Conversational implicatures: interacting with grammar

Christopher Potts

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This talk: partly joint work with Mike Frank, Noah Goodman, Dan Jurafsky, Roger Levy & Adam Vogel

Associated paper (draft form; comments welcome!): http://stanford.edu/~cgpotts/papers.html
Conversational implicature

**Definition (Grice 1975)**

Speaker \( S \) saying \( U \) to listener \( L \) conversationally implicates \( q \) iff

1. \( S \) and \( L \) mutually, publicly presume that \( S \) is cooperative.
2. To maintain 1 given \( U \), it must be supposed that \( S \) thinks \( q \).
3. \( S \) thinks that both \( S \) and \( L \) mutually, publicly presume that \( L \) is willing and able to work out that 2 holds.
Conversational implicature

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Example

Ann: What city does Paul live in?
Bob: Hmm ... he lives in California.

(A) Assume Bob is cooperative.
(B) Bob supplied less information than was required, seemingly contradicting (A).
(C) Assume Bob does not know which city Paul lives in.
(D) Then Bob’s answer is optimal given his evidence.
**Conversational implicature**

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**Implicature as social, interactional**

Implicatures are inferences that listeners make to reconcile the speaker’s linguistic behavior with the assumption that the speaker is cooperative.

**Implicatures and cognitive complexity**

The speaker must believe that the listener will infer that the speaker believes the implicature.
Two strands of inquiry

Interactional models

• Embrace the social nature of implicatures.
• Derive implicatures from nested belief models with cooperative structure.
• Focus on contextual variability and uncertainty.

Grammar models

• Limit interaction to semantic interpretation.
• Derive implicatures without nested beliefs or cooperativity.
• Place variability and uncertainty outside the theory of implicature.
Two strands of inquiry

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My goal

Despite divisive rhetoric, the two sides in this debate are not in opposition, but rather offer complementary insights.
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<th>Plan for today</th>
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<tr>
<td>1. Conversational implicature</td>
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(Scalar) Implicature calculation

Example

A: Sandy’s work this term was satisfactory.

Implicature: Sandy’s work was not excellent (= \( \neg q \))

1 Contextual premise: the speaker A intends to exhaustively answer ‘What was the quality of Sandy’s work this term?’

2 Contextual premise: A has complete knowledge of Sandy’s work for the term (say, A assigned all the grades for the class).

3 Assume A is cooperative in the Gricean sense.

4 The proposition q that Sandy’s work was excellent is more informative than p, the content of A’s utterance.

5 q is as polite and easy to express in this context as p.

6 By 1, q is more relevant than p.

7 By 3 – 6, A must lack sufficient evidence to assert q.

8 By 2, A must lack evidence for q because q is false.
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Properties of conversational implicatures

1. Context dependence
2. Linguistic dependence
3. Cognitive complexity
4. Uncertainty (and re-enforceability)
5. Post-semanticality
Cancelability

- Cancelability is *not* a consequence of Grice’s (1975) definition.
- The definition seems to leave room for cancelation in particular cases, but it does not ensure it for all.
- Cancelation always compromises the speaker’s cooperativity to some degree.
  - In many cases, this is tolerable.
  - If the compromises are too great, the speaker’s behavior is uncooperative to the point of infelicity.
Scales and partial orders

Examples (Levinson 1983:134)

⟨ all, most, many, some, few ⟩
⟨ and, or ⟩
⟨ n, . . . , 5, 4, 3, 2, 1 ⟩
⟨ excellent, good ⟩
⟨ hot, warm ⟩
⟨ always, often, sometimes ⟩
⟨ succeed, V-ing, try to V, want to V ⟩
⟨ necessarily p, p, possibly p ⟩
⟨ certain that p, probable that p, possible that p ⟩
⟨ must, should, may ⟩
⟨ cold, cool ⟩
⟨ love, like ⟩
⟨ none, not all ⟩
Scales and partial orders

Examples (A few other standard lexical scales)

⟨ first, second, third, fourth, fifth ⟩
⟨ definite, indefinite ⟩
⟨ lover, friend ⟩
⟨ need, want ⟩
⟨ old, middle-aged, young ⟩
⟨ general, colonel, major, captain, . . . ⟩
Scales and partial orders

Examples (Mere partial orders; Hirschberg 1985:§5)

1. A: So, is she married?
   B: She’s engaged

2. A: Do you speak German?
   B: My husband does.

3. A: Are you on your honeymoon?
   B: Well, I was.
A simple reference game

Example

<table>
<thead>
<tr>
<th></th>
<th>‘hat’</th>
<th>‘glasses’</th>
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<tbody>
<tr>
<td>( r_1 )</td>
<td>F</td>
<td>T</td>
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<tr>
<td>( r_2 )</td>
<td>T</td>
<td>T</td>
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A simple reference game

Example

(A) Assume the speaker is cooperative.
(B) ‘glasses’ is less informative than ‘hat’.
(C) To reconcile ‘glasses’ with (A), assume the speaker lacks evidence for ‘hat’.
(D) By the nature of the game, the speaker lacks evidence for ‘hat’ if ‘hat’ is false.
Scalar implicatures: the theoretical landscape

Noncism
Russell 2006; Geurts 2011

Neo-Griceanism
Horn 1984; Sauerland 2001

Impliciture/Explicature
Bach 1994; Sperber & Wilson 1995

Presumptive/Generalized
Grice 1975; Levinson 2000

Logical Forms
Chierchia et al. 2012
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Iterated Bayesian models

Figure: A communication game supporting a scalar implicature.
Iterated Bayesian models

Figure: A communication game supporting a scalar implicature.

Figure: The faces implicature in production and interpretation.
Iterated Bayesian models

Figure: A communication game supporting a scalar implicature.

Figure: The faces implicature in production and interpretation.
Priors and context dependence

(a) Scenario

(b) [·]

(c) Prior

(d) Costs

Figure: A communication game supporting a scalar implicature.

(a) $L(S_0)$ for $P(r_1) = 0.3$. 

Figure: The influence of the prior.
Predicting Pragmatic Reasoning
in Language Games
Michael C. Frank and Noah D. Goodman

One of the most astonishing features of human language is its ability to convey meaning through context.

**Grammar-driven models**

**Interactional models**

**Table:**

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<th>$r_{bs}$</th>
<th>$r_{bc}$</th>
<th>$r_{gs}$</th>
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<td>0.4</td>
<td>0</td>
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<td>green</td>
<td>0</td>
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<td>1</td>
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<tr>
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**Prior: Salience Condition**

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Priors in Stiller et al. (2011)

N=24 per group

Age

Percent correct

2 3 4 adult

+ 3 other stimulus sets

Stiller, Goodman, & Frank (2011)

Slides from Mike Frank
Priors in Stiller et al. (2011)

Distracting elements are really distracting:

Failure seems odd on a straight neoqGricean account, more plausible on CFS (2008)

Slides from Mike Frank
Here are all the people:

My friend has glasses.
Can you show me my friend?
Priors in Stiller et al. (2011)

Proportion of faces without top hat in familiarization (%)
Costs and linguistic dependence

(a) Scenario

(b) $\left[ \cdot \right]$

(c) Prior

(d) Costs

Figure: A communication game supporting a scalar implicature.

Figure: The influence of costs.
Cognitive complexity and bounded rationality

Figure: A complex faces scenario. The $S(L(S_0))$ agent does not interpret ‘glasses’ pragmatically, but the $L(S(L(S_0)))$ agent does.
Extremely bounded rationality
Uncertainty about . . .

- the context
- the linguistic norms
- the speaker’s preferred way to resolve tensions in the maxims
- the speaker’s commitment to cooperativity
- the speaker’s ability to undertake the necessary reasoning
- the listener’s beliefs about the speaker’s abilities
- . . .
Post-semanticality

Generalizes the idea: each successively higher (more pragmatic) level is derived from a more literal lower level, beginning with (probabilistic) truth conditions:

$$L(S(\ldots(L(S_0))))$$
Related models

- Golland et al. (2010): $L(S_0)$
- Frank & Goodman (2012): $L(S(L(S_0)))$, with only the outer listener incorporating the prior.
- Vogel et al. (2013): $L(S(L_0))$ and $L(S_0)$ embedded in a multi-agent model of sequential decision making under uncertainty called the Decentralized Partially Observable Markov Decision Process.
Bayesian and Best Response models

(a) \( S_0 \)

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<tr>
<td>( r_1 )</td>
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<td>( r_2 )</td>
<td>0.5</td>
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(b) \( L(S_0) \)

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<td>'glasses'</td>
<td>0.67</td>
<td>0.33</td>
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Figure: Softmax model.

(a) \( S_0 \)

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(b) \( L^{br}(S_0) \)

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Figure: Best-response model.
Relation to other phenomena

- Implicatures encourage mutual exclusivity, a.k.a., the pigeon-hole principle (E. Clark 1987; Frank et al. 2009).
- Implicatures are modulated by the discourse participants’ questions, goals, and preferences (van Rooy, 2003; Benz, 2005; Vogel et al., 2013).
- Implicatures are a window into the interactions between sentence-processing and high-level contextual understanding (Grodner & Sedivy, 2008; Huang & Snedeker, 2009; Grodner et al., 2010; Asher & Lascarides, 2013).
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| 4 | Embedded implicatures |
| 5 | Uncancelable implicatures |
**Grammar models**

**Chierchia et al. (2012):**

“More specifically, the facts suggest that SIs are not pragmatic in nature but arise, instead, as a consequence of semantic or syntactic mechanisms, which we’ve characterized with the operator, O. This operator, although inspired by Gricean reasoning, must be incorporated into the theory of syntax or semantics, so that — like the overt operator *only* — it will find its way to embedded positions.”
Position in the theoretical landscape

- **Noncism**: Russell 2006; Geurts 2011
- **Neo-Griceanism**: Horn 1984; Sauerland 2001
- **Impliciture/Explicature**: Bach 1994; Sperber & Wilson 1995
- **Presumptive/Generalized**: Grice 1975; Levinson 2000
- **Logical Forms**: Chierchia et al. 2012
Exhaustification

Definition (Exhaustification operator)

\[ O_{ALT}(p) = p \land \forall q \in ALT : (p \not\sqsubseteq q) \sqsubseteq \neg q \]

(Spector, 2007; Fox, 2007, 2009; Magri, 2009; Chierchia et al., 2012)
Scalar implicatures in logical forms

Definition (Exhaustification operator)

\[ O_{ALT}(p) = p \land \forall q \in ALT : (p \not\sqsubset q) \sqsubset \neg q \]

Example (Logical form)

\[ O_{ALT}(\llbracket p \lor q \rrbracket) = \{\llbracket p \land q \rrbracket\} \]
\[ \llbracket p \lor q \rrbracket = \{w_1, w_2, w_3\} \]
\[ \llbracket p \rrbracket = \{w_1, w_2\} \quad \lor \quad \llbracket q \rrbracket = \{w_1, w_3\} \]
Scalar implicatures in logical forms

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\[ O_{ALT}(p) = p \land \forall q \in ALT : (p \not\sqsubseteq q) \sqsubseteq \neg q \]

**Example (Logical form)**

\[
\begin{align*}
\text{Kim} & \quad \text{VP} \\
\text{believe} & \quad O_{ALT}([p \lor q]) = [p \land q] \\
& \quad [p \lor q] = \{w_1, w_2, w_3\} \\
& \quad [p] = \{w_1, w_2\} \quad \lor \quad [q] = \{w_1, w_3\}
\end{align*}
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Scalar implicatures in logical forms

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Implicit interactionality

Chierchia et al. (2012)

“the facts suggest that SIs are not pragmatic in nature but arise, instead, as a consequence of semantic or syntactic mechanisms”
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“the facts suggest that SIs are not pragmatic in nature but arise, instead, as a consequence of semantic or syntactic mechanisms”

Resolving underspecification pragmatically

The grammatical system specifies a many-to-one mapping from surface forms to logical forms. Only a pragmatic theory can explain how discourse participants coordinate on these LFs.
Implicit interactionality

**Chierchia et al. (2012)**

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**Resolving underspecification pragmatically**

The grammatical system specifies a many-to-one mapping from surface forms to logical forms. Only a pragmatic theory can explain how discourse participants coordinate on these LFs.

**Chierchia et al. (2012)**

“One can capture the correlation with various contextual considerations, under the standard assumption [...] that such considerations enter into the choice between competing representations (those that contain the operator and those that do not).”
Coordinating on a logical form in context

Essentially all the properties of implicature that I discussed earlier are predicted to hold on this theory as well.

Example

A: Sandy’s work this term was satisfactory.

*Potential implicature:* Sandy’s work was not excellent

Available logical forms:

Sandy’s work was

1. \([\textit{satisfactory}]\)
2. \(O_{\text{ALT}}(\textit{satisfactory}) = \{\textit{excellent}\}(\textit{satisfactory})\)
3. \(O_{\text{ALT}}(\textit{satisfactory}) = \{\textit{good}\}, \{\textit{excellent}\}(\textit{satisfactory})\)
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Cases considered here and in the paper

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<td>Apparent embedding is an artifact of truth-functional analysis</td>
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Attitude embedding

Example

George believes that some of his advisors are crooks.

Implicature: George believes not all of his advisors are crooks.
Attitude embedding

Example

George believes that some of his advisors are crooks.

Implicature: George believes not all of his advisors are crooks.

Grammatical analysis

\[
\text{believes} \quad (\text{advisor} \cap \text{crook} \neq 0) \land (\text{advisor} \not\subseteq \text{crook})
\]

\[
\{ B \mid \text{advisor} \cap B \neq 0 \} \cap \{ B \mid \text{advisor} \not\subseteq B \} \quad \text{are crooks}
\]

\[
O_{\text{some} \rightarrow \{\text{all}\}}(\text{some}) = \text{some-and-not-all} \quad \text{of his advisors}
\]

\[
O_{\text{some} \rightarrow \{\text{all}\}} \quad \text{some}
\]
Attitude embedding

Example
George believes that some of his advisors are crooks.
Implicature: George believes not all of his advisors are crooks.

Gricean calculation (Russell, 2006)

1 Contextual assumption:
   G. believes all his advisors are crooks ∨
   G. believes not all his advisors are crooks
   \( (p ∨ q) \)

2 Standard Gricean implicature:
   not(G. believes all of his advisors are crooks).
   \( \neg p \)

3 From 1 – 2 and disjunctive elimination:
   G. believes not all of his advisors are crooks.
   \( q \)
Conditional antecedents

Example

$S$ If you take phonology or semantics, you attend meeting A. If you take both, you attend meeting B.

Implicature: If you take phonology or semantics but not both . . .
Conditional antecedents

**Example**

\[ S \text{ If you take phonology or semantics, you attend meeting A. If you take both, you attend meeting B.} \]

**Implicature:** If you take phonology or semantics but not both . . .

**A classical contradiction**

If we interpret the disjunctive antecedent inclusively, contradiction:

1. \((\text{phono} \lor \text{sem}) \rightarrow a\)
2. \((\text{phono} \land \text{sem}) \rightarrow b\)
3. \((a \land b) \rightarrow \bot\)
4. By 2, 1 & transitivity: \((\text{phono} \land \text{sem}) \rightarrow a\)
5. By 2 and 4: \((\text{phono} \land \text{sem}) \rightarrow (a \land b)\)
6. By 3, 5 & transitivity: \((\text{phono} \land \text{sem}) \rightarrow \bot\)
Conditional antecedents

Example

If you take phonology or semantics, you attend meeting A. If you take both, you attend meeting B.

Implicature: If you take phonology or semantics but not both . . .

Grammatical analysis

If we exhaustify the disjunctive antecedent clause

\[ O_{ALT}(\text{phono} \lor \text{sem}) \rightarrow a \]

then there is no contradiction: \([\text{phono} \lor \neg \text{sem}]\) and \([\text{phono} \land \text{sem}]\) are mutually exclusive, so there is no problem with having them lead to incompatible outcomes.
Conditional antecedents

Example

$S$ If you take phonology or semantics, you attend meeting A. If you take both, you attend meeting B.

Implicature: If you take phonology or semantics but not both . . .

Kratzer–Lewis conditional (hat-tip to Dan Lassiter)

1. From the worlds that verify $[[\text{phono } \lor \text{ sem}]]$, select the subset $X$ of worlds that are most similar to the actual world.
2. $[[a]](w) = T$ for all $w \in X$.

<table>
<thead>
<tr>
<th></th>
<th>phono</th>
<th>sem</th>
<th>a</th>
<th>b</th>
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<tbody>
<tr>
<td>$w_1$</td>
<td>T</td>
<td>F</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>$w_2$</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>F</td>
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<tr>
<td>$w_3$</td>
<td>T</td>
<td>T</td>
<td>F</td>
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Hurford’s constraint

Hurford’s (1974) constraint

“The joining of two sentences by or is unacceptable if one sentence entails the other; otherwise the use of or is acceptable.”

(12) Ivan is an American or a Russian.
(13) That painting is of a man or a woman.
(14) The value of x is greater than or equal to 6.
(15) *John is an American or a Californian.
(16) *That painting is of a man or a bachelor.
(17) *The value of x is greater than or not equal to 6.
(20) Inmates may smoke or drink, or both.
Hurford’s constraint

Hurford’s (1974) constraint

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(20) Inmates may smoke or₁ drink, or₂ both.

1 Violates HC: (\text{smoke} \lor \text{drink}) \lor (\text{smoke} \land \text{drink})
2 Respects HC: O_{ALT}(\text{smoke} \lor \text{drink}) \lor (\text{smoke} \land \text{drink})
Hurford’s constraint — Is the constraint real?

We must first make exceptions for cases where the disjuncts are intended as synonyms:

Example

1. She’s an oenophile or wine lover

Apparent counterexamples found via Google N-grams and the WordNet hypernym hierarchy:

Examples (From the Web)

2. Stop discrimination of an applicant or person
3. Promptly report any accident or occurrence.
4. Recreational boat or vessel accidents are generally covered by general maritime tort law.
5. Visits by Copts to the Holy Land can hardly be regarded as treason or crime.
Hurford’s constraint — Is the constraint real?

Examples (From the Web)

6. The anchor will lie on the bottom and the canoe or boat will be held by the streams current.

7. How to be a Bikini or Swimwear Model

8. I believe that music can change or affect your emotions.

9. When their resignation is accepted they become an emeritus archbishop or bishop.

10. Why are you recommending angioplasty or surgery for me?

11. So the next time your home project calls for a caulk or sealant, choose the name you trust.

12. Many state arbitration statutes contemplate motions to correct or modify being made to the tribunal directly.

13. Being a captain or officer is a privilege, and with that privilege comes great responsibility.
Hurford’s constraint

Counterexamples to Hurford’s constraint: http://goo.gl/VAGqnB

- 161 to date
- 86 where Left ⊨ Right
- 75 where Left ⊨ Right
- Finding more is easy but boring (lots of Web searches).
Intrusive constructions

Examples

1. If Jack and Jill get married {to each other}, then their parents will have to see each other again.
2. Because he earns $40K, he can’t afford a house in Palo Alto.
3. Having three children is less work than having four.
4. It is safer to drive home and drink beer than it is to drink beer and drive home.
5. It is better to eat some of the cake than it is to eat all of it.

See Wilson (1975); Carston (1988); Levinson (2000); Recanati (2003); Horn (2006); King & Stanley (2006); Simons (2013)
Intrusive constructions

Levinson (2000:200):
“on a purely semantic basis should be self-contradictory”.

Russell (2006)
Phrases like *eat some/all the cake* are generics, with the *some* version crucially excluding situations in which all the cake was eaten, because these are not generic eat-some-cake situations. Predicts markedness for non-generic comparisons.

Geurts (2009:§73):
“I believe that, in cases like these, we are forced to admit that scalar terms give rise to local upper-bounding interpretations, which cannot be accounted for in terms of implicature; they are local quasi-implicatures.”
A case of local enrichment

Chemla & Spector (2011), experiment 2

Exactly one letter is connected with some of its circles.

1. **Literal meaning**: one letter is connected with some or all of its circles, the other letters are connected with no circle.

2. **Global reading**: one letter is connected with some but not all of its circles, the other letters are connected with no circle.

3. **Local reading**: one letter is connected with some but not all of its circles, the other letters may be connected with either none or all of their circles.
A case of local enrichment

Chemla & Spector (2011), experiment 2

Exactly one letter is connected with some of its circles.

- Griceans depend on implicature → literal and so can’t simulate Local.
- If Griceans can derive an implicature, it will be the Global one, which is false in the Local scenario.
A case of local enrichment

Chemla & Spector (2011), experiment 2

Exactly one letter is connected with some of its circles.

Background and discussion: Chemla 2009; Geurts & Pouscoulous 2009; Clifton & Dube 2010; Ippolito 2010; Sauerland 2010
The theoretical import of embedded implicatures

- The Gricean can adopt the LFs of this theory to explain embedded implicatures.
- Embedded implicatures are still shaped by pragmatic forces, so the Gricean’s contributions remain vital.
- The questions are therefore much narrower: what is the nature of these phenomena?
1. Conversational implicature
2. Interactional models of implicature
3. Grammar-driven models of implicature
4. Embedded implicatures
5. Uncancelable implicatures
Grice’s view

Grice (1975)

“Since, to assume the presence of a conversational implicature, we have to assume that at least the Cooperative Principle is being observed, and since it is possible to opt out of the observation of this principle, it follows that a generalized conversational implicature can be canceled in a particular case.”
A recipe for obligatory implicatures

There are forms $\varphi$ and $\psi$ such that, relative to the current context,

1. $\llbracket \varphi \rrbracket \sqsubseteq \llbracket \psi \rrbracket$, and
2. $\psi$ is strictly more costly than $\phi$.

Examples (Spector 2007; Magri 2009)

1. $(p \lor q)$ vs. $p$
2. $(\# \text{always}) \text{tall}$
3. $(\# \text{Some}) \text{Italians come from a warm country.}$
Obligatory implicatures in the interactional model

Example (Spector 2007)

*Contextual premise:* the atoms of the molecule are inseparable.

1. Some atoms went right.
2. The atoms went right.

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<tr>
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<th>‘some’</th>
<th>‘the’</th>
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<tbody>
<tr>
<td><strong>p</strong></td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>(a)</td>
<td>⬠</td>
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<tr>
<th></th>
<th>‘some’</th>
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<tbody>
<tr>
<td><strong>p</strong></td>
<td>0.27</td>
<td>0.73</td>
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<tr>
<td>(c)</td>
<td>S₀</td>
<td></td>
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<tr>
<td>(d)</td>
<td>L(S₀)</td>
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<tr>
<td><strong>p</strong></td>
<td>0.5</td>
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**Figure:** Where two forms are synonymous and one is more marked, the more marked one is infelicitous. A speaker who used the marked form would need semantic motivation, impossible with synonyms.
Uncertainty, uncancelability, and uncooperativity

- Uncancelable implicatures are an artifact of idealization.
- There is always doubt surrounding the relevant lexical and contextual assumptions about synonymy.
- In any case, uncancelability and uncooperativity are related, as the Gricean predicts:
  1. Opt out of quantity: “p or q, and I’m not telling which!”
  2. Never motivated: “p or q, in fact, p!”

See Lauer 2013
Conclusion: interacting with grammar

1 Even if implicatures can be embedded in logical forms, they are still exquisitely sensitive to high-level plans, goals, and preferences of the discourse participants.
## Conclusion: interacting with grammar

1. Even if implicatures can be embedded in logical forms, they are still exquisitely sensitive to high-level plans, goals, and preferences of the discourse participants.

2. Kyle to Ellen: “I have $8.”
   - b. Context B: Movie tickets cost $8.
Conclusion: interacting with grammar

1. Even if implicatures can be embedded in logical forms, they are still exquisitely sensitive to high-level plans, goals, and preferences of the discourse participants.

2. Kyle to Ellen: “I have $8.”
   b. Context B: Movie tickets cost $8.

3. Chierchia et al. (2012): “one can capture the correlation with various contextual considerations, under the standard assumption [...] that such considerations enter into the choice between competing representations (those that contain the operator and those that do not).”
Conclusion: interacting with grammar

4 Logical Form theories tell us where a speaker can put certain covert semantic operators.

5 It’s up to a theory of (inter)action and social cognition to tell us
   ▶ what the speaker did
   ▶ why she did it
   ▶ how the hearer will understand her discourse move.
Conclusion: interacting with grammar

Noncism
Russell 2006; Geurts 2011

Neo-Griceanism
Horn 1984; Sauerland 2001

Impliciture/Explicature
Bach 1994; Sperber & Wilson 1995

Presumptive/Generalized
Grice 1975; Levinson 2000

Logical Forms
Chierchia et al. 2012
References I

References II


References III


References IV


References V


# References VIII
