

Multiplicity and modifiers*

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Abstract

A sentence with an adverbial modifier under negation like *Mike didn't wash the window with soap* gives rise to an inference that Mike did wash the window. A sentence with a plural noun like *Mike washed windows* gives rise to a so-called 'multiplicity' inference that Mike washed multiple windows. In this note, we focus on the interaction between these two inferences in sentences containing both an adverbial modifier and a plural noun under negation, like *Mike didn't wash windows with soap*. We observe that this sentence has a reading conveying that Mike didn't wash any window with soap but that he did wash multiple windows (albeit not with soap). As we discuss, this reading is not predicted by any version of the implicature approach to the multiplicity inference, in combination with the implicature treatment of the inference of adverbial modifiers. We sketch two solutions for this problem. The first keeps the implicature approach to adverbial modifiers but adopts a non-implicature approach to multiplicity based on homogeneity. The second solution keeps instead the implicature approach to the multiplicity inference but treats the inference of adverbial modifiers as a presupposition. In addition, it adopts the idea that presuppositions can be strengthened via implicatures, as proposed recently in the literature. Either way, the interaction between multiplicity and the inference of adverbial modifiers suggests that we cannot treat both as implicatures: if we want to treat either one as an implicature, we need to do something different for the other. We end by comparing the case above to analogous cases involving different scalar inferences and showing that the alternative non-implicature ambiguity approach to the multiplicity inference doesn't provide a solution to our problem.

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1 Introduction

A sentence with a plural noun like (1a) gives rise to the so-called ‘multiplicity inference’ in (1b).

- (1) a. This morning, Mike washed windows.
b. \rightsquigarrow *This morning, Mike washed multiple windows* MULTIPLICITY INFERENCE

As is well known, the multiplicity inference arises in positive cases but disappears under negation, as shown in (2). For this reason, a prominent approach in the literature treats it as an implicature (Sauerland, 2003; Sauerland et al., 2005b; Spector, 2007; Zweig, 2009; Ivlieva, 2013; Mayr, 2015).

- (2) a. This morning, Mike didn’t wash windows.
b. $\not\rightsquigarrow$ *This morning, Mike didn’t wash multiple windows*
c. \rightsquigarrow *This morning, Mike didn’t wash any window*

Similarly, the inference of sentences with an adverbial modifier under negation, as in (3), has been analysed as an implicature (Simons, 2001; Katzir, 2007; Schlenker, 2008).^{1,2}

- (3) a. This morning, Mike didn’t wash the window with soap.
b. \rightsquigarrow *This morning, Mike did wash the window*

In this squib, we focus on the interaction between these two inferences in sentences containing both an adverbial modifier and a plural noun under negation, as in (4a). We observe that (4a) has a reading which conveys that this morning Mike didn’t wash any window with soap but, at the same time, he did wash multiple windows (albeit not with soap) — a reading in which the multiplicity inference appears ‘on top’ of the inference of adverbial modifiers.^{3,4}

- (4) a. This morning, Mike didn’t wash windows with soap.
b. \rightsquigarrow *This morning, Mike did wash multiple windows*

As we discuss, this reading is not predicted by any version of the implicature approach to the multiplicity inference combined with the implicature treatment of the inference of adverbial modifiers.

We sketch two solutions for this problem. The first keeps the implicature approach to adverbial modifiers but adopts a non-implicature approach to multiplicity based on homogeneity (Križ, 2017). The second solution keeps the implicature approach to the multiplicity inference but treats the inference of adverbial modifiers as a presupposition (Simons, 2001; Schlenker, 2008); a pre-

¹See also Chemla 2009a and Cremers et al. 2017 for experimental evidence of this inference.

²Since this inference is focus-sensitive (Simons, 2001), we use sentence final adverbs and all examples are intended to be read with default intonation.

³The judgments are admittedly subtle, because, as we discuss below, the inference under investigation entails the other predicted readings. For this reason, one has to make sure the intuitions about the reading we focus on here are not simply intuitions about compatibility. We examined the intended reading with multiple native speakers using different versions of the main example. The majority of them contributed the intuition that the sentence suggested the relevant inference above. We are therefore confident that this reading exists. Eventually, a full experimental investigation is needed to understand the empirical picture more in detail.

⁴Note that (4a) has also a pragmatically implausible reading paraphrasable as ‘By using soap, Mike didn’t wash windows’ in which the adverb scopes above negation. Here, we focus on the reading in which the adverb scopes below negation.

supposition which can itself be strengthened via implicatures (Gajewski & Sharvit, 2011; Spector & Sudo, 2017). All in all, the interaction between the multiplicity inference and the inference of adverbial modifiers suggests that we cannot treat both as implicatures: if one is analysed as an implicature, we need to propose a different analysis for the other.

The rest of the paper is organised as follows. Section 2 sketches the implicature account of the inference of adverbial modifiers and the main theories within the implicature approach to the multiplicity inference. Section 3 discusses the problem coming from the combination of these two inferences and Section 4 sketches the two solutions to the problem. Some open and related issues are discussed in Section 5, where we also show that the ambiguity approach to the multiplicity inference (Farkas & de Swart, 2010; Grimm, 2013; Marti, 2017) doesn't provide a solution to our problem.

2 Multiplicity, modifiers, and implicatures

2.1 The implicature theory of the inference of adverbial modifiers

In previous literature, the inference in (3b) has been analysed as a scalar implicature (Katzir, 2007). This account arises from a general theory of alternatives and is not an isolated claim about the inference of adverbial modifiers. Under this approach, (3a) is predicted to have as alternative the corresponding sentence without the adverbial modifier, (5):

(5) This morning, Mike didn't wash the window.

On the basis of this, given a theory of scalar implicatures according to which a hearer tends to conclude that any relevant and more informative alternative sentence that the speaker might have said and didn't say is false (Grice 1975 and much subsequent work), the inference in (3b) is straightforwardly derived.⁵ That is, since (5) is a stronger alternative, upon hearing (3a) the hearer would conclude that (5) is false, giving rise to the inference in (3b).

2.2 The implicature approach to the multiplicity inference

The main issue that any theory of the multiplicity inference has to explain is why it arises in positive sentences, such as (1a), but disappears in negative ones, such as (2a), repeated below in (6) and (7). That is, why (7) tends to convey the meaning that Mike didn't wash any window, rather than the negation of (6) that he didn't wash multiple windows.⁶

(6) This morning, Mike washed windows.

(7) This morning, Mike didn't wash windows.

⁵We keep the assumptions about the underlying theory of implicatures as minimal as possible.

⁶The reading that Mike didn't wash more than one window can be forced by marked intonation, as in (i). We put this reading aside, as it is not relevant here and can be accounted for by any of the approaches discussed below; see Tieu & Romoli (To appear) for discussion.

(i) Mike didn't wash any winDOWS, he washed only one!

The general consensus in the literature is that the positive sentence in (6) has a reading compatible with Mike washing just one window, paraphrased in (8):

(8) Mike washed one or more windows.

This immediately accounts for the interpretation of (7) as this is simply the negation of (8). What is left unexplained, however, is how the multiplicity inference arises in positive cases.

As mentioned, a prominent approach is to analyse this inference as a scalar implicature. The main idea is that the literal meaning of a plural sentence in (8) is compared to its singular counterpart, conveying that Mike washed (only) one window. How this competition is implemented differ across the three main types of implicature accounts, which we sketch in the following.

The first account is based on enriching the sentence locally, at the predicate level, where the plural and the singular nouns are assumed to differ (Mayr 2015; Ivlieva 2013; Zweig 2009). While a singular noun in (9) has only atomic elements in its denotation (assuming all the relevant windows in the context are a, b and c), its corresponding plural form in (10) denotes both atoms and sums thereof (e.g., Schwarzschild, 1996).

(9) $\llbracket \text{window} \rrbracket = \{a, b, c\}$

(10) $\llbracket \text{windows} \rrbracket = \{a, b, c, \{a, b\}, \{a, c\}, \{c, b\}, \{a, b, c\}\}$

When the plural in (10) combines with the rest of the sentence, it gives rise to the meaning in (8) that Mike washed one or more windows. However, since the singular predicate is ‘stronger’ than the plural one, that is (9) is a subset of (10), the latter can be strengthened with a local implicature at the predicate level (provided a theory of implicature which can apply locally).⁷ That is, the plural predicate in (10) can be compared to the singular predicate in (9) and strengthened by being reduced to the complement of the former, becoming equivalent to (11):

(11) $\llbracket \text{windows} \rrbracket = \{\{a, b\}, \{a, c\}, \{c, b\}, \{a, b, c\}\}$

When combined with the rest of the sentence, (11) gives rise to the multiplicity inference that Mike washed multiple windows. Importantly, when plural predicates appear in downward entailing environments, such as in the scope of negation, the singular competitor is not stronger anymore and no implicature is computed.⁸ Therefore this approach correctly captures the contrast between positive and negative sentences.

A second type of implicature account is based on higher order implicatures: implicatures arising on alternatives and the implicatures that such alternatives would have had, had they been asserted (Spector 2007). The starting point is that that a singular and a plural sentence are equivalent and both mean (8). The different interpretations they give rise to — and in particular the multiplicity inference of plural sentences — follow from the assumption that they are compared to different alternatives. In particular, the singular sentence in (12) has as alternative the sentence in

⁷Zweig (2009) and Ivlieva (2013) actually make use of an event semantics and have the strengthening apply at the VP-level, after existential quantification over events took place. This detail is not important for our purposes so we put it aside here.

⁸The sensitivity to monotonicity exhibited by scalar implicatures is generally derived by appealing to a principle preventing them from arising if they weaken the literal meaning of the sentence. This captures the difference between the contribution of implicatures in upward versus downward entailing environments; see Chierchia et al. 2012, among many others, for discussion.

(13), which is stronger than (12). (12) then can be enriched with the negation of (13) and ends up conveying the meaning which can be paraphrased as in (14).

(12) Mike washed a window.

(13) Mike washed at least two windows.

(14) Mike washed exactly one window. SG SENTENCE ENRICHED BY ITS IMPLICATURE

The plural sentence then is compared to the corresponding singular sentence already enriched by its implicature, that is to (14). Since (14) is stronger than (8), it will be negated and it will give rise to the multiplicity inference. This is, if it is true that Mike washed one or more windows, but it's not true that he washed exactly one window, then it must be that he washed multiple windows. Again, given that implicatures tend not to appear in the scope of downward entailing operators, this approach too can account for the contrast between upward and downward entailing environments.

Finally, the third account by Sauerland (2003) and Sauerland et al. (2005b), is based on the comparison between the singular and the plural predicates at the level of presuppositions, via Maximise Presupposition (e.g., Heim, 1991; Percus, 1998; Singh, 2008; Chemla, 2008; Marty, 2017). The assumption is that while (12) and its corresponding plural counterpart in (15) are truth-conditionally equivalent, they differ in the presuppositions their predicate is associated with.

(15) Mike washed windows.

Namely, the singular, but not the plural, is associated with a presupposition that its cardinality is exactly one. On the basis of this, the use of the plural leads to the inference, via Maximise Presupposition, that the exactly-one presupposition of the singular is false.⁹ As a result, the hearer concludes that Mike washed one or more window but not exactly one, i.e., that Mike washed multiple windows. The sensitivity to monotonicity, the contrast between (6) vs. (7), is derived by the assumption that Maximise Presupposition can only apply if it strengthens the entire sentence. This immediately predicts that it will not apply under negation, as it would make the sentence weaker than it's literal meaning.

In sum, there are three main types of theories within the implicature approach and they can account for the sensitivity to monotonicity and a variety of complex data in relation to the multiplicity inference which we didn't review here (see Spector 2007; Zweig 2009; Križ 2017 and Ivlieva 2013 for discussion). We turn now to show, however, that none of these theories can account for the problematic case discussed above, if combined with an implicature approach to the inference of adverbial modifiers.

3 The problem

Let us now go back to the inference of the adverbial modifiers and the multiplicity inference, repeated from above:

⁹More precisely the assumption is that both (12) and its plural counterpart in (15) are equivalent, as the presupposition of the former projects through the existential quantification associated with the bare plural and becomes a part of the assertion. However, at the predicate level the singular has a stronger presupposition than the plural. Maximise Presupposition then is assumed to apply in the scope of the existential quantifier, giving rise to the meaning of plural that Mike washed one or more windows but not exactly one, i.e., that he washed multiple windows.

- (16) a. This morning, Mike didn't wash the window with soap.
 b. \rightsquigarrow *This morning, Mike did wash the window*
- (17) a. This morning, Mike washed windows.
 b. \rightsquigarrow *This morning, Mike washed multiple windows*

When we combine the two, we observe that (18) has a reading in which the multiplicity inference appears on top of the inference of the adverbial modifier:

- (18) This morning, Mike didn't wash windows with soap.
 \rightsquigarrow *This morning, Mike did wash multiple windows (albeit not with soap)*

Let us now consider the predictions of the implicature approach to adverbial modifiers combined with different versions of the implicature approach to the multiplicity inference, starting from the local-strengthening theories (Mayr, 2015; Ivlieva, 2013; Zweig, 2009). Under this approach, the plural noun can be strengthened locally, or it can be interpreted literally.¹⁰ Either way the reading we are after is not predicted. To illustrate, consider first the case in which the noun is not strengthened, paraphrased in (19). While this may be a possible reading of the sentence, it doesn't account for the reading we are after: it is compatible with Mike washing only one window.

- (19) Mike didn't wash any window with soap but he did wash one or more windows.

If, on the other hand, the predicate is strengthened, the predicted reading is in (20). The multiplicity inference arising from the inference of the adverbial modifier is now correctly captured, but the literal meaning of the sentence (the first conjunct in (20)) appears too weak: it is compatible with Mike washing one window with soap, *contra* intuitions.

- (20) Mike didn't wash multiple windows with soap but he did wash multiple windows.

The situation is even worse for the global approach based on higher-order implicatures by Spector (2007): not only does this approach fail to capture for the described reading, but it also predicts the intuitively unattested reading paraphrased in (21).¹¹

- (21) Mike didn't wash any window with soap but he did wash exactly one window.

Finally, the problem for the presupposed implicature approach (Sauerland, 2003; Sauerland et al., 2005b) is that Maximise Presupposition is not predicted to apply in the case of (18), as it would weaken the meaning of the sentence. Therefore, the predicted reading is again (19). If we lift the restriction and nonetheless apply Maximise Presupposition, the predicted reading is (20), which is

¹⁰Some of the local-strengthening theories assume that the strengthening of plural is obligatory. It can however happen globally, rather than locally, which in the relevant cases discussed here would be vacuous and therefore equivalent to not strengthening the predicate at all; see Mayr 2015 and Ivlieva 2013 for discussion.

¹¹We refer the reader to Spector 2007 for details. As a sketch of why the reading above is predicted, consider that (18) has (i) as its alternative, i.e., the singular alternative enriched with its implicature derived, in turn, from its alternative in (ii). The negation of (i) then gives rise to the unattested reading in (21).

(i) Mike didn't wash a window with soap but he did wash multiple windows.

(ii) Mike didn't wash at least two windows.

also intuitively incorrect.

In sum, none of the implicature theories of the multiplicity inference in combination with an implicature-based analysis of the inference of adverbial modifiers can account for the problematic reading above. In the next section, we sketch two solutions to the problem: the homogeneity approach to the multiplicity inference by Križ (2017) combined with the implicature approach to the inference of adverbial modifiers and a presuppositional theory of the latter combined with the implicature approach to the multiplicity.

4 Two solutions

4.1 The first solution: the multiplicity inference is not an implicature

Križ (2017) proposes an alternative approach to the multiplicity inference in terms of homogeneity. The main idea is that most predicates are undefined under certain conditions when they apply to pluralities. What is relevant here, when a predicate like *windows* appears in an episodic sentence such as (1a), repeated below in (22), it gives rise to the following trivalent truth-conditions: it is true when both (22a) and (22b) are true, false when both are false, and undefined otherwise. This predicts the intuitively correct reading of (22), i.e., that it is true if and only if Mike washed more than one window.

- (22) Mike washed windows.
- a. Mike washed one or more windows.
 - b. Mike washed multiple windows.

When (22) is negated, as in (23), negation leaves undefinedness untouched, giving rise to the following truth-conditions: (23) is true when both (23a) and (23b) are true, false when both are false, and undefined otherwise. These truth-conditions capture the intuition that (23) is true if and only if Mike didn't wash any window.¹² Hence, the homogeneity approach can account for the alternation between positive and negative cases.

- (23) Mike didn't wash windows.
- a. Mike didn't wash one or more windows.
 - b. Mike didn't wash multiple windows.

Let us now go back to the problematic case in (24) and its meaning strengthened with the implicature of the adverbial modifier *à la* Katzir (2007) in (25):

- (24) Mike didn't wash windows with soap.
- (25) Mike didn't wash windows with soap and he did wash windows.

The homogeneity approach predicts that the first conjunct of (25) is true whenever both (22a) and (22b) are true, false when both are false and undefined otherwise. The second conjunct, on the other hand, is true when both (23a) and (23b) are true, false if both are false and undefined

¹² The negation assumed here is standard negation, making a true sentence false, a false sentence true and keeping the undefinedness untouched.

otherwise. Putting these together, it follows that the conjunction in (25) is true if and only if all of (22a), (22b), (23a) and (23b) are true.¹³ This reading is paraphrased in (26) and this is precisely the reading we are after:

(26) Mike didn't wash any window with soap but he did wash multiple windows.

In sum, adopting the homogeneity approach allows us to account of the problematic case by keeping the implicature approach to the inference of adverbial modifiers.¹⁴

4.2 The second solution: The inference of modifiers is not an implicature

Another solution to the puzzle is to abandon the scalar implicatures theory of the inference of adverbial modifiers and analyse them as presuppositions instead (Simons, 2001; Schlenker, 2008).¹⁵ Under this approach, the sentence in (27) not only entails (27a), but also presupposes it. This idea is supported by the projection data in (28a)–(28d) which suggest that Mike washed windows, i.e., this inference project out of the scope of the operators below and in that it resembles closely the behaviour of presuppositions.¹⁶

(27) Mike washed windows with soap.

a. \rightsquigarrow *Mike washed (one or more) windows* PRESUPPOSITION

(28) a. Mike didn't wash windows with soap.

b. Did Mike wash windows with soap?

c. Perhaps Mike washed windows with soap.

d. If Mike washed windows with soap, he will probably to it again.

\rightsquigarrow *Mike washed (one or more) windows*

Given the assumptions that the inference of the adverbial modifiers is a presupposition and that presuppositions project through negation, our problematic case repeated in (29), would also presuppose (27a), repeated below in (29a). This alone however does not solve the puzzle, as (29a) means that Mike washed one or more windows, not that he washed more than one window. What we need is the multiplicity inference arising on top of (29a).

¹³Note that the implicit assumption here is that the negation of the alternatives is also the standard negation defined above in Footnote 12; see Spector & Sudo 2017 for discussion.

¹⁴An anonymous reviewer suggested us a similar account linked to the homogeneity presupposition associated with distributive predicates. While we think this is a possible alternative route, we do not pursue it here for two reasons. First, as Križ (2017) argues, homogeneity isn't limited to the distributive predicates only. Therefore linking homogeneity to distributivity seems at best not general enough. Second, for the account to work we would need the homogeneity presupposition to project universally through the existential quantification associated with the episodic bare plural. Though this doesn't seem to be what happens with presuppositions and existential quantification in general (see Chemla 2009b, among others).

¹⁵A third possibility would be to analyse the inference of the adverbial modifier neither as an implicature nor as a presupposition, but as an inference of a different kind altogether. Pursuing this direction would have to minimally include an account of how this inference arises and allow it, under the second solution below, to be strengthened by implicatures. We do not develop this option here.

¹⁶While the projection facts constitute a suggestive piece of evidence in favor of the presuppositional analysis, we do not think they are per se conclusive. For discussion about projection behavior and status of the inference projecting see Chemla 2010; Romoli 2012; Tonhauser et al. 2019; see also Chemla (2009a) for an experimental comparison of the inference of adverbial modifiers and presuppositions, on one side, and implicatures on the other.

- (29) Mike didn't wash windows with soap.
 a. \rightsquigarrow *Mike did wash (one or more) windows* PRESUPPOSITION

The remaining ingredient is adopting the idea that presuppositions can be in itself strengthened by implicatures (Spector & Sudo 2017; see also Gajewski & Sharvit 2011; Sudo & Romoli 2017; Magri 2010; Marty 2017). The gist of the idea is that if a sentence ϕ has an alternative ψ with a stronger presupposition, the negation of that stronger presupposition is added to the presupposition(s) of ϕ . To illustrate, and putting aside for now the details of the different versions of the implicature approach to the multiplicity inference (to which we return in the next subsection), the alternative of (29) is (30).

- (30) Mike didn't wash exactly one window with soap.
 a. \rightsquigarrow *Mike did wash exactly one window* PRESUPPOSITION

(30) presupposes (30a), which is stronger than the presupposition of (29) in (29a). Therefore the negation of (30a) is added to the presupposition of (29) and we obtain the right reading that Mike didn't wash any window with soap but he did wash multiple windows, as illustrated in (31).

- (31) Mike didn't wash windows with soap.
 a. \rightsquigarrow *Mike didn't wash any window with soap.* ASSERTION
 b. \rightsquigarrow *Mike did wash one or more windows.* PRESUPPOSITION
 c. \rightsquigarrow *Mike didn't wash exactly one window*
 ADDED NEGATION OF THE PRESUPPOSITION OF THE ALTERNATIVE

In sum, this approach can account for the reading we are after. In fact, it can be seen as an argument for a presuppositional treatment of the inference of adverbial modifiers, an implicature approach to multiplicity inferences, and the idea that presuppositions can be strengthened via implicatures.

4.3 Issues for the presuppositional solution

The presuppositional solution integrates a presuppositional account of the inference of adverbial modifiers with an implicature treatment of the multiplicity inference (which can apply at the assertion and the presuppositional levels). However, not all implicature account of the multiplicity inference fare equally well in this approach. The main issue is whether the result of deriving the inference of adverbial modifiers as strengthened presuppositions is compatible with maintaining the general theory of alternatives by Katzir (2007). In other words, the question is whether the inference obtained at the presuppositional level is compatible with that obtained at the assertion level.

To illustrate the issue, consider first that all three approaches can be applied at the presuppositional level to strengthen the presupposition of the adverbial modifiers to obtain the correct inference, e.g. that Mike washed multiple windows. The question is what the predicted inference at the assertion level is and whether it is compatible with the strengthened presupposition.

Let us start with the local approach by Mayr (2015); Ivlieva (2013) and Zweig (2009). This approach is compatible with Katzir's (2007) theory of alternatives. This is because in the case at hand no local strengthening applies, given the presence of negation, and therefore the only predicted inference is the weak implicature that Mike washed one or more windows. The latter

is compatible (and in fact entailed) by the strengthened presupposition of the sentence (e.g. Mike washed multiple windows) and therefore no issue arises.

The situation is different, however, if one adopts Spector’s (2007) approach to the multiplicity inference. As noted above, this approach gives rise to the unattested reading in (21). This is not only unattested but also in contradiction with the strengthened presupposition that Mike washed multiple windows. The question for Spector 2007 is therefore how to block (21).

Finally, it is not entirely clear how to combine the presuppositional approach to the inference of adverbial modifiers with Sauerland et al.’s (2005a) approach to the multiplicity inference. In particular, as discussed above, Maximise Presupposition is assumed not to apply in this case, so it is unclear how the presuppositional treatment of the adverbial modifier would help.¹⁷

In sum, not all implicature accounts are straightforwardly compatible with the presuppositional solution sketched above and not all of them are compatible with retaining Katzir’s (2007) theory of alternatives.

5 Discussion

5.1 A comparison with other scalar terms

In this subsection, we enlarge the focus from the multiplicity inference to scalar terms more generally and their interaction with modifiers under negation.¹⁸ As a start, consider the sentence in (32) with a scalar adjective *good* and an adverbial modifier *gladly* under negation. Intuitively, (32)—if anything—suggests (32a). While this inference is a subtle one, it is clear that the sentence doesn’t give rise to the opposite inference, namely that Patricia gave Peter an excellent grade. However, this is precisely the inference predicted by the implicature approach.¹⁹

(32) Patricia didn’t give Peter a good grade gladly.

¹⁷We could assume that Maximise Presupposition applies nonetheless, after the adverbial modifier has introduced its presupposition. At that level, (i) would be compared with the alternative in (ii) (assuming, with Sauerland et al. (2005a), that the DP has raised above leaving a trace x). Both (i) and (ii) presuppose that Mike washed x (the presupposition introduced by the adverb) and (i) in addition presupposes that $|x| = 1$ (the presupposition introduced by the singular).

(i) [_{VP} Mike washed PL x with soap]

(ii) [_{VP} Mike washed SG x with soap]

(i) would therefore implicate that the presupposition of (ii) is false. When combined with the rest of the sentence, (i) would convey that Mike washed multiple windows and asserts that he didn’t wash any window with soap. This derives the right results. What remains unclear is why Maximise Presupposition can apply in this case but not in a simple negative case like *Mike didn’t wash windows*.

¹⁸Many thanks to Benjamin Spector (p.c.) for helpful discussion on the issues touched upon in this section.

¹⁹This is because among the alternatives of (32) we have (i), which is not entailed by the assertion and therefore ends up being negated, giving rise to the inference that Patricia gave Peter an excellent grade.

(i) Patricia didn’t give Peter an excellent grade.

Note, however, that a sentence like (33) is challenging for the implicature approach to the inference of adverbial modifiers only to the extent that one can show that the alternative in (i) is relevant in the given context. Thanks to an anonymous reviewer for discussion on this point.

- a. \rightsquigarrow *Patricia gave Peter a good grade (but not an excellent one)*

The presuppositional approach to the inference of adverbial modifiers, on the other hand, predicts the inference in (32a), as it is the (strengthened) presupposition of (33), which projects through negation.

- (33) Patricia gave Peter a good grade gladly.

This could be taken as an argument for the presuppositional view of the inference of adverbial modifiers. However, when we look at other scalar terms, like disjunction, the implicature approach to adverbial modifiers appears to fare better.

Consider first the case of the free choice inference, triggered by a disjunction embedded in the scope of a possibility modal, analysed by many as an implicature.²⁰ (34) gives rise to the inference that each of the disjunct is possible: Miriam can play with her computer and she can play with her i-Pad (though possibly not with both).

- (34) Miriam can play with her computer or her i-Pad.
 a. \rightsquigarrow *Miriam can play with her computer and she can play with her i-Pad*

Now consider (35): the analogous case to the one we focused on above, involving a free choice inference and the inference of an adverbial modifier under negation.²¹ It seems to have a reading that Miriam can't play with her computer and that she can't play with her i-Pad after dinner, but before dinner, she has free choice between the two. That is, the free choice inference seems to arise on top of the inference of the adverbial modifiers, similarly to the multiplicity inference discussed above.

- (35) Miriam can't play with her computer or her i-Pad after dinner.
 a. \rightsquigarrow *Miriam can't play with her computer and she can't play with her i-Pad after dinner, but before dinner she can play with one and she can play with the other*

If this is true, then combining the implicature approach to the inference of the adverbial modifier with an implicature account of the free choice inference straightforwardly predicts the reading in (35).

More surprisingly, the implicature approach to the inference of adverbial modifiers also predicts a conjunctive inference with a simple disjunction like (36). Namely, it predicts the reading in (36a).

- (36) Miriam didn't go to Paris or Berlin by train.
 a. \rightsquigarrow *Miriam did go to Paris and she did go to Berlin (albeit not by train)*

The presuppositional view, on the other hand, predicts the inference in (35a) (provided we apply recursively the strengthening of the relevant presupposition) but it doesn't predict the inference in (36a). In fact, it predicts (36) to have the inference in (37). While the judgments are subtle and this should be investigated further, we think that if anything (36a) suggests (36b) rather than (37).

²⁰See Fox 2007; Chemla 2010; Klinedinst 2007; Franke 2011; Santorio & Romoli 2017; Bar-lev & Fox 2017, among others.

²¹Again, as in the case of the multiplicity inference and the inference of the adverbial modifiers, the intended reading is one in which *after dinner* is in the scope of negation.

(37) *Miriam went to Paris or Berlin but not both*

In sum, cases involving disjunction appears to favour the implicature approach to the inference of adverbial modifiers. On the other hand, the case of adjectives like *good* seems to push in the opposite direction, suggesting that we should adopt the presuppositional view. The general interaction between modifiers under negation and scalar terms needs therefore further exploration; an exploration which however goes beyond the scope of this squib.

5.2 A note on the ambiguity approach to the multiplicity inference

In closing, let us briefly note that the other main non-implicature approach to the multiplicity inference, the ambiguity approach (Farkas & de Swart, 2010; Grimm, 2013; Marti, 2017), does not solve our problem.

To illustrate, the main idea of this approach is that a plural noun like *windows* is ambiguous between an inclusive interpretation which includes atomic elements and sums thereof and an exclusive interpretation which only includes sums, giving rise to the interpretations in (38) and (39), respectively. The choice between the two meanings is regulated by the Strongest Meaning Hypothesis which favors the strongest reading—the one that asymmetrically entails the other—i.e., the exclusive interpretation in positive cases and the inclusive one in negative ones.

(38) Mike washed one or more windows. INCLUSIVE

(39) Mike washed more than one window. EXCLUSIVE

The ambiguity approach however cannot account for our problematic data, regardless of whether it is combined with the implicature or the presuppositional account of adverbial modifiers. The problem is that in order to obtain the intended reading, we would need to somehow select the inclusive meaning of *windows* in the asserted component of the sentence and the exclusive one in the presupposed/implicated part and it is unclear how to do it compositionally.²² Thus the ambiguity approach cannot account for the interpretation we are after and we do not see any obvious amendment to this theory which would allow it to.²³

²²One could consider allowing different denotations of the plural to be used in the assertion and presuppositional levels. This would however predict that in case of lexical ambiguity, different meanings could be selected at these different levels. For instance, (i) should be able to obtain the reading paraphrased in (ii), in which *bank* obtains a different interpretation in the assertion and the presuppositional levels, contrary to facts.

(i) Patricia knows that the fisherman went to the bank.

(ii) Patricia believes that the fisherman went to the bank₁ and the fisherman did go to the bank₂.

²³As discussed by Farkas & de Swart (2010); Spector (2007); Ivlieva (2013) and Križ (2017), the ambiguity approach also has problems with accounting for the multiplicity inference in sentences with non-monotonic quantifiers, as in (i):

(i) Exactly two students solved problems.

↪ *Two students solved more than one problem and all of the others didn't solve any problems*

6 Conclusion

In this note, we have focused on the interaction between adverbial modifiers and multiplicity inferences in sentences containing a plural noun and an adverb in the scope of negation like *This morning, Mike didn't wash windows with soap*. We have shown that a reading of this sentence – entailing that Mike didn't wash any window with soap but that he did wash multiple windows (albeit not with soap) – is problematic for the implicature approach to the multiplicity inference in combination with the implicature treatment of the inference of adverbial modifiers. We have sketched two solutions for this problem. The first was to keep the implicature approach to adverbial modifiers but adopting a non-implicature approach to multiplicity, based on homogeneity. The second solution was to keep instead the implicature approach to the multiplicity inference but treat the inference of adverbial modifiers as a presupposition, in combination with the idea that presuppositions can be strengthened via implicatures. Either way, the interaction between multiplicity and the inference of adverbial modifiers suggests that we cannot treat both as implicatures: if we want to treat either one as an implicature, we need to do something different for the other.

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