julius Cheng

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