On the Calculation of Implicatures

We argue that Chierchia's (2001, 2006) observation that Scalar Implicatures (SIs) disappear under downward entailing (DE) operators must be qualified: SIs disappear completely under strictly DE operators, they persist under non-monotonic (NM) operators, and they partly persist under Strawson DE (SDE) operators. We propose that these effects are the result of a general pragmatic rule that favors preserving the implicature, unless there is a "good enough" reason to cancel it.

The data. Consider the four-way contrast in (1). (1a) shows that the SI of *not everyone arrived* ((2)) is part of the content of *not everyone arrived* (Chierchia 2001), because (1a) implies that John is certain that someone arrived. (1b) shows that (2) disappears when the main clause appears under the DE operator *not* (Chierchia 2001, 2006), because intuitively (and unless *everyone* is focused, in which case *not* may be used meta-linguistically), (1b) is incompatible with a situation where John doesn't entertain the possibility that everyone arrived. We add two observations: (I) In (1c), where the upward entailing *certain* (see (3)) is replaced with the SDE *sorry* (see (4)-(5)), the embedded SI persists in the presupposition part of the main clause, but disappears in the assertion part. Intuitively, (1c) presupposes that John is aware that: (i) not everyone arrived and (ii) someone arrived, and it adds the information that John wants the opposite of 'not everyone arrived' (namely, 'everyone arrived') to be true; (II) In (1d), where the subject is the NM *exactly two men*, the embedded SI persists.

Support for observations (I)-(II) comes from the *or both*-test. *Or both* is used to overtly cancel the implicature of "A or B" (i.e., 'but not both'; e.g., (6a)). As (6b,c) show, *or both* sounds strange under DE and SDE operators. *Or both* is redundant here, because the implicature of *not every* is cancelled (in the assertion). But *or both* sounds OK under NM operators (as shown in (6d)), because it is not redundant (*exactly two men* doesn't cancel the implicature triggered by *not every*).

The theoretical issue. Expanding on the Gricean theory of implicatures, Chierchia argues that SIs are calculated along with standard meanings, so that *not everyone arrived* is assigned a pair of meanings, stated formally in (7a) and informally in (7b) (the first member is the standard meaning, the second includes the implicature as well), and (1a) is assigned the pair in (8a). The second member of (7a) is stronger than the first, and as such, it is usually the preferred interpretation of *not everyone arrived*. The same holds of the pair in (8a); this is why we infer from (1a) that John is certain that someone arrived. But when the first member is stronger, it wins over the second ("implicature cancellation"), as in (1b): the second member of (9a) is the weaker. But Chierchia's theory is silent on observations (I)-(II): neither member of (10a) is stronger than the other, and the same is true of (11a).

Proposal. We suggest that Chierchia's theory is essentially correct, but must be qualified in the following way: The second member of every pair (i.e., the one that contains the implicature) is selected, unless the first member is Strawson-stronger (i.e., unless the first member Strawson-entails the second, see (12)). In (10a), the first member Strawson-entails the second (explaining why the implicature disappears in the truth conditions of (1c)). In (11a), neither member is Strawson-stronger than the other (explaining why the implicature persists in (1d)). Chierchia's account of (1a) and (1b) is unaffected by our proposed qualification: Since "classical" entailment implies Strawson-entailment, the second member of (8a) is Strawson-stronger than the first, and the first member of (9a) is Strawson-stronger than the second. We suggest that the implicature persists in the presupposition of (1c) because it is essential to the computation of Strawson-entailment. In addition, the oddity of (6b) and (6c) (i.e., the redundancy of *or both*) is expected, as the first member in (13) (and (14)) is Strawson-stronger than the second, thus canceling the implicature of *or*. The non-redundancy of *or both* in (6d) is also expected, as neither member in (15) is Strawson-stronger than the other, leading to the persistence of the implicature (which means that it may sometimes need to be cancelled overtly).

Summary. Based on observations regarding implicatures under SDE and NM operators, we propose an amendment to Chierchia's theory that preserves its insights while accounting for some new facts.

(1) a. John is certain that not everyone arrived.
b. John isn’t certain that not everyone arrived.
c. John is sorry that not everyone arrived.
d. Exactly two men are certain that not everyone arrived.

(2) $[\lambda w \in W.\ \{x \in D{:}x \text{ arrived}_w\} \neq \varnothing]$ (‘someone arrived’)

(3) $[[\textit{certain}]] = [\lambda p \in D_{<s,t>}.\ \lambda x \in D.\ \lambda w \in W.\ DOX_w(\text{John}) \subseteq \{w' \in W{:}p(w')=\text{True}\}]$
$(DOX_w(\text{John}) = \{w' \in W{:}w' \text{ is compatible with what John believes in } w\})$

(4) $[[\textit{sorry}]] = [\lambda p \in D_{<s,t>}.\ \lambda x \in D.\ \lambda w \in W{:}\ \text{(i) } p(w)=\text{True and (ii) } DOX_w(\text{John}) \subseteq \{w' \in W{:}p(w')=\text{True}\}.\ DES_w(\text{John}) \subseteq \{w' \in W{:}p(w')=\text{False}\}]$
(a. $DES_w(\text{John}) = \{w' \in W{:}w' \text{ is compatible with what John desires in } w\}$;
b. β is the domain restriction (“presupposition”) in $[\lambda\alpha{:}\beta.\gamma]$ and γ the value description.)

(5) A function f is SDE iff for all $\langle X,Y\rangle$ such that $X \Rightarrow Y$ and f(X) is defined, $f(Y) \Rightarrow f(X)$ (where ‘$\Rightarrow$’ stands for cross-categorial entailment; von Fintel 1999)

(6) a. John is certain that the boss or her assistant, or both, have disappeared.
b. #John isn’t certain that the boss or her assistant, or both, have disappeared.
c. #John is sorry that the boss or her assistant, or both, have disappeared.
d. Exactly two men are certain that the boss or her assistant, or both, have disappeared.

(7) a. $\langle[\lambda w \in W.\{x \in D{:}x \text{ arrived}_w\} \subset D], [\lambda w \in W.\{x \in D{:}x \text{ arrived}_w\} \subset D \text{ and } \{x \in D{:}x \text{ arrived}_w\} \neq \varnothing]\rangle$
b. <‘not everyone arrived’, ‘not everyone arrived and someone arrived’>

(8) a. $\langle[\lambda w \in W.DOX_w(\text{John}) \subseteq \{w' \in W{:}\{x \in D{:}x \text{ arrived}_{w'}\} \subset D\}], [\lambda w \in W.\ DOX_w(\text{John}) \subseteq \{w' \in W{:}\{x \in D{:}x \text{ arrived}_{w'}\} \subset D \text{ and } \{x \in D{:}x \text{ arrived}_{w'}\} \neq \varnothing\}]\rangle$
b. <‘John is certain that not everyone arrived’, ‘John is certain that not everyone arrived and that someone arrived’>

(9) a. $\langle[\lambda w \in W.DOX_w(\text{John}) \nsubseteq \{w' \in W{:}\ \langle\{x \in D{:}x \text{ arrived}_{w'}\} \subset D\}], [\lambda w \in W.\ DOX_w(\text{John}) \nsubseteq \{w' \in W{:}\{x \in D{:}x \text{ arrived}_{w'}\} \subset D \text{ and } \{x \in D{:}x \text{ arrived}_{w'}\} \neq \varnothing\}]\rangle$
b. <‘John isn’t certain that not everyone arrived’, ‘John isn’t certain that not everyone arrived and that someone arrived’>

(10) a. $\langle[\lambda w \in W{:}\ \text{(i) } \{x \in D{:}x \text{ arrived}_w\} \subset D \text{ and (ii) } DOX_w(\text{John}) \subseteq \{w' \in W{:}\ \{x \in D{:}x \text{ arrived}_{w'}\} \subset D\}\ .\ DES_w(\text{John}) \subseteq \{w' \in W{:}\{x \in D{:}x \text{ arrived}_{w'}\} = D\}], [\lambda w \in W{:}\ \text{(i) } \{x \in D{:}x \text{ arrived}_w\} \subset D \text{ and } \{x \in D{:}x \text{ arrived}_w\} \neq \varnothing \text{ and (ii) } DOX_w(\text{John}) \subseteq \{w' \in W{:}\ \{x{:}x \text{ arrived}_{w'}\} \subset D \text{ and } \{x \in D{:}x \text{ arrived}_{w'}\} \neq \varnothing\}.\ DES_w(\text{John}) \subseteq \{w' \in W{:}\{x \in D{:}x \text{ arrived}_{w'}\} = D \text{ or } \{x \in D{:}x \text{ arrived}_{w'}\} = \varnothing\}]\rangle$
b. <‘John is sorry that not everyone arrived’, ‘John is sorry that not everyone arrived and that someone arrived’>

(11) a. $\langle[\lambda w \in W{:}|\{x \in D{:}\ DOX_w(x) \subseteq \{w' \in W{:}\{y \in D{:}y \text{ arrived}_{w'}\} \subset D\}\}|=2], [\lambda w \in W{:}|\{x \in D{:}\ DOX_w(x) \subseteq \{w' \in W{:}\{y \in D{:}y \text{ arrived}_{w'}\} \subset D \text{ and } \{y \in D{:}y \text{ arrived}_{w'}\} \neq \varnothing\}\}|=2]\rangle$
b. <‘exactly two men are certain that not everyone arrived’, ‘exactly two men are certain that not everyone arrived that that someone arrived’>

(12) f Strawson-entails g iff for every X such that g(X) is defined, f(X) ==> g(X).
(von Fintel 1999, Herdan and Sharvit 2006)

(13) <‘John isn’t certain that the boss or her assistant died’, ‘John isn’t certain that the boss or her assistant, but not both, have disappeared’>

(14) <‘John is sorry that the boss or her assistant died’, ‘John is sorry that the boss or her assistant, but not both, have disappeared>

(15) <‘exactly two men are certain that the boss or her assistant died’, ‘exactly two men are certain that the boss or her assistant, but not both, have disappeared’>