Today’s talk

Some questions

1. What are the factors that affect scalar implicature processing?
2. What is the time course of scalar implicature processing?

Motivation

- insight into the architecture of the comprehension system
- consequences for the types of meaning postulated by pragmatic theories
1 Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2 From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3 Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
   - Results: constraints on implicature processing

4 Conclusion
Speaker meaning

How do we infer what speakers mean when they produce an utterance?

(1) Anne: Was the exam hard?
    Bill: Some students failed.
    a. Some, but not all, students failed.
    b. The exam was hard.
Classification of meaning  
Grice, 1975

- total signification
  - said
  - implicated
    - conventionally
    - conversationally
      - generalized
      - particularized
Conventional implicature

- part of an expression’s meaning, rather than derived from principles of language use
- not part of the truth conditions

(2) This restaurant is expensive but really good.
\[ \sim \] There is a contrast between ‘expensive’ and ‘really good’.
Classification of meaning  Grice, 1975

- total signification
  - said
  - implicated
    - conventionally
    - conversationally
      - generalized
      - particularized
Cooperative Principle

“Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.”

Conversational maxims

Quality: Make your contribution true; do not convey what you believe false or unjustified.
Quantity: Be as informative as required.
Relevance: Be relevant.
Manner: Be perspicuous; avoid obscurity and ambiguity and strive for brevity and order.
Particularized Conversational Implicature (PCI)
Implicature arises in virtue of special features of the context.

Generalized Conversational Implicature (GCI)
Implicature arises unless context blocks it.

(3) Anne: Was the exam hard?
Bill: Some students failed.
   a. \(\sim\) Some, but not all, students failed.
   b. \(\sim\) The exam was hard.
Gricean Pragmatics

- Grice and the cooperative principle
- Scalar implicature: the phenomenon

From theory to experiment

- Early debate: the question of default
- Empirical evidence
- Interim summary

Experiments in the gumball paradigm

- Starting point
- The gumball paradigm
- Results: constraints on implicature processing

Conclusion
The prototypical GCI: scalar implicature

Scale: \( \langle \text{all, some} \rangle \)

(4) Anne: Was the exam hard?
    Bill: Some students failed.
    Some, but not all, students failed.

Scale: \( \langle \text{and, or} \rangle \)

(5) Peter: Who is in that room?
    Mary: John or Bill.
    \( \equiv \) It’s not the case that both John and Bill are.
The Gricean explanation

Grice’s conversational maxims:

**Quantity-1**: Make your contribution as informative as is required (for the current purpose of the exchange).

**Truthfulness**: Do not say what you believe to be false.

Hearer’s reasoning about speaker S

- S uttered the statement with *some* instead of *all*, which would have also been relevant
- the *all* statement (A) is more informative than (i.e. entails) the *some* statement
- if S knew that A holds, she would have uttered it
- S is competent wrt the truth of A
- thus, it is not the case that A holds
A key feature of conversational implicatures: cancelability

(6) *Explicit cancellation*
Anne: Was the exam hard?
Bill: Some students failed. In fact, all of them did.

(7) *Implicit cancellation*
John: Is there any evidence against them?
Mary: Some of their identity documents are forgeries.
1 Gricean Pragmatics
   • Grice and the cooperative principle
   • Scalar implicature: the phenomenon

2 From theory to experiment
   • Early debate: the question of default
   • Empirical evidence
   • Interim summary

3 Experiments in the gumball paradigm
   • Starting point
   • The gumball paradigm
   • Results: constraints on implicature processing

4 Conclusion
**Scalar implicatures as defaults** *Levinson, 2000*

Default heuristics have developed to maximize the speed of communication. Therefore, online generation of a GCI should be rapid, cancellation should be effortful.

**Scalar implicatures as context-driven inferences** *Sperber & Wilson, 1995, Carston, 1998*

Scalar implicatures are only generated where licensed by the context. Therefore, online generation of a GCI should be effortful, cancellation should not be necessary.
Predictions

Interpretations of statement with scalar item $X$, where $X' \in \text{Alt}(X)$

**upper-bound:** $S[X] \land \neg S[X']$ ...some but not all...

**lower-bound:** $S[X]$ ...some (and possibly all)...
Predictions

Interpretations of statement with scalar item $X$, where $X' \in \text{Alt}(X)$

**upper-bound:** $S[X] \land \neg S[X']$  ...some but not all...

**lower-bound:** $S[X]$  ...some (and possibly all)...

Predictions for required processing effort

**Default:** literal controls = upper-bound $<$ lower-bound

**Context-Driven:** literal controls = lower-bound $<$ upper-bound
Predictions

Interpretations of statement with scalar item $X$, where $X' \in \text{Alt}(X)$

**upper-bound:** $S[X] \land \neg S[X']$  ...some but not all...

**lower-bound:** $S[X]$  ...some (and possibly all)...
1 Gricean Pragmatics
- Grice and the cooperative principle
- Scalar implicature: the phenomenon

2 From theory to experiment
- Early debate: the question of default
- Empirical evidence
- Interim summary

3 Experiments in the gumball paradigm
- Starting point
- The gumball paradigm
- Results: constraints on implicature processing

4 Conclusion
Some early results: slow implicatures

Noveck & Posada, 2003, Bott & Noveck, 2004

(8) Some elephants are mammals.
    \textit{true under lower-bound interpretation}
    \textit{false under upper-bound interpretation}

(9) All elephants are mammals.
    \begin{itemize}
    \item measure: proportions of \textit{true} judgments and reaction times
    \item results:
    \end{itemize}
Some early results: slow implicatures

Noveck & Posada, 2003, Bott & Noveck, 2004

(8) Some elephants are mammals.
   \textit{true under lower-bound interpretation}
   \textit{false under upper-bound interpretation}

(9) All elephants are mammals.

- measure: proportions of \textit{true} judgments and reaction times
- results:
  - 40\% \textit{true} judgments for sentences like (8) vs. 88\% for (9)
(8) Some elephants are mammals. 
\textit{true under lower-bound interpretation} 
\textit{false under upper-bound interpretation}

(9) All elephants are mammals.

- measure: proportions of \textit{true} judgments and reaction times
- results:
  - 40\% \textit{true} judgments for sentences like (8) vs. 88\% for (9)
  - semantic responses (lower-bound) are faster than pragmatic responses (upper-bound)
Some early results: slow implicatures

Noveck & Posada, 2003, Bott & Noveck, 2004

(8) Some elephants are mammals.
   true under lower-bound interpretation
   false under upper-bound interpretation

(9) All elephants are mammals.

- measure: proportions of true judgments and reaction times
- results:
  - 40% true judgments for sentences like (8) vs. 88% for (9)
  - semantic responses (lower-bound) are faster than pragmatic responses (upper-bound)
  - responses to (9) are faster than pragmatic responses
Some early results: slow implicatures

Noveck & Posada, 2003, Bott & Noveck, 2004

(8) Some elephants are mammals.
   _true_ under lower-bound interpretation
   _false_ under upper-bound interpretation

(9) All elephants are mammals.

- measure: proportions of _true_ judgments and reaction times
- results:
  - 40% _true_ judgments for sentences like (8) vs. 88% for (9)
  - semantic responses (lower-bound) are faster than pragmatic responses (upper-bound)
  - responses to (9) are faster than pragmatic responses
- conclusion: implicature is a slow and effortful process, not a default
Problems with early studies

- reading - no control over focus structure
- decontextualized stimuli
- reaction times include both computation time and time to program and execute motor command

solution: eye-tracking

sensitive, time-locked measure of linguistic processing (Tanenhaus et al., 1995)

eye movements more implicit measure of comprehension than overt judgments

fine-grained measure of how interpretation unfolds over time
Problems with early studies

- reading - no control over focus structure
- decontextualized stimuli
- reaction times include both computation time and time to program and execute motor command
- solution: eye-tracking
  - sensitive, time-locked measure of linguistic processing
    (Tanenhaus et al., 1995)
  - eye movements more implicit measure of comprehension than overt judgments
  - fine-grained measure of how interpretation unfolds over time
Target = beaker
Cohort = beetle
Unrelated = carriage

Look at the cross. Click on the beaker.
Some more recent results: slow implicatures

Huang & Snedeker, 2009

“Point to the girl that has some/all/two/three of the so...”

- measure: eye movements
Some more recent results: slow implicatures

Huang & Snedeker, 2009

“Point to the girl that has some/all/two/three of the so...”

- measure: eye movements
Some more recent results: slow implicatures

Huang & Snedeker, 2009

“Point to the girl that has some/all/two/three of the so...”

- measure: eye movements
- predictions:
  - default: same pattern in all conditions (fast convergence on target after quantifier)
  - context-driven: delayed looks to target only for “some”
“Point to the girl that has some/all/two/three of the so...”
Some more recent results: **rapid implicatures** Grodner et al., 2010

“Click on the girl that has some/all/none of the ba...”

![Figure 1: The displays for (A) the Early-Summa, Alla, and Nunna conditions, and (B) the Late-Summa condition](image)
“Click on the girl that has some/all/none of the ba...”
Some more recent results: **rapid implicatures** Grodner et al., 2010

“Click on the girl that has **some/all/none** of the ba...”
“Click on the girl that has some/all/none of the ba…”
1. Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2. From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3. Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
   - Results: constraints on implicature processing

4. Conclusion
- lots of evidence for delayed implicatures
- some evidence for rapid implicatures
Interim summary, speculation, & motivation

- lots of evidence for delayed implicatures
- some evidence for rapid implicatures
- under a simple default vs. context-driven view, this is puzzling

...too simplistic – implicature is often effortful, but sometimes not
...too complex – potentially unnecessary dichotomy between GCI and PCI
...alternative: constraint-based model
lots of evidence for delayed implicatures

some evidence for rapid implicatures

under a simple default vs. context-driven view, this is puzzling
  too simplistic – implicature is often effortful, but sometimes not
Interim summary, speculation, & motivation

- lots of evidence for delayed implicatures
- some evidence for rapid implicatures
- under a simple default vs. context-driven view, this is puzzling
  - too simplistic – implicature is often effortful, but sometimes not
  - too complex – potentially unnecessary dichotomy between GCI and PCI
    (as has been argued e.g. by Sperber & Wilson, 1995)
lots of evidence for delayed implicatures
some evidence for rapid implicatures
under a simple default vs. context-driven view, this is puzzling
- too simplistic – implicature is often effortful, but sometimes not
- too complex – potentially unnecessary dichotomy between GCI and PCI (as has been argued e.g. by Sperber & Wilson, 1995)
alternative: constraint-based model
An alternative approach

Constraint-based model  
\( e.g. \) Trueswell et al 1993, MacDonald et al 1994

- all relevant available information taken into account from earliest moments of lexical processing
- assumes probabilistic representation of cues at all levels of linguistic and non-linguistic processing
- GCI/PCI distinction disappears - unified approach that asks how we estimate \( p(SI|c_1, c_2, \ldots, c_n) \)

Prediction

- if available information provides good/reliable cues to pragmatic interpretation: *rapid* implicature
- else: *delayed* implicature, depending on strength of cues and amount of competition between them
1. Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2. From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3. Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
   - Results: constraints on implicature processing

4. Conclusion
What are the constraints?

- under a constraint-based account, the enterprise becomes one of determining the constraints that are at work in implicature processing

The old question
Are scalar implicatures computed by default?

The new questions
1. What are the factors that facilitate or inhibit implicature generation?
2. How do these factors affect the processing mechanism?
Some constraints

- cognitive load (De Neys & Schaeken 2007): higher cognitive load decreases likelihood of generating implicature
- prosody (Schwarz et al 2009): pitch accent on scalar item increases likelihood of generating implicature
- politeness considerations (Bonnefon et al 2009): threat of face loss decreases likelihood of generating implicature
Some constraints

- **cognitive load** (De Neys & Schaeken 2007): higher cognitive load decreases likelihood of generating implicature
- **prosody** (Schwarz et al 2009): pitch accent on scalar item increases likelihood of generating implicature
- **politeness considerations** (Bonnefon et al 2009): threat of face loss decreases likelihood of generating implicature
- **syntactic**: simple vs. partitive *some* (judgment data)
- **pragmatic**: lexical alternatives (naturalness ratings, reaction times)
- **pragmatic**: range of interpretation (reaction times, eye movements)
1 Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2 From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3 Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
   - Results: constraints on implicature processing

4 Conclusion
The gumball paradigm

procedure:
1. display 1 (2s)
The gumball paradigm

procedure:
1. display 1 (2s)
2. “KA-CHING”
The gumball paradigm

procedure:

1. display 1 (2s)
2. “KA-CHING”
3. display 2
The gumball paradigm

procedure:
1. display 1 (2s)
2. “KA-CHING”
3. display 2
4. “You got some of the gumballs.”
The gumball paradigm

- procedure:
  1. display 1 (2s)
  2. "KA-CHING"
  3. display 2
  4. "You got some of the gumballs."
  5. respond YES (agree)/NO (disagree)
The gumball paradigm

procedure:
1. display 1 (2s)
2. “KA-CHING”
3. display 2
4. “You got some of the gumballs.”
5. respond YES (agree)/NO (disagree)
Target set sizes

Quantifier constructions

- some
- some of the
- all of the
- none of the
- one of the
- two of the
- three of the
- seven of the
- eleven of the
1 Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2 From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3 Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
     - Results: constraints on implicature processing

4 Conclusion
Judgments – the familiar picture

- "You got all / some of the gumballs."
- For unpartitioned set: strongly reduced YES responses for some of the, reflecting implicature.
Syntactic effect: partitive vs. simple “some”

- "You got some / all of the / some of the gumballs."
- Simple *some* less likely to give rise to implicature
<table>
<thead>
<tr>
<th>% YES for un-partitioned set</th>
<th>semantic responders</th>
<th>pragmatic responders</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>≥ 75%</td>
<td>≤ 25%</td>
</tr>
<tr>
<td>14</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
Semantic vs. pragmatic responders

<table>
<thead>
<tr>
<th>% YES for un-partitioned set</th>
<th>semantic responders</th>
<th>pragmatic responders</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 75%</td>
<td>14</td>
<td>≤ 25%</td>
</tr>
<tr>
<td>n</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

- reaction times: the familiar picture
- pragmatic responses are slower than semantic responses
BUT

Potential problems

1. NO responses are slower than YES responses in general
2. Baseline issue:
   - The comparison assumes that the semantic YES response for the unpartitioned set is the baseline
   - But there is a better alternative to *some*: *all*
   - Possibility of intrusion of lexical alternative on the speed of even the semantic response
Intrusion effect

- fast responses in the mid range (5 - 11 gumballs)
- intrusion effect for unpartitioned set:
  slow pragmatic and semantic responses compared to fastest region
- no obvious explanation under accounts that assume semantic processing before integration of pragmatic constraints
Intrusion effect

- fast responses in the mid range (5 - 11 gumballs)
- intrusion effect for unpartitioned set:
  slow pragmatic and semantic responses compared to fastest region
- no obvious explanation under accounts that assume semantic processing before integration of pragmatic constraints
Subitizing (Kaufmann et al 1949)

- Fast, accurate judgments of set size
- No counting necessary
- Dramatic increase in time to respond for each added object
Subitizing (Kaufmann et al 1949)

- fast, accurate judgments of set size
- no counting necessary
- dramatic increase in time to respond for each added object
The subitizing problem

- number terms available as alternative to *some* within experiment in Huang & Snedeker, but not Grodner et al
- assume that number terms are more natural in subitizing range than *some*
- then, including number terms as lexical alternatives should result in intrusion effects for processing of *some* within that range (due to competition of alternatives, as with *all* for unpartitioned set)
The subitizing problem

- number terms available as alternative to *some* within experiment in Huang & Snedeker, but not Grodner et al
- assume that *number terms are more natural in subitizing range than some*
- then, including number terms as lexical alternatives should result in intrusion effects for processing of *some* within that range (due to competition of alternatives, as with *all* for unpartitioned set)
The subitizing problem

- number terms available as alternative to *some* within experiment in Huang & Snedeker, but not Grodner et al
- assume that number terms are more natural in subitizing range than *some*
- then, including number terms as lexical alternatives should result in intrusion effects for processing of *some* within that range (due to competition of alternatives, as with *all* for unpartitioned set)
Naturalness ratings from the gumball paradigm

- mean ratings for
  - *all*, *two*, *some*,
  - *some of the*
Naturalness ratings from the gumball paradigm

- mean ratings for *all, two, some, some of the*
- number terms are more natural lexical alternatives to *some* in the subitizing range
mean ratings for *all, two, some, some of the*

- number terms are more natural lexical alternatives to *some* in the subitizing range
Intrusion effect for subitizing range:
slow responses for *some*
compared to fastest region
Intrusion effect (number terms)

- Intrusion effect for subitizing range: slow responses for *some* compared to fastest region.
- Processing of *some* is sensitive to competition from lexical alternatives.
- Caution when comparing *some* to *all* or number terms in subitizing range: observed delays may not be due to implicature computation at all.

Judith Degen (University of Rochester)
Rapid implicatures in the absence of lexical competition?

asymmetric displays

"You got some/all/two/six of the gumballs."

symmetric displays
Rapid implicatures in the absence of lexical competition?

“\textit{You got some/all/two/six of the gumballs.}”
Rapid implicatures in the absence of lexical competition?

asymmetric displays

symmetric displays

“You got some/all/two/six of the gumballs.”
Preliminary results

Judith Degen (University of Rochester)
Preliminary results

rapid implicature outside of subitizing range!
1 Gricean Pragmatics
   - Grice and the cooperative principle
   - Scalar implicature: the phenomenon

2 From theory to experiment
   - Early debate: the question of default
   - Empirical evidence
   - Interim summary

3 Experiments in the gumball paradigm
   - Starting point
   - The gumball paradigm
   - Results: constraints on implicature processing

4 Conclusion


- Scalar implicatures are not (processing) default inferences
- They are more likely to be generated if the partitive is used
- They are more rapidly generated
  - If there is no competition from lexical alternatives to *some*
  - If set sizes to be evaluated are outside the subitizing range

Under a constraint-based account, implicature processing can be modeled as competition between two alternative meanings (upper- and lower-bound) that receive probabilistic support from multiple constraints
follow-ups in planning to investigate further factors:
- speaker competence
- sentence type (with Richard Breheny)
  - scalar item in matrix clause or embedded in referential expression
  - interaction with presence of number terms
Thank you


