In Defense of the Grammatical Approach to Local Implicatures*

1. Introduction

So-called "local implicatures" have been the focus of much recent debate. The purpose of this paper is to contribute to this debate by asking what we can learn from three puzzles discussed in Sharvit & Gajewski (2008), namely, the cancellation of such implicatures by *or both*, their behavior in the complement clauses of negative factive verbs such as *sorry*, and their behavior in root and embedded questions. Our conclusion will be that reference to local implicatures is needed during the course of semantic computation. However, none of the currently proposed theories is equipped to solve all of these puzzles. For example, the theory proposed in Fox (2003) and Chierchia et al. (2009) can handle the *or both* puzzle, but not the *sorry* puzzle; and a version of Chierchia (2004) can handle the *sorry* puzzle, but not the *or both* puzzle.

Some propositional attitude verbs, such as *certain*, sometimes produce local implicatures (Chierchia 2004, 2006), in addition to global ones. Thus, (1a) may have two implicatures: the implicature in (1b) (the strengthened meaning of (1a)), which is related to the implicature of the embedded clause, and the global implicature in (1c). The strengthened meaning of (1a) in (1b) entails the global implicature in (1c).

(1) a. John is certain that the boss or her assistant disappeared.

b. Implicature of embedded clause: the boss or her assistant, but not both, disappeared.
Strengthened meaning of (1a): John's certainty is that the boss or her assistant, but not both, disappeared.

c. Global implicature: John does not rule out the possibility that the boss and her assistant did not both disappear.

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The implicature of the embedded clause in (1b) is identical to the one the embedded clause sometimes has when it appears unembedded, as is the case of (2a), which has the implicature in (2b).

(2) a. The boss or her assistant disappeared.
b. The boss or her assistant, but not both, disappeared.

Likewise, upon hearing (3a) we often infer, not only that John said (2a) to himself, but that his saying (2a) to himself entails (3b).

(3) a. John said to himself: "The boss or her assistant disappeared."
b. John thought that the boss or her assistant, but not both, disappeared.

Informally, we will refer to the strengthened meaning in (1b) as its "local implicature". The local implicature/strengthened meaning in (1b), of the sentence in (1a), seems to be produced from the projection of the implicature of the embedded clause. Without any evidence that contradicts the local implicature (1b), it is what we infer from (1a) (despite the fact that (1a) is also compatible with a situation where both the boss and her assistant disappeared). The implicature (1c) of (1a), on the other hand, is not produced in this way: it is also inferred from *John is certain that it is possible that the boss and her assistant did not both disappear* (whose embedded clause never has (2b) as an implicature).

The fact that (1a) sometimes has the local implicature in (1b) is not under dispute. That is to say, no one, as far as we know, disputes the claim that speakers tend to infer the local implicature/strengthened meaning in (1b) from (1a). What is often debated is the source of this implicature. According to some authors (e.g., Russell 2006), the local implicature in (1b) is derived strictly in the pragmatic component, that is to say, after the meaning of the entire sentence in (1a) has been computed. In that sense, a "local" implicature is not different from any other implicature. Other authors (most notoriously, Chierchia 2004) argue that the production of the implicature in (1b) requires access to the meaning of the embedded clause in (1a) before the computation of the meaning of the entire clause is completed, and therefore its derivation is done

alongside the compositional computation of the truth conditions of (1a). Recently (e.g., Geurts 2009, Geurts & Pouscoulous 2009) it has been argued that judgments elicited in experiments support the former approach. The goal of this paper is to raise some challenges for both approaches on the basis of the following empirical observations: (a) the cancellation effects of *or both*; (b) the emergence of local implicatures in embedded clauses of factive attitude predicates such as *sorry* and *discover*; and (c) the emergence of local implicatures in interrogative clauses. We argue that an adequate account of these facts requires reference to local implicatures within the semantic component. Therefore, any theory that does not acknowledge the existence of these faces a serious challenge. On the other hand, grammatical approaches are on the right track in calculating local implicatures, but none of the existing grammatical approaches can cover all the facts. These facts are described in Section 2. Section 3 introduces the grammatical approach, and section 4 discusses the analysis of the puzzles introduced in section 2 within the grammatical approach, and the challenge they pose for non-grammatical and grammatical approaches.

Importantly, the challenges we discuss here are relevant only to implicatures generated in complement clauses of attitude verbs. We have very little to say about other types of local implicatures. Therefore, it is plausible, for all we know, that local implicatures come in more than one variety, and that some of these varieties have different sources.

2. Some puzzles

2.1. The *or both* puzzle

As is well known (see, e.g., Gazdar 1979, Horn 1989), implicatures may be canceled by downward entailing (henceforth, DE) operators (as shown by the fact that (4b) doesn't have the 'but-not-both' implicature in (4b'), although (4a) does have the implicature in (4a')).[1]

(4) a. John likes chemistry or math.
   a'. John likes exactly one of {chemistry, math}.
   b. John doesn't like chemistry or math.
   b'. John doesn't like exactly one of {chemistry, math}.

[1] Our use of the term 'cancellation' differs slightly from that of the authors cited. We speak of negation as cancelling an implicature when the implicature would have otherwise been present in the absence of negation.

In addition, the 'but-not-both' implicature associated with *or* may also be canceled by *or both* (as shown by the fact that (5) doesn't have the implicature in (4a')).

(5) John likes chemistry or math, or both.

Interestingly, local implicatures in embedded clauses are canceled by the same means (DE operators, *or both*), whereas the global implicatures of the sentences that embed these clauses are unaffected.[2] For example, (6a) has only the global implicature in (6c), but not the implicature in (6b).

(6) a. John is certain that the boss or her assistant, or both, disappeared.
b. John's certainty: the boss or her assistant, but not both, disappeared.
c. It is possible, for all John knows, that the boss and her assistant did not both disappear.

In other words, *or both* serves to cancel the local implicature introduced by an instance of disjunction – though global implicatures are unaffected. If (7b) were not in some sense canceled, (7b) would be the 'strengthened' meaning of (7a). However since (7b) is weaker than (7a), the exclusive interpretation of *or* goes away. The global implicature (7c), on the other hand, remains unaffected.

(7) a. John doubts/isn't certain that the boss or her assistant disappeared.
b. John's doubt: the boss or her assistant, but not both, disappeared.
c. It is possible, for all John knows, that the boss and her assistant did not both disappear.

The first part of the *or both* puzzle is why *or both* cancels implicatures at all. Truth-conditionally, (A or B) (in our case "the boss disappeared or her assistant disappeared") and ((A or B) or (A and B)) (in our case, "the boss disappeared or her assistant disappeared, or the boss disappeared and her assistant disappeared") are equivalent. So we might expect them to behave equivalently in terms of implicatures. An answer to this puzzle has recently been proposed by Chierchia et al. 2009.

[2] Though see Chierchia et al. (2009) for evidence that a new global implicature may arise in some environments.

The second part of the *or both* puzzle derives from a novel observation (see Sharvit and Gajewski 2008). Specifically, *or both* cannot be felicitously added to all instances of disjunction. Consider, for example, the contrast in (8), where the main verb is a downward entailing (henceforth, DE) operator.

(8) a. John doubts that the boss or her assistant disappeared.
b. #John doubts that the boss or her assistant, or both, disappeared.

It appears, then, that *or both* cannot be used felicitously together with another operator that independently cancels the implicatures produced by a disjunction. This appears to be generally true with implicature-cancelling DE operators. *No students* cancels the implicature 'x likes chemistry or math but not both' of 'x likes chemistry or math'. This is evidenced by the fact that (9a') is not an implicature of (9a). And, indeed, *or both* is infelicitous in (9b).

(9) a. No students like chemistry or math.
a.' No students like exactly one of {chemistry, math}.
b. #No students like chemistry or math, or both.

In section 4 we show that any theory that embraces a grammatical approach to implicatures can, in principle, offer an explanation of the canceling behavior of *or both*, and of the conditions on its felicitous use. Specifically, we will argue that without reference to the 'local' implicature produced by *or* in an embedded clause, before the completion of the semantic computation, the cancelling effects of *or both* remain a mystery.

2.2. The *sorry/discover* puzzle

In addition to the correlation between cancellation by DE operators cancellation by *or both* (as illustrated in section 2.1), there is a correlation between cancellation by DE operators and licensing of NPIs (such as *any* and *ever*), as illustrated in (10).

(10) John doubts/isn't certain that he will ever finish his dissertation.

However, not all verbs pattern in the same way. For example, "negative" factive verbs show a pattern that is, on the one hand, different from the pattern shown by *certain*, but on the other hand, it is also different from the pattern shown by the DE *doubt* or *isn't certain*. As noted by Simons (2006) (see also Russell 2006), some factive attitude predicates show the pattern illustrated in (11): the *or* in (11a) may be interpreted exclusively in (11b) but not (11c).

(11) a. John is sorry that the boss or her assistant disappeared.
b. John believes that the boss or her assistant, but not both, disappeared.
c. John is sorry that the boss or her assistant, but not both, disappeared.

The fact that the exclusive interpretation of *or* goes away, i.e. (11c) cannot serve as the strengthened meaning of (11a), may perhaps be attributed to the "negativity" (or DEness) of *sorry* (i.e., that to be 'sorry that p' means to wish the negation of p). This is supported by the fact that *sorry*, like *doubt*/*not certain* but unlike *certain*, licenses NPIs (see (12)); and by the fact that *sorry*, like *doubt*/*not certain* but unlike *certain*, does not go well with *or both* (see (13)).

(12)a. John is sorry that he ever started his dissertation.
b. *John is certain that he ever started his dissertation.
c. John doubts/is not certain that he ever started his dissertation.
(13)a. #John is sorry that the boss or her assistant, or both, disappeared.
b. John is certain that the boss or her assistant, or both, disappeared.
c. #John doubts/is not certain that the boss or her assistant, or both, disappeared.

So one could, perhaps, say that the fact that (11a) doesn't implicate (11c) correlates with the fact that (7b) is not implicated by (7a) (with *doubt*/*isn't certain*). But even if this were indeed the case, the fact that (11b) is implicated by (11a) remains a mystery. Any theory of "local" implicatures has to account for these facts.

Again, we will argue below that a grammatical approach has the tools to account for these facts, by accessing implicatures in embedded clauses in the course of the semantic computation.

2.3. The interrogatives puzzle

The next set of puzzling facts involves interrogative clauses. Matrix interrogative clauses with *X or Y or both* are well formed (as evidenced by (14)) and, at the same time, they license NPIs (as evidenced by (15)).

(14) Which employees did the boss or her assistant(, or both,) talk to?
(15) Which employees were ever sent to Paris?

This pattern is different from the one shown by *certain* (which, as we saw, goes well with *X or Y or both*, but doesn't license NPIs).

However, not all question-embedding predicates behave in the same way with respect to the implicature-canceller *or both*, as suggested by the contrast in acceptability between (16), with question-embedding *know*, and (17), with question-embedding *surprise*.

(16) John knows which employees the boss or her assistant, or both, talked to.
(17) #It surprised John which employees the boss or her assistant, or both, talked to.

So part of the puzzle is to explain the effects of the embedding verb on the presence of *X or Y or both* and the licensing of NPIs.

The puzzle is even bigger when we consider the fact that proposition-taking *surprise* contrasts with question-taking *surprise* regarding NPI-licensing (see the contrast between (18) and (19)), but neither one of them is acceptable with *or both* (as shown by the unacceptability of both (17) and (20)).

(18) John is surprised that Mary ever owned a car.
(19) #It surprised John which employees ever owned a car.
(20) #John is surprised that the boss or her assistant, or both, talked to Mary.

In other words, while NPI-licensing correlates with cancellation of local implicatures in declarative clauses, the correlation breaks down in interrogative clauses.

These are the puzzles we believe any theory of local implicatures must account for (in addition to the well-known standard cases discussed in section 1). In section 3 we introduce the

grammatical approach to local implicatures. Section 4 compares the grammatical and non-grammatical approaches in relation to the puzzles introduced in this section. Our general conclusion will be that in order to solve these puzzles, access to local implicatures is needed in the course of semantic computation. Since this is possible only within the grammatical approach, we take these puzzles to constitute evidence in its favor.

Some clarification before we continue. It is not our intention to choose among different possible versions (existing or merely conceivable) of the grammatical approach (in fact as we have already mentioned, none of them handles all the data); only to show that, in principle, this approach has the tools required to deal with the puzzles introduced in this section (as opposed to the non-grammatical approach which, we believe, does not). Therefore, we will not compare, for example, the approach advocated in Sharvit and Gajewski (2008), which is based on Chierchia (2004), with the one advocated in Fox (2003) and subsequent work. These approaches differ from each other in that the latter assumes that local implicatures arise thanks to the presence of a syntactic operator that induces them, whereas the former does not. A systematic comparison of these two approaches (and their predictions) is left for further research.

3. Local Implicatures – the standard cases

3.1. Where the non-grammatical approach seems to fail

Until local implicatures were brought (by Chierchia; see also Landman 1998, Levinson 2000 and others) to the attention of pragmaticists, it was widely accepted within the pragmatics tradition (following Grice 1975) that all implicatures, and specifically all scalar implicatures, arise as a result of purely conversational principles. The idea was that when a hearer compares a sentence with a scalar item to its alternatives (created by replacing that item with all the items on the relevant scale), she reasons on the basis of cooperative principles that any stronger alternative to the assertion, if there is one, must be false (otherwise, the speaker would have opted for it). The only alternatives considered are alternatives to the main assertion (and crucially not smaller 'pieces' of it).

To illustrate, assuming that the scalar item *or* has only one alternative distinct from itself (namely, *and*), this theory correctly predicts (2a) (*The boss or her assistant disappeared*) to have the implicature it has (as illustrated in (21a)), and it also predicts the negation of (2a) to lose that implicature (as illustrated in (21b)).

(21) a. The boss or her assistant disappeared.

Alternatives: {The boss or her assistant disappeared, The boss and her assistant disappeared}

Assuming the stronger alternative to the assertion – namely, 'The boss and her assistant disappeared', which entails 'The boss or her assistant disappeared' – is false creates the implicature:

Only one of {the boss, the boss's assistant} disappeared.

b. It isn't true that the boss or her assistant disappeared.

Alternatives: {It isn't true that the boss or her assistant disappeared, It isn't true that the boss and her assistant disappeared}

Since there is no stronger alternative to the assertion – as 'It isn't true that the boss and her assistant disappeared' doesn't entail 'It isn't true that the boss or her assistant disappeared' – the following implicature is not created:

It isn't true that only one of {the boss, the boss's assistant} disappeared.

This theory has the additional desirable feature that it doesn't require negation to cancel an implicature: implicatures may be canceled by contextual information too. That is to say, the hearer is not obliged to assume that stronger alternatives are false: this is merely a default strategy, which may be abandoned whenever the context suggests that it should be. In our case, if the context is compatible with the simultaneous disappearance of the boss and her assistant, *The boss or her assistant disappeared* doesn't require the hearer to infer that only one of {the boss, the boss's assistant disappeared}.

However, as pointed out by Chierchia (2004), the algorithm described in (21) fails when we consider implicatures in the scope of attitude verbs (i.e., 'local' implicatures), as illustrated in (22). The algorithm correctly predicts (1a) (*John is certain that the boss or her assistant disappeared*) to have the weak implicature in (1c) (namely, "it is possible, for all John knows, that the boss and her assistant did not both disappear"), but fails to predict the stronger implicature in (1b) (namely, "John's certainty: [only one of {the boss, the boss's assistant} disappeared]").

(22) John is certain that the boss or her assistant disappeared.

Alternatives: {John is certain that the boss or her assistant disappeared, John is certain that the boss and her assistant disappeared}

Assuming that 'John is certain that the boss and her assistant disappeared' – the stronger of the two – is false leads to the following implicature:

> It is possible, for all John knows, that the boss and her assistant did not both disappear.

In view of this problem, Chierchia proposed a grammatical algorithm to generate implicatures, an algorithm where the production of implicatures is done during semantic computation. In his system, scalar items are lexically associated with specific implicatures, and the compositional semantics generates pairs of meanings in every step of the computation. In each pair <a;b>,[3] the first member – a – is the standard meaning, the second member – b – consists of the standard meaning plus the implicature contributed by the scalar item. To illustrate, assuming that the standard meaning of *or* is inclusive ($\vee$), and its implicature-enriched meaning is exclusive, the pair of meanings associated with *or* is <$\vee$; exclusive *or*>). In addition, assuming that *or* is cross-categorial,[4] we generate the pair of meanings in (23a) for the NP *the boss or her assistant*, the pair of meanings in (23b) for the clause *The boss or her assistant disappeared*, and the pair of meanings in (23c) for the complex clause *John is certain that the boss or her assistant disappeared*.

(23) a. $<[\lambda P \in D_{<e,t>}.\ P(\text{the boss}) \vee P(\text{the boss's assistant})];\ [\lambda P \in D_{<e,t>}.\ (P(\text{the boss}) \vee P(\text{the boss's assistant})) \wedge \neg(P(\text{the boss}) \wedge P(\text{the boss's assistant}))]>$

b. <[(the boss disappeared) $\vee$ (the boss's assistant disappeared)]; ([(the boss disappeared $\vee$ (the boss's assistant disappeared)] $\wedge$ $\neg$(the boss and the boss's assistant disappeared))>

c. <[John's certainty: [(the boss disappeared) $\vee$ (the boss's assistant disappeared)]];

[3] It is worth noting that we assume a simplified version of the algorithm given in Chierchia (2004).

[4] That is to say, it may have the following standard meaning: $[\lambda x \in D_e\ .\ \lambda y \in D_e\ .\ \lambda P \in D_{<e,t>}\ .\ P(x) \vee P(y)]$, as well as the following standard meaning: $[\lambda Q \in D_{<<e,t>,t>}\ .\ \lambda Q' \in D_{<<e,t>,t>}\ .\ \lambda P \in D_{<e,t>}\ .\ Q(P) \vee Q'(P)]$)

[John's certainty: ([(the boss disappeared $\vee$ (the boss's assistant disappeared)] $\wedge$ $\neg$(the boss and the boss's assistant disappeared))]>

In the default case, the stronger member of the pair is preferred over the weaker one, but both members are always accessible. Because the procedure relies on relative strength, in many simplex cases (e.g., (24a) and its negation (25a), where the implicature-inducing item *or* appears in a matrix clause), this procedure yields the same results as the non-grammatical procedure. But in complex cases (e.g., (26a) and its negation (27a), where the implicature-inducing item *or* appears in an embedded clause), the grammatical procedure is genuinely different from the non-grammatical procedure, and the predictions are, of course, strikingly different.

(24) a. The boss or her assistant disappeared.

b. Pair of meanings of (24a) (= (23b))

<The boss or her assistant disappeared; The boss or her assistant, but not the boss and her assistant, disappeared>

c. Prediction: in the default case, the second member is preferred (because it is stronger than the first).

(25) a. It isn't true that the boss or her assistant disappeared.

b. Pair of meanings of (25a):

<It isn't true that the boss or her assistant disappeared; It isn't true that the boss or her assistant, but not the boss and her assistant, disappeared>

c. Prediction: in the default case, the first member is preferred (because it is stronger than the second).

(26) a. John is certain that the boss or her assistant disappeared.

b. Pair of meanings of (26a) (= (23c))

<John is certain that the boss or her assistant disappeared; John is certain that the boss or her assistant, but not both, disappeared>

b'. <For all worlds w compatible with what John believes in the actual world, the boss or her assistant in w disappeared in w; For all worlds w compatible with what John believes in the actual world, the boss or her assistant in w, but not both, disappeared in w>

c. Prediction: in the default case, the second member is preferred (because it is stronger than the first).

(27) a. John doubts/isn't certain that the boss or her assistant disappeared.

b. Pair of meanings of (27a):

<John isn't certain that the boss or her assistant disappeared; John isn't certain that the boss or her assistant, but not both, disappeared>

b'. <There is at least one world w compatible with what John believes in the actual world such that it isn't the case that the boss or her assistant in w disappeared in w; There is at least one world w compatible with what John believes in the actual world such that it isn't the case that the boss or her assistant in w, but not both, disappeared in w>

c. Prediction: in the default case, the first member is preferred because it is stronger than the second).

Thus, the generation of local implicatures, and their cancellation by DE operators, are accounted for.

It is worth stressing what the similarities and differences between that two approaches are. Both approaches rely on the assumption that scalar items such as *or* introduce alternatives, and implicatures arise as a result of rational principles for choosing among the alternatives.[5] In this limited sense, the approaches are similar because they both rely on conversational principles (and in both approaches, the default strategy may be abandoned if the context so requires). However, while within the non-grammatical approach the strategy of selecting the "surviving" alterative occurs after all semantic computation is completed, within the grammatical approach the selection strategy may, in principle, be employed at any level of semantic computation. It is this difference that results in strikingly different predictions in those cases where scalar items appear in embedded environments.

3.2. Can the non-grammatical approach to local implicatures be salvaged?

[5] A reviewer asks what we mean by "rational". Here we mean that the choice of a strengthened meaning in Chierchia's (2004) theory and of the placement for an exhaustive operator in Chierchia et al. (2009) is guided by considerations of overall strength. See the discussion in section 4.6 of Chierchia et al. concerning preference for representations leading to stronger readings.

In this section we ask whether there might be a way to account for the facts discussed above within the non-grammatical approach after all. The reasons for doing this seem obvious: there is no question that the grammatical component within the non-grammatical approach is simpler, and since both approaches rely on a mechanism of choosing among alternatives, it seems desirable to prefer the simpler one.

As we just saw, Chierchia's grammatical approach to local implicatures arose out of his observation that the naive algorithm that correctly predicts (1a) to have the weak implicature in (1c) fails to predict the strong implicature in (1b). The procedure is repeated below.

(28) John is certain that the boss or her assistant disappeared.

Alternatives: {John is certain that the boss or her assistant disappeared, John is certain that the boss and her assistant disappeared}

Assuming that 'John is certain that the boss and her assistant disappeared' – the stronger of the two – is false leads to the following implicature:

It is possible, for all John knows, that the boss and her assistant did not both disappear.

The challenge posed for proponents of the non-grammatical approach is then clear: What would it take (i.e., what additional assumptions would be needed) to salvage the view that all implicatures are the result of conversational considerations which come into play only when the computation of the meaning of the entire sentence is complete (and crucially not in the course of the semantic computation)?

The most serious attempt that we are aware of to save this view is due to Sauerland (2004a). In that work, Sauerland doesn't discuss scalar items in the scope of attitude verbs, but rather scalar items in the scope of other scalar items. Chierchia takes these cases too to be instances of local implicatures. To see why, consider (29), with the scalar items *or* and *some*.

(29) Kai ate the broccoli or some of the peas.

(29) implicates that Kai ate the broccoli and no peas, or Kai ate some but not all of the peas and no broccoli. That is to say, one of the implicatures of (29) is 'Kai didn't eat all of the peas'. This

implicature might be thought of as "local" because it is identical to the implicature of the unembedded sentence *Kai ate some of the peas* (indicating that *some* implicates 'not all'). And indeed, Chierchia's treatment of these implicatures is very similar to his grammatical treatment of "local" implicatures in the scope of attitude verbs. On the other hand, Sauerland's treatment can be seen as non-grammatical. Let us discuss the two solutions in turn.

To handle the case of a scalar item appearing in the scope of another scalar item, Chierchia (2004) builds a mechanism that produces the result in (30) (see Gajewski, to appear, for discussion).

(30) Where A and B contain scalar items,
Strong(A(B)) = [Strong(A)](B) and A(Strong(B))

(Strong(A) is the strengthened meaning of A, the second member of its pair of meanings.)

Assuming, for simplicity, that *the broccoli or some of the peas* has the logical form [[*or* (*some* of *the peas*)](*the broccoli*)], and that the pair of meanings of *some of* is as in (31), we predict the pair of meanings in (32) for the NP *the broccoli or some of the peas* and the pair of meanings in (33) for the sentence in (29) (i.e., *Kai ate the broccoli or some of the peas*).

(31) $\langle[\lambda z \in D_e \ . \ \lambda P \in D_{<e,t>} \ .$ there is a x such that: $x \leq z \wedge P(x)]$; $[\lambda z \in D_e \ . \ \lambda P \in D_{<e,t>} \ .$ (there is a x such that: $x \leq z \wedge P(x)) \wedge \neg$(there is an x such that: $x = z \wedge P(x))]\rangle$

(32) $\langle[\lambda P \in D_{<e,t>} \ .$ P(the broccoli) $\vee$ (there is an x such that: $x \leq$(the peas) $\wedge$ P(x))];
$[\lambda P \in D_{<e,t>} \ .$ ([P(the broccoli) $\vee$ (there is an x such that: $x \leq$(the peas) $\wedge$ P(x))] $\wedge \neg$[P(the broccoli) $\wedge$ (there is an x such that: $x \leq$(the peas) $\wedge$ P(x))]) $\wedge$ [P(the broccoli) $\vee$ [(there is an x such that: $x \leq$(the peas) $\wedge$ P(x)) $\wedge \neg$(there is an x such that: $x =$(the peas) $\wedge$ P(x))]]]$\rangle$

(33) <Kai ate the broccoli or some of the peas; (Kai ate the broccoli or some of the peas, but not both the broccoli and some of the peas) and (Kai ate the broccoli or some – but not all – of the peas)>

It follows from the stronger member of the pair in (33) – i.e., its second member – that Kai didn't eat all of the peas, as desired.[6]

Sauerland, on the other hand, pursues a solution that is faithful to the non-grammatical approach. Given that there are two scalar items in (29), he assumes that the relevant set of alternatives is quite rich. Suppose we follow Sauerland's suggestion and consider all the alternatives created by replacing at least one scalar item with one of its stronger alternatives. We then get the following set of alternatives: {Kai ate the broccoli or some of the peas, Kai ate the broccoli and all of the peas, Kai ate the broccoli and some of the peas, Kai ate the broccoli or all of the peas}. Negating those that are distinct from 'Kai ate the broccoli or some of the peas' produces the following set of implicatures: {it isn't the case that Kai ate the broccoli and all of the peas, it isn't the case that Kai ate the broccoli and some of the peas, it isn't the case that Kai ate the broccoli or all of the peas}. None of these is the implicature we are after.

To solve this problem Sauerland proposes that the scale associated with *or* is not merely <or, and> but rather the scale in (34), where A and B are both weaker than 'A and B', both stronger than 'A or B', but are not ordered with respect to each other.

(34) 'A and B' >> A, B >> 'A or B'

This renders 'Kai ate all of the peas' an alternative to (29), and its negation, an implicature of (29). The conclusion is, for Sauerland, that what appears to be a local implicature (in the sense that it is identical to the implicature generated by a corresponding simplex sentence) may be derived by non-grammatical means. The more general conclusion is that perhaps there is no need for reference to local implicatures in the semantic component, in order to predict the observed intuitions regarding cases where one scalar item appears in the scope of another.

The interesting question that arises is whether a similar change in the set of assumptions (i.e., changing our assumptions regarding what the alternatives to *or* are) would suffice to make the right predictions for (1a) (i.e., for scalar items in the scope of attitude verbs) as well. Sauerland's own conclusion (in Sauerland (2004b)) is that this is not possible. The new scale for

[6] The algorithm in (30) is needed because if we simply assumed that the strong meanings of *or* and *some* apply to each other, we would get "Kai ate the broccoli, and it isn't the case that Kai ate some of the peas and Kai didn't eat all of the peas" as a possible inference, which is tantamount to "Kai ate the broccoli and all of the peas."

or clearly doesn't generate the implicature in (1b) by means of simply negating the relevant alternatives (i.e., 'John isn't certain that the boss disappeared' and 'John isn't certain that her assistant disappeared'). However, one can still claim that for certain sentence-embedding verbs (i.e., speech act verbs) the non-grammatical approach suffices, by taking into account more general pragmatic reasoning. For example, one typical reason for asserting (35) is that Bill made an utterance equivalent to (2a), and that Bill's reasoning is similar to the reasoning of any person uttering (2a).

(35) Bill said that the boss or her assistant disappeared.

But Sauerland acknowledges that it is unclear whether such reasoning can plausibly be extended to cases of sentence-embedding predicates that describe mental attitudes as opposed to speech acts.

A different position is taken in Russell (2006), where a different non-grammatical approach is pursued (see also van Rooij and Schulz 2004). The example originally used by Chierchia (unlike our (1a)), involves the attitude verb *believe*,[7] and this is also the verb that Russell uses in his discussion. Thus, consider (36).

(36) John believes that the boss or her assistant disappeared.

Russell assumes that a background assumption generally made by speakers is that John is opinionated regarding the strong alternative to the embedded clause; that is to say, he either believes the proposition 'the boss and her assistant disappeared' or its negation. And indeed, taken together, this background assumption, the assertion of (36), and the negation of the (strong) alternative to (36) (i.e., 'it isn't the case that John believes that the boss and her assistant disappeared') entail 'John believes that the boss or her assistant, but not both, disappeared'.

Notice, however, that contrary to Russell's claim, we cannot always take John's "opinionatedness" for granted. "Opinionatedness" seems to be closely linked to the semantic properties of the verb in question. In (36), where the embedding verb is the Neg-raising *believe*,

[7] The original example also involves the scalar item *some*, not *or*, but we believe this latter fact to be of no crucial importance.

we indeed have reason to take as a background assumption that John either believes p or its negation (and that he is also similarly opinionated regarding all the alternatives to the embedded clause). But verbs that are not Neg-raising do not seem to involve such a background assumption. Let us see why.

That *believe* is Neg-raising is evidenced by the fact that speakers tend to infer (37b) from (37a).

(37) a. John doesn't believe it's raining.
b. John believes it's not raining.

Indeed, beginning with the work of Bartsch (1973), many researchers (e.g., Heim 2000, Gajewski 2005, 2008) have taken 'John believes p or John believes (not p)' to be not merely a background assumption, but a semantic presupposition of *believe*. This way, 'John believes it's not raining' follows from the negation of 'John believes it's raining'. However, not all verbs behave like that: *certain*, the verb we used in (1a), is not a Neg-raising predicate, as evidenced by the fact that speakers do not tend to infer (38b) from (38a). In fact, (38a) is fully consistent with a situation where John entertains the possibility that it's raining and the possibility that it is not.

(38) a. John isn't certain it's raining.
b. John is certain it's not raining.

Therefore, there is no empirical motivation to assume that John's "opinionatedness" is always part of the background; it is clearly determined by the lexical properties of the embedding verb. Specifically, there is no empirical motivation to assume that 'John either believes that the boss and her assistant disappeared or he believes that it isn't the case that the boss and her assistant disappeared' is a background assumption of (1a) (i.e., *John is certain that the boss or her assistant disappeared*). And yet, (1a) has the local implicature in (1b), even in the context described in (39), which lacks such a background assumption.

(39) A: Does John know that even after the earthquake, neither the boss nor her assistant disappeared?

B: No, he doesn't. In fact, he is certain that the boss or her assistant disappeared.

Still, the contrast between the presuppositions of the Neg-raising *believe* and the non-Neg-raising *certain* does not, by itself, conclusively show that the grammatical approach is superior to the non-grammatical approach. It might still be argued that although non-Neg-raising verbs do not have the presupposition required for the production of a local implicature as part of their semantics, they are still compatible with such a presupposition. There are also more complex globalist approaches that can derive these local implicatures. As a reviewer points out, the theory discussed in Chemla and Spector (2009) can derive the local implicature (1b), by considering the following an alternative to (1a): *for all John knows it is possible that the boss and her assistant disappeared*. Therefore, in order to argue in favor of the grammatical approach, one has to provide more compelling evidence.

We believe that the puzzles introduced in section 2 provide much more compelling reasons to assume that reference to embedded implicatures must be made in the course of the semantic computation. Therefore, in the next section we compare the treatment of the puzzles discussed in section 2 offered by grammatical approaches, and the challenges posed by these puzzles for non-grammatical approaches and different variants of the grammatical approach.

4. Back to the puzzles

4.1. The cancellation behavior of *or both*

In this section, we examine the cancelling powers of *or both* within the grammatical approach, as well as the felicity conditions on its use. We also show why the non-grammatical approach is at a disadvantage in accounting for these phenomena.

When *or both* applies to a disjunction, that disjunction introduces an implicature in the scope of *or both*. Without this local implicature, the addition of *or both* would not add anything to the meaning. On these grounds, we argue that the interpretation of *or both* requires a grammatical mechanism for introducing implicatures.

As we saw in section 3.2, Chierchia (2004) addresses the case of a scalar item in the scope of another by building a mechanism that produces the following result.

(40) Where A and B contain scalar items,

Strong(A(B)) = [Strong(A)](B) and A(Strong(B))

This algorithm, which (as we saw) yields correct results for *Kai ate the broccoli or some of the peas*, yields incorrect results for *or both* disjunctions. An *or both* disjunction (e.g., *The boss or her assistant disappeared*) has the schematic structure in (41).

(41) (A or B) or (A and B)

By Chierchia's algorithm, then:

(42) Strong[(A or B) or (A and B)] =

(i) (A or B) or_{exc} (A and B) (or_{exc} = exclusive disjunction)

and

(ii) (A or_{exc} B) or (A and B)

This is equivalent to the strengthened meaning of A *or* B, i.e., exclusive disjunction. That is, no cancellation has taken place. To achieve cancellation, the lower disjunction must be treated throughout as already strengthened to exclusive disjunction (as in (44b,c); see Fox 2003 for discussion). Such a proposal is made by Chierchia et al. (2009). According to Chierchia et al., strengthening of scalar operators is optional and free. However, there are pragmatic constraints that can force strengthening. Chierchia et al. give the example of Hurford's constraint, see (43)a. an example of a violation of this constraint is given in (43)b.

(43) a. <u>Hurford's Constraint</u>

A sentence that contains a disjunctive phrase of the form S or S' is infelicitous if S entails S' or S' entails S.

b. #Bill is an Ohioan or an American.

This constraint applies to *or both* sentences, since they are of the structure [A *or* B] *or* [A *and* B] and A *and* B entails A *or* B. That is, the structure in (44a) violates Hurford's Constraint and is therefore unacceptable. The only way to prevent a Hurford's Constraint violation for (44a) is to

force an exclusive interpretation of the embedded disjunction, as in (44b). Chierchia et al. enforce this exclusive interpretation with a syntactically present exhaustivity operator. We wish to remain agnostic as to how grammatical strengthening is obtained, but we accept that grammatical strengthening is required to avoid violating Hurford's Constraint.

(44) a. (A *or* B), *or both* (A *and* B)
b. (A or_{exc} B) or (A and B)

Now we must make sure that if we strengthen the wide scope disjunction, we do not get the exclusive reading back for the whole disjunction. Notice that giving an exclusive interpretation to the wide scope disjunction has no effect, so long as we understand that the embedded disjunction is interpreted exclusively.

(45) a. (A or_{exc} B) or_{exc} (A and B)
b. = [(A or_{exc} B) or (A and B)] and not [(A or_{exc} B) and (A and B)]

(45) is equivalent to inclusive disjunction – adding the clause that A or_{exc} B and A *and* B are not both true is redundant; they cannot possibly be both true. Thus, the cancelling effect of *or both* is captured under the grammatical approach if "freezing" of local implicatures is allowed. Ignoring the question of what precisely the "freezing" mechanism looks like,[8] what is important for the current discussion is that without access to local implicatures prior to the end of the semantic computation, there would be no way to explain how [A *or* B] and [A *or* B, *or both*] differ in implicatures (given their truth-conditional equivalence).

Furthermore without access to local implicatures prior to the end of semantic computation it would be difficult to explain where *or both* may be used and where it may not. Recall that *or both* is infelicitous when applied to a disjunction in the scope of a DE operator.

(46)a. John is certain that the boss or her assistant, or both, disappeared. (non-DE)
b. #John doubts that the boss or her assistant, or both, disappeared. (DE)

[8] Fox (2003) uses such evidence to argue for a syntactically present operator that introduces implicatures. Sharvit and Gajewski (2008) argue against this view. We come back to this issue in Section 4.2.

The appropriate description of the phenomenon seems to be that *or both* is infelicitous when the local implicature of the disjunction it modifies would be canceled independently. This is a kind of economy condition. The only effect of adding *or both* to a disjunction is to eliminate a local implicature. If another operator that contributes more than just cancellation also effects cancellation, the addition of *or both* is superfluous.

Crucially, the non-grammatical view doesn't explain the behavior of *or both*. It remains a puzzle, for example, why *or both* blocks (47b) as the strengthened meaning of (47a), given the truth conditional equivalence of (A or B) and ((A or B) or (A and B)).

(47) a. John is certain that the boss or her assistant, or both, disappeared.
b. John's certainty: the boss or her assistant, but not both, disappeared.

Suppose we made the assumption (which we think is unmotivated, see section 3.2) that *certain* comes with a presupposition similar to that of *believe*; we would still make an in correct prediction. That presupposition should be active in (47a), and we would expect (47b) to emerge in the same way it emerges in (1a). This is clearly a wrong prediction.

Furthermore, since the non-grammatical approach fails to explain the cancellation behavior of *or both* it cannot provide a basis for explaining the contrast between (47a) and (48) below.

(48) #John doubts that the boss or her assistant, or both, disappeared.

Only an approach that makes reference, in the grammar, to implicatures of embedded clauses has a shot at explaining the contrast between (47a) and (48). The important difference is that (48), unlike (47a), involves an operator that cancels <u>local</u> implicatures.

4.2. The behavior of factive verbs

As we saw in section 2, *sorry* doesn't pattern with *certain* with respect to local implicatures. This was shown by the fact that (11a), repeated below as (49a), implicates (49b) but not (49c).

(49) a. John is sorry that the boss or her assistant disappeared.

b. John believes that the boss or her assistant, but not both, disappeared.

c. John is sorry that the boss or her assistant, but not both, disappeared.

At first sight, it looks as if the grammatical approach is not equipped to deal with these facts. To see why, let us adopt the semantics for *sorry* in (50), according to which it presupposes that its complement is true and that the agent believes the complement (as indicated by in the second line in (50)), and asserts that the agent wants the negation of the complement (as indicated in the third line in (50)).[9] $DOX_w(x)$ is the set of x's doxastic alternatives in w, and $BUL_w(x)$ is the set of x's buletic alternatives in w.

(50) $[\![sorry]\!] = [\lambda p \in D_{<s,t>} . \lambda x \in D_e . \lambda w \in W:$
(i) $p(w)=True$, and (ii) $DOX_w(x) \subseteq \{w' \in W: p(w')=True\}$.
$BUL_w(x) \subseteq \{w' \in W: p(w')=False\}]$

If we follow Chierchia's algorithm, the pair of meanings associated with *John is sorry that the boss or her assistant disappeared* is the one given formally in (51a) and informally in (51b).

(51) a. $<[\lambda w \in W:$
(i) $boss_w$ or $assistant_w$ $disappeared_w$ and (ii) $DOX_w(J) \subseteq \{w' \in W: boss_{w'}$ or $assistant_{w'}$ $disappeared_{w'}\}$.
$BUL_w(J) \subseteq \{w' \in W: NEG(boss_{w'}$ or $assistant_{w'}$ $disappear_{w'})\}]$;
$[\lambda w \in W:$
(i) $boss_w$ or $assistant_w$ $disappeared_w$ and $boss_w$ and $assistant_w$ didn't both $disappear_w$ and (ii) $DOX_w(J) \subseteq \{w' \in W: boss_{w'}$ or $assistant_{w'}$ $disappeared_{w'}$, and $boss_{w'}$ and $assistant_{w'}$ didn't both $disappear_{w'}\}$.
$BUL_w(J) \subseteq \{w' \in W:$ it isn't the case that: $boss_{w'}$ or $assistant_{w'}$ $disappeared_{w'}$ and $boss_{w'}$ and $assistant_{w'}$ didn't both $disappear_{w'}\}]>$

[9] We use the convention (see Heim & Kratzer 1998) according to which $[\lambda\gamma: \alpha. \beta]$ is a function whose domain is restricted by α and whose output is described by β.

b. <[Presupposition: the boss or her assistant disappeared and John knows it. Assertion: John wishes it weren't the case that the boss or her assistant disappeared];
[Presupposition: the boss or her assistant, but not both, disappeared and John knows it. Assertion: John wishes it weren't the case that the boss or her assistant, but not both, disappeared]>

For one member of the pair in (51a)/(51b) to be stronger than the other it has to be the case that the presuppositions+assertion of one member entail the presuppositions+assertion of the other member. But this is not the case: the assertion part in the first member (i.e., 'John's desire: the boss didn't disappear and her assistant didn't disappear') is stronger than the assertion part in the second member (because it entails 'John's desire: either the boss didn't disappear and her assistant didn't disappear, or the boss and her assistant both disappeared'); but the presupposition part in the second member (i.e., 'John believes that the boss or her assistant, but not both, disappeared') is stronger than the presupposition part in the first member (because it entails 'John believes that the boss or her assistant disappeared').

One could, of course, take this to be a genuine problem for the grammatical approach theory (indeed, this seems to be the position taken by Simons). Our position is different; we think this kind of example is simply an indication that the grammatical approach requires the following amendment: pairs of meanings are generated not only in the course of generating assertions, but also in the course of generating presuppositions. In other words, the presupposition tier of *sorry* consists of a pair of propositions, and the assertion tier does too. In each case, the strongest one is selected. Accordingly, the semantics of *sorry* which takes implicatures into account (indicated by the fact that the interpretation function [[ ]] is relativized to implicature-enriched meanings) is as in (52). We assume p is the pair $<p_S; p_I>$, p_S is the standard meaning of p, and p_I is the meaning of p plus the implicatures contributed by the scalar items. The type of 'p' is taken to be <s,t> (despite the fact that it is a pair of propositions).

(52) $[\![sorry]\!]^I = [\lambda p \in D_{<s,t>} . \lambda x \in D_e . \lambda w \in W :$
$<$(i) $p_S(w)$=True, and (ii) $DOX_w(x) \subseteq \{w' \in W : p_S(w')=True\}$;
(i) $p_I(w)$=True, and (ii) $DOX_w(x) \subseteq \{w' \in W : p_I(w')=True\}>$.
$<BUL_w(x) \subseteq \{w' \in W : p_S(w')=False\}$;

$BUL_w(x) \subseteq \{w' \in W: p_I(w')=False\}>]$

Why should each tier – presupposition and assertion – generate its own pair? We believe the reason for this is linked to the reason why *sorry* licenses NPIs at all. As is well-known (see von Fintel 1999 among many others), *sorry* is not DE in the strict sense (as evidenced by the fact that (53a) doesn't entail (53b)), but it is (what von Fintel calls) Strawson DE, in the sense of (54) (as evidenced by the fact that (53a) and (53c) – the presupposition of (53b) – together entail (53b)).

(53) a. John is sorry that Mary hates professors.
b. John is sorry that Mary hates linguistics professors.
c. John believes that Mary hates linguistics professors.

(54) f Strawson-entails g iff for every X such that f(X) and g(X) are defined, f(X) ==> g(X)
(f and g are functions, '==>' stands for cross-categorial entailment; see von Fintel 1999)

If we adopt the view (proposed by von Fintel) that NPI-licensing requires Strawson DE-ment, we open the door to a much more general assumption, namely, that Strawson-entailment is the kind of entailment that is relevant for many semantic operations/processes in natural language in general. Therefore, assuming a multi-tiered version of Chierchia's algorithm for local implicatures is neither unreasonable nor implausible (in fact, it is expected). In each case, the stronger member is selected.[10] Under this view, the relevant pairs of (49a) are as in (55).

(55) John is sorry that the boss or her assistant disappeared.
Presupposition pair:
<John believes that the boss or her assistant disappeared; John believes that the boss or her assistant, but not both, disappeared>
(2^{nd} member is stronger than 1^{st}; hence the implicature in (49b)).
Assertion pair:

[10] On the presupposition tier, this selection resembles the principle of Maximize Presupposition (Heim 1991). However, the effect cannot be reduced to application of Maximize Presupposition. The assertion must be factored out, as we have done here.

<John wants [NOT (the boss or her assistant disappeared)]; John wants [NOT (the boss or her assistant but not both disappeared)]>
(1st member is stronger than 2nd; hence the lack of implicature in (49c)).

Chierchia's account of the local implicature of *certain* and his account of cancellation by negation (e.g., *not certain*) is unaffected by our proposed qualification. This is because "classical" entailment implies Strawson-entailment.

Now, recall that *or both* is unacceptable under *sorry*, cf. (13a), repeated below as (56).

(56) #John is sorry that the boss or her assistant, or both, disappeared.

Given our discussion in section 4.1, this fact suggests that, if *or both* has no effect on even just one of the two coordinates of meaning, that is sufficient to result in infelicity.

How can the non-grammatical approach to local implicatures handle the behavior of *sorry*? The relevant example is repeated in (57a), and has the strengthened presupposition in (57b).

(57) a. John is sorry that the boss or her assistant disappeared.
b. John believes that the boss or her assistant, but not both, disappeared.

Recall that Russell (2006) assumes that an operative background assumption is that the subject of an attitude verb is opinionated regarding the strong alternative to the embedded clause. The strong alternative to the embedded clause, in this case, is 'The boss and her assistant disappeared.' So John either believes this proposition or its negation. On the other hand, the negation of the alternative to (57) is (58a), which presupposes (58b).

(58) a. John is not sorry that the boss and her assistant disappeared.
b. John believes that the boss and her assistant disappeared.

(58b), together with John's opinionatedness regarding 'The boss and her assistant disappeared', do not entail (57b). It is hard to see how without accessing the local implicature in the semantic

component we would be able to account for the emergence of an implicature in the presupposition.

Another interesting apparent counter-example to the grammatical view is *discover* (also discussed, who makes a slightly different point.)

(59) John discovered that the boss or her assistant disappeared.

The potential problem is this. The factivity of *discover* presumably requires that John came to believe the same proposition that is presupposed. But according to Simons, (59) can be felicitous and true in a scenario where the boss or her assistant, but not both, disappeared, yet John – who previously believed neither disappeared – reached the conclusion that they both did.

While we agree with Simons's observation, we do not think it conflicts with the multi-tiered version of the grammatical approach. Presumably, at the presupposition tier the following pair is generated: <John had not been aware that the boss or her assistant had disappeared; John had not been aware that the boss or her assistant, but not both, had disappeared>. The first member of this pair is stronger than the second and is, therefore, selected as the presupposition of (59). So, an utterance of (59) requires its context to entail the first member. A context in which exactly one of {the boss, the assistant} actually disappeared but John is erroneously convinced that both disappeared meets this requirement. So the participants of a conversation in which (59) is uttered are free to conclude that John came to believe that both disappeared, if this is indeed what the context implies, even though this goes against selecting the strong member, in the assertion part (recall the selecting the strongest member is a default strategy, not a requirement).

It is worth noting that contextual considerations alone cannot always discard the stronger meaning. For if this were the case, we would expect *John is sorry that the boss or her assistant disappeared* to be felicitous in a context where John erroneously believes that the boss and her assistant disappeared, contrary to fact. When an implicature is generated in the presupposition tier (e.g., the presupposition imposed by 'x is sorry that A or B', namely, that 'x believes A or B, but not both), it is much harder to override it.

In (56) above we observed that *or both* is unacceptable in the complement of *sorry*. There we suggested that *or both* might be unacceptable if it has no effect on at least one coordinate of

meaning. Now we turn to the case of *or both* in the complement of *discover*. As the following example shows, *or both* is acceptable in the complement of *discover*.

(60) Sue discovered that the boss or her assistant, or both, disappeared.

As just discussed, *discover* carries a negative presupposition. Hence, on the presupposition tier, the addition of *or both* has no effect. This suggests a refinement of our condition on the acceptability of *or both*: *or both* is unacceptable if it has no effect on the assertion tier.

Other apparent counter-examples are discussed in Geurts (2009): *prefer* and *say* do not seem to have either a negative presupposition or a negative assertion. Geurts observers, correctly, the following behavior.

(61) a. I prefer to visit Tokyo or Kyoto =/=> I prefer not to visit both.

b. Bonnie said that Clyde bought a new car or bicycle =/=> Bonnie said that he didn't buy both.

Notice that *or both* is acceptable in both cases.

(62) a. I prefer to visit Tokyo or Kyoto or both.

b. Bonnie said that Clyde bought a new car or bicycle, or both.

How can we make sense of these facts? Starting with (61a), notice that preference is always evaluated relative to alternatives. It is plausible that *I prefer to visit Tokyo or Kyoto* is evaluated relative to alternatives of the form {'I visit Tokyo', 'I visit Kyoto', 'I visit Paris', 'I visit Prague',…}. If these are the alternatives, and if *prefer* presupposes that only the contextually supplied alternatives are feasible, then the implicature indeed goes through. But any context that admits "plural" alternatives (e.g., 'I prefer to visit Tokyo and Kyoto') would be a context where the *but not both* implicature is canceled. Thus, we do not think (61a) constitutes a real counter-example to the grammatical approach. The same is true of (61b): indeed to say *Clyde bought a car or bicycle* doesn't entail saying *Clyde didn't buy both* – in the sense that these are not the actual words that come out of the Bonnie's mouth. But Bonnie could very well imply that Clyde

didn't buy both, as also indicated by the acceptability of *or both* in *Bonnie said that Clyde bought a new car or bicycle or both* (which cancels that implicature).

One more point before we continue. Up until now we have been agnostic about the technical implementation of the grammatical approach to implicatures. In principle, there are two ways to implement such an approach. One could assume a syntactic exhaustivity operator as in Fox (2003) and subsequent work, or a compositional algorithm as in Chierchia (2004) and subsequent work. It is important to note that the first is compatible with the *or both* cancellation data discussed in Section 4.1, but it is not compatible with the approach to *sorry* presented in this section (because a syntactic exhaustivity operator would not allow independent treatment of the presupposition and assertion tiers). On the other hand, not having a syntactic exhaustivity operator is compatible with the facts about *sorry*, but it is not clear that it can handle the full range of data concerning *or both* (because 'freezing' of local implicatures seems to be required here, see also Chierchia et al., to appear, on embeddings of *or both* under necessity modals). Although we know both of these proposals to be only partially correct, this does not undermine our argument that reference to implicatures is required at all points in the grammatical computation.

4.3. Local implicatures in interrogative clauses

Recall from section 2.3 that interrogatives also seem to pattern differently from verbs such as *certain* regarding local implicatures. Matrix interrogative clauses with *X or Y or both* are well formed (as evidenced by (14), repeated below as (63)) and, at the same time, they license NPIs (as evidenced by (15), repeated below as (64)).

(63) Which employees did the boss or her assistant (, or both,) talk to?

(64) Which employees were ever sent to Paris?

At first sight, this seems puzzling: our naïve expectation is that *ever* can occur only in environments where *or both* is infelicitous (c.f., *John isn't certain that Bill has ever been to Paris / #John isn't certain that the boss or her assistant, or both, disappeared*). We will now see why this expectation does not apply to interrogative clauses.

According to Guerzoni and Sharvit (2007), weak NPIs (*any*, *ever*) are licensed only in those questions that are strongly exhaustive. In other words, licensing of NPIs in questions is distinct from licensing of NPIs in declaratives, and does not rely on DE-ness. This is consistent with the fact that questions are not DE environments (as illustrated by the fact that (65a) doesn't entail (65b)).

(65) a. (I wonder) which employees owned a car?
b. (I wonder) which employees owned an Italian car?

A "strongly exhaustive" question is a question that makes reference to both "positive" and "negative" possible answers. For example, to know a question in the "weakly exhaustive" sense is to believe all the possible answers to it that happen to be true, and to know it in the "strongly exhaustive" sense is to believe that the set of true possible answers to it equals the set of possible answers that are in fact true. Thus, one can know which students left in the weakly exhaustive sense (by believing that Sue and Pam left, if they indeed left), or in the strongly exhaustive sense (by believing that Sue and Pam are they only ones who left). *Know*, as we just illustrated, can be construed as either weakly exhaustive or strongly exhaustive, but some predicates have one meaning but not the other. *Wonder* is strictly strongly exhaustive (it is hard to imagine a situation where one would want to believe the true possible answers to a question while remaining agnostic about the false ones), and *surprise* seems to be strictly weakly exhaustive as evidenced by (66) (see Heim 1994).

(66) #Although John expected the students who had actually left to leave, it still surprised him which students left, because he also expected Bill, who hadn't left, to leave.

As observed by Guerzoni and Sharvit, *wonder*-type verbs license NPIs, *know*-type verbs do so only in their strongly exhaustive guise (and speakers sometimes have trouble deciding which of the two readings is the intended one), and *surprise*-type verbs do not license NPIs in embedded questions at all.

(67) a. John wondered which students had ever been to Paris.

b. ??John knows which students had ever been to Paris.

c. *It surprised John which students had ever been to Paris.

Crucially, the fact that NPIs, as well as "local" implicatures, are licensed in questions, is not a problem for the grammatical view of local implicatures: NPIs are licensed in questions via strength of exhaustivity, not DE-ment, and therefore there is nothing to prevent local implicatures from arising there.[11] This means that the acceptability of *or both* in (63) need not conflict with the fact that *ever* is licensed in (64).

But how do local implicatures arise in interrogative clauses in the first place? Assuming that a matrix clause is always (semantically) prefixed with *I wonder…..*, implicatures arise, in the presupposition and/or assertion tier, as long as one proposition in one of those tiers is stronger than the other. For example, the assertion tier of *I wonder which employees the boss or her assistant talked to* has the pair of meanings in (68a), and its presupposition tier has the pair of meanings in (68b).

(68) a.<I want to know which employees the boss or her assistant talked to; I want to know which employees the boss or her assistant, but not both, talked to>

b.<I believe there are some employees that the boss or her assistant talk to; I believe there are some employees the boss or her assistant, but not both, talked to>

In the presupposition tier, the second member is stronger than the first. In the assertion tier, neither member is stronger than the other, because knowing which employees the boss or her assistant talked to, in either the strongly or weakly exhaustive sense, doesn't entail and isn't entailed by knowing which employees the boss or her assistant but not both talk to, in either the strongly or weakly exhaustive sense. However, my wanting to know which employees are such that the boss or her assistant, but not both, talked to is consistent with my belief that there are some employees that the boss or her assistant, but not both, talked to. Therefore, the implicature persists in the assertion tier (presumably because it doesn't conflict with it). This persistence is

[11] See Chierchia 2007 for an attempt to derive the licensing of NPIs in "strong" questions from the assumption that they carry a non-cancellable implicature of domain widening.

what is responsible for the acceptability of *or both* in *I wonder which employees the boss or her assistant, or both, talked to*. Recall from Section 4.2 that we concluded that *or both* is unacceptable if it has no effect on the assertion tier. The crucial example involved a "negative" presupposition (e.g., *#John discovered that the boss or her assistant, or both, disappeared*), where the implicature is canceled. In the example currently under discussion, the implicature is not canceled in the presupposition tier, therefore it persists in the assertion tier. Consequently, *or both* does have an effect on the assertion tier.

Things are different in the *surprise* case. Guerzoni and Sharvit (2007) attribute the fact that question-taking *surprise* cannot license NPIs to the fact that it is inherently weakly exhaustive. By contrast, proposition-taking *surprise* is Strawson DE (just like *sorry*, see section 3.2), and as such, licenses NPIs. Just like *sorry*, proposition-taking *surprise* (whose meaning is very similar to that of *sorry*) doesn't produce a local implicature in its assertion (hence the unacceptability of (20), cf. (13)). Likewise, question-taking *surprise* doesn't produce local implicatures in the assertion tier, for the same reason. To see this, consider (70), in a context where the boss or her assistant (but not both), talked to the employee Fred and the employee Sam.

(69) It surprised John which employees the boss or her assistant talked to.

(70) a.<In the past, John expected NOT [the boss or her assistant talked to Fred and Sam]; In the past, John expected NOT [the boss or her assistant, but not both, talked to Fred and Sam]>

b.<John now knows that the boss or her assistant talked to Fred and Sam; John now knows that the boss or her assistant, but not both, talked to Fred and Sam>

(70a) is the assertion tier of *It surprised John which employees the boss or her assistant talked to* and (70b) is the presupposition tier. Clearly, in the assertion tier, where negation has narrow scope, no implicature is generated.

This analysis predicts that *or both* should not be acceptable in an interrogative complement of *surprise*. The reason is that the negation on the assertion tier prevents the generation of local implicatures and, thus, prevents *or both* from having an effect. This prediction is borne out:

(71) #It surprised John which employees the boss or her assistant, or both, talked to.

As we suggested above in our discussion of *discover*, *or both* must have an effect on the assertion tier to be acceptable.[12]

Within the non-grammatical approach to local implicatures, a problem similar to the one that arises with respect to *sorry* arises with respect to local implicatures of questions. The relevant example is repeated in (72a), and has the strengthened presupposition in (72b).

(72) a. I wonder which employees the boss or her assistant talked to.
b. I believe the boss or her assistant, but not both, talked to some employees.

Once again, we would have to take as part of the background the assumption that I am opinionated regarding the strong alternative to 'The boss or her assistant talked to some employees' (namely, 'The boss and her assistant talked to some employees'). But the negation of (72a) is (65).

(73) I do not wonder which employees the boss or her assistant talked to.

Taken together with my opinionatedness, this doesn't entail (72b).

5. Conclusion

We have presented a number of challenges that any theory of implicatures must address. As we have shown, no existing theory covers the entire range of facts. But we conclude that whatever the correct theory is, it must make reference to local implicatures during the semantic computation. We are not claiming that ALL implicatures arise in the same manner (see also

[12] For some speakers, the following sentence sounds acceptable:

(i) It surprised Bill how many people ordered the cake or the ice cream, or both.

We conjecture that the presence of another scope bearing element in the embedded clause ('how many') is responsible for this judgment.

Geurts 2008): as we have already pointed out, it is quite plausible that the implicatures that arise when one implicature-inducing quantifier is in the scope of another may receive a more traditional, Gricean, account. But when we look at the wide range of implicatures produced in the scope of attitude verbs, we are led to the conclusion that these are best handled within some version of the grammatical approach to implicatures.

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