Scalar implicature calculation in Chierchia et al.

Chris Potts, Ling 236: Context dependence in language and communication, Spring 2012

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1 Overview

- This handout reviews the theory of scalar implicatures described by Chierchia et al. (To appear) (henceforth CFS08).
- My goal is just to convey what the system is like.
  - It's an example of a influential formal theory of grammatical implicatures.
  - Knowing about it might also help with Raj Singh's lectures this week (tutorial Wed 4:30-6:00 pm in 460-126; research talk Thu 4:30-6:00 pm in 460-126).
- CFS08 are mainly concerned with the status of implicatures that are expressed by syntactically embedded operators. We will save detailed discussion of those phenomena for April 23. Here, I just show how CFS08 derive such meanings.

2 The exhaustification operator

Definition 1 (The exhaustification operator)**.** Where p is a proposition and ALT is a function from propositions into sets of propositions (insist that p is in its domain):

$$O(p, ALT) = p \wedge \forall q \in ALT(p) : (p \not\rightarrow q) \rightarrow \neg q$$

The proposal *O*s can appear anywhere in the logical form of a sentence (with a preference for inserting them in places where the result is logically stronger; see their section 4.6).

Related proposals Exhaustification is at the heart of Groenendijk and Stokhof's (1984) theory of questions and their answers (see also McCarthy 1980). The above operator is a common proposal for the meaning of *only* (for discussion: Rooth 1996; Büring and Hartmann 2001; Beaver and Clark 2008). Schulz and van Rooij (2006) use exhaustification for implicature calculation (see also de Jager and van Rooij 2007). The approach in the present paper is directly inspired by those of Sauerland (2001), Spector (2007), and Fox (2007, 2009). See the next section for a major improvement to the definition.

Critical discussion Alonso-Ovalle 2008; Gajewski 2012

Simple example involving disjunction

	p	q	$p \wedge q$	$p \vee q$	$p \bar{\vee} q$
w_1	T	T	T	T	F
w_2	T	F	F	T	T
w_3	F	T	F	T	T
w_4	F	F	F	F	F
	$\{w_1, w_2\}$	$\{w_1, w_3\}$	$\{w_1\}$	$\{w_1, w_2, w_3\}$	$\{w_2, w_3\}$

(1) Assume that the only alternative to $\vee$ is $\wedge$:

a. $ALT = \left[\{w_1, w_2, w_3\} \mapsto \{\{w_1\}\}\right]$

b. $$\begin{aligned} O(\{w_1, w_2, w_3\}, ALT) &= \{w_1, w_2, w_3\} \cap (W - \{w_1\}) \\ &= \{w_1, w_2, w_3\} \cap \{w_2, w_3, w_4\} \\ &= \{w_2, w_3\} \end{aligned}$$

(2) Assume that $\vee$ also competes with its disjuncts — things go wrong (CFS08, fn. 32, 36):

a. $\left[\{w_1, w_2, w_3\} \mapsto \{\{w_1\}, \{w_1, w_2\}, \{w_1, w_3\}\}\right]$

b. $$\begin{aligned} O(\{w_1, w_2, w_3\}, ALT) &= \{w_1, w_2, w_3\} \cap (W - \{w_1\}) \cap (W - \{w_1, w_2\}) \cap (W - \{w_1, w_3\}) \\ &= \{w_1, w_2, w_3\} \cap \{w_2, w_3, w_4\} \cap \{w_3, w_4\} \cap \{w_2, w_4\} \\ &= \emptyset \end{aligned}$$

2.1 An improved exhaustivity operator: innocent exclusion only

Definition 2 (Innocently excludable alternatives)**.** Given a set of alternatives $ALT(p)$ to p:

i. Consistent(A, p, ALT) iff $A \subseteq ALT(p)$ and $\left(\bigcap\{\neg a \mid a \in A\} \cup \{p\}\right) \neq \emptyset$

ii. MaximalConsistent(A, p, ALT) iff Consistent(A, p, ALT) and there is no B such that $A \subset B$ and Consistent(A, p, ALT)

iii. InnocentlyExcludable(a, p, ALT) iff $a \in A$ for all A such that MaximalConsistent(A, p, ALT)

Definition 3 (Exhaustivity with innocent exclusion only)**.**

$$O(p, ALT) = p \wedge \forall q \in \text{InnocentlyExcludable}(q, p, ALT) : (p \not\to q) \to \neg q$$

The disjunctive example again

(3) a. $ALT\big(\{w_1, w_2, w_3\}\big) = \{\{w_1\}, \{w_1, w_2\}, \{w_1, w_3\}\}$

b. $p = \{w_1, w_2, w_3\}$

c. The maximal p-consistent sets of sets based on ALT: $\left\{ \begin{array}{l} \{\{w_1\}, \{w_1, w_2\}\}, \\ \{\{w_1\}, \{w_1, w_3\}\} \end{array} \right\}$

d. Intersection of maximal p-consistent sets: $\{\{w_1\}\}$

3 Metalinguistic negation

CFS08 have the option to analyze metalinguistic negation of scalar implicatures as involving regular negation of an exhaustified phrase in the scope of the negation:

(4) Joe didn't see Mary OR Sue; he saw BOTH.

a. $ALT = \left[\{w_1, w_2, w_3\} \mapsto \{\{w_1\}\}\right]$

b. $\mathbf{not}(O(\{w_1, w_2, w_3\}, ALT) = (W - \{w_2, w_3\})$
$= \{w_1, w_4\}$

4 Intrusive implicatures

CFS08's argument is mainly based on intrusive implicatures: examples where the implicature needs to be incorporated into the argument to a truth-functional operator in order to maintain consistency. Here is a variant of their example involving a conditional:

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

a. If we interpret the disjunctive antecedent inclusively, the example is contradictory:

i. $(p \vee s) \rightarrow a$
ii. $(p \wedge s) \rightarrow b$
iii. $(a \wedge b) \rightarrow \bot$
iv. By transitivity: $(p \wedge s) \rightarrow a$
v. By ii and iv: $(p \wedge s) \rightarrow (a \wedge b)$
vi. By v: $(p \wedge s) \rightarrow \bot$

b. If we instead exhaustify the disjunctive antecedent clause

$$O((p \vee s), ALT) \rightarrow a$$

then there is no contradiction: $[\![p \bar{\vee} s]\!]$ and $[\![p \wedge s]\!]$ are mutually exclusive, so there is no problem with having them lead to incompatible outcomes.

For additional 'intrusive' examples, see the handout from today 'Navigating the semantics/pragmatics border lands', section 4.

5 Quantifiers

As above, we easily obtain the right truth conditions if the exhaustification operator is allowed to create implicature-like meanings that are arguments to other operators.

(6) Exactly two students wrote a paper or ran an experiment. The others either did both or made a class presentation.

a. Example model:
   i. $[\![\textbf{student}]\!] = \{a, b, c\}$
   ii. $[\![\textbf{paper}]\!] = \{a, b\}$
   iii. $[\![\textbf{experiment}]\!] = \{b, c\}$
   iv. $[\![\textbf{exactly-2}(A)(B)]\!] = \mathtt{T}$ iff $|[\![A]\!] \cap [\![B]\!]| = 2$

b. $[\![\textbf{exactly-2}\big(\textbf{student}\big)\big(\textbf{paper} \cup \textbf{exp}\big)]\!] = \mathtt{F}$

c. $[\![\textbf{exactly-2}\big(\textbf{student}\big)\big(O(\textbf{paper} \cup \textbf{exp}, ALT)\big)]\!] = \mathtt{T}$

6 Hurford's generalization

- In the above examples, it was relatively easy to distinguish the basic meaning from the implicature-enriched one, because the enriched meaning was either weaker than the basic one (in sec. 4) or independent of it (sec. 5).
- Where the enriched meaning is stronger than the basic one, it is harder to establish that the meaning needs to be incorporated into the grammar.
- To address this, CFS08 rely on Hurford's (1974) Constraint (HC). The idea is that if we assume HC to be true as a local constraint on disjunctive phrases, then we will need to rely on local enrichment in order to explain why apparent HC violations are okay (Gazdar 1979a,b; Singh 2008).

> "We used HC to force the presence of an exhaustivity operator in an embedded position, and were able to show that in some cases, very specific readings were predicted which turned out to be the only possible readings." (p. 17)

(HC) A sentence that contains a disjunctive phrase of the form *S or S′* is infelicitous if S entails S' or S' entails S.

(7) a. $^{\#}$Mary saw a dog or an animal.
b. $^{\#}$Mary saw an animal or a dog.

(8) [Mary solved problem A or problem B] or [Mary solved both problems].

a. Violates HC: $(a \vee b) \vee (a \wedge b)$
b. Respects HC: $O(a \vee b, ALT) \vee (a \wedge b)$

7 A few other remarks

- I've been selective in my illustrations, but I think the only serious hole this leaves is the discussion of disjunctive permission statements, which call for the 'innocent exclusion' version of exhaustification (def. 3).
- CFS08 group their examples into "downward-entailing or non-monotone" and "upward entailing" because the argumentation needs to be very different in the two cases. I did not use their grouping here so as to avoid the relevant semantic concepts, but the distinctions are really important: if you argue that a phrase P is ambiguous between meanings A and B, then your job is really, really hard if there are entailment relations between A and B.
- The above shows that CFS08 can derive embedded implicatures. On April 23, we will try to figure out the extent to which a standard Gricean account (like the one from the April 2 handout) can achieve these same results.

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