A scalar implicature-based approach to Neg-raising

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Abstract. In this paper, I give an analysis of neg-raising inferences as scalar implicatures. The main motivation for this account as opposed to a presupposition-based approach (Bartsch 1973 and Gajewski 2005, 2007) comes from the differences between presuppositions and neg-raising inferences, noticed by Gajewski (2005, 2007) and Homer (2012). In response to this issue, Gajewski (2007) argues that neg-raising predicates are soft presuppositional triggers and adopts the account of how their presuppositions arise by Abusch (2002, 2010). However, I argue that there is a difference between soft triggers and neg-raising predicates in their behavior in embeddings; a difference that is straightforwardly accounted for in the present approach. Furthermore, by adopting Abusch's (2010) account of soft triggers, Gajewski (2007) inherits the assumptions of a pragmatic principle of disjunctive closure and of a non-standard interaction between semantics and pragmatics - assumptions that are not needed by the present proposal, which is just based on a regular theory of scalar implicatures.

1. Introduction

It is an old observation in the literature that certain sentence embedding predicates such as *think* and *want* interact with negation in a surprising way: when negated, these predicates are generally interpreted as if negation was taking scope in the embedded clause. In brief, sentences like (1-a) and (2-a) are generally interpreted as (1-b) and (2-b), respectively.

(1) a. John doesn't think Bill left.
     b. John thinks Bill didn't leave.

(2) a. John doesn't want Bill to leave.
     b. John wants Bill not to leave.

The traditional name for this phenomenon is "neg-raising", and predicates like *think* and *want* are called "neg-raising predicates".[1] The fact that a sentence with wide scope negation appears to

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[1]Beyond *think* and *want*, there are many other neg-raising predicates, the following in (i) is a list from Horn 1989.

(i) a. *believe, suppose, imagine, expect, reckon, feel*
     b. *seem, appear, look like, sound like, feel like*
     c. *be probable, be likely, figure to*
     d. *intend, choose, plan*
     e. *be supposed to, ought, should, be desirable, advise, suggest*

imply the one with narrow scope is not predicted by the standard semantics of such predicates.[2] Furthermore, other sentence-embedding predicates do not exhibit this property; compare (1-a) and (2-a) above with the sentence with a non-neg-raising predicate like *be certain* in (3-a): the latter does not imply at all the corresponding sentence with internal negation in (3-b).

(3)   a.   John isn't certain that Bill left.
        b.   John is certain that Bill didn't leave.

A successful approach to Neg-raising in the literature is the presuppositional account defended in Bartsch 1973 and Gajewski 2005, 2007. This account can explain a variety of data relating to neg-raising, however, it also faces the problem of explaining why the presupposition that it postulates does not behave like other presuppositions in embeddings other than negation.[3] Gajewski (2007) tries to overcome this problem by connecting neg-raising predicates to "soft" presuppositional triggers, in the sense of Abusch (2002, 2010), a class of triggers whose presupposition is particularly weak and context-dependent. I argue that, nonetheless, the behavior of neg-raising predicates is different also from that of this class of presuppositional triggers. Furthermore, as I discuss below, by adopting Abusch's (2010) account of soft triggers, Gajewski (2007) inherits some empirical issues and extra non-standard assumptions about the semantics-pragmatic interface associated with that view.

In this paper, following ideas in Chemla 2009a and Abusch (2002, 2010), I propose a scalar implicature based account of the inferences associated with neg-raising predicates ("neg-raising inferences", henceforth). I discuss two main arguments which favor this approach over the presuppositional one: first, it can straightforwardly account for the differences between between neg-raising predicates and presuppositional triggers. Second, it is based on an independently justified theory of scalar implicatures and it does not need to adopt the system in Abusch 2010, which, as I discuss below, has conceptual and empirical problems. While being based on implicatures, the account that

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See Horn 1978 for a general introduction to neg-raising and Homer 2012 for an extensive discussion of neg-raising modals.

[2]The standard way to analyze such predicates, stemming from Hintikka (1969), is as universal quantifiers over possible worlds, restricted to some modal base. So for instance the semantics of *believe* is in (i), where M is a function from worlds and individuals to sets of worlds, in this case the set of worlds compatible with the beliefs of a in w.

(i) $[\![\text{believe}]\!](p)(a)(w) = \forall w' \in M(w,a)[p(w)]$

It is clear that negating (i) as in (ii-a) is not equivalent to (ii-b), where negation takes narrow scope.

(ii)   a. $\neg[\forall w' \in M(w,a)[p(w)]]$
           b. $\forall w' \in M(w,a)[\neg p(w)]$

[3]I will not be able to do full justice to the predictions of the presuppositional approach within the limits of this paper. See Romoli 2012 for extensive discussion of the good predictions of the presuppositional approach and how they can be reproduced in the scalar implicature approach proposed here.

I propose is different from Horn's (1978) in that it only uses regular and independently motivated scalar implicatures.

This paper is organized as follows: in section 2, I summarize the version of the presuppositional approach by Gajewski (2005, 2007) and the account of soft triggers by Abusch (2010) that Gajewski (2007) adopts. In section 3, I discuss a problematic prediction of this approach. This constitutes the motivation for the scalar implicature-based analysis of neg-raising that I outline in section 4. In section 5, I discuss its predictions and in particular how the proposal accounts for the differences between neg-raising inferences and presuppositions. I conclude the paper in section 6.

2. The presuppositional approach

2.1. The excluded middle as a presupposition

Gajewski (2005), building on Bartsch (1973), proposes a presuppositional account of neg-raising. The idea is that a sentence like (4-a), schematized as in (4-b), presupposes the so-called excluded middle proposition in (4-c), something that in the case of (4-a) we could paraphrase as "John has an opinion as to whether Bill is here".

(4) a. John believes that Bill is here.
  b. $\textbf{believe}_j(p)$
  c. $\textbf{believe}_j(p) \vee \textbf{believe}_j(\neg p)$

The positive case is not particularly interesting, because (4-c) is entailed by (4-b). However, when we negate (4-a) as in (5-a), under the assumption that presuppositions project through negation, we obtain the result in (5-d). This is obtained because (5-b) together with its presupposition in (5-c) entails (5-d) (if it's false that John believes that Bill is here and he has an opinion as to whether Bill is here or not, then he must believe that Bill is not here).

(5) a. John doesn't believe that Bill is here.
  b. $\neg\textbf{believe}(p)$
  c. $\textbf{believe}_j(p) \vee \textbf{believe}_j(\neg p)$
  d. $\textbf{believe}_j(\neg p)$

The main problem for a presuppositional approach to neg-raising is the fact that there is very little evidence that the proposition assumed to give rise to neg-raising, the excluded middle proposition, has a presuppositional status. As Gajewski (2005, 68) says, "the evidence turns out to be mixed, tending towards suggesting that neg-raising predicates are not presuppositional." The standard test for presuppositionality is the projection behavior, that is the phenomenon exemplified by (6-a),

which presupposes (6-b) in the same way as complex sentences embedding (6-a) like (6-c)-(6-f) do.

(6) a.   It was Mary who killed Bill.
     b.   Somebody killed Bill.
     c.   It wasn't Mary who killed Bill.
     d.   If it was Mary who killed Bill, she should confess.
     e.   Perhaps it was Mary who killed Bill.
     f.   Was it Mary who killed Bill?

Negation aside, however, the rest of the projection behavior of the excluded middle does not look presuppositional. Compare the cases in (6-d)-(6-f) above, with those in (7-d)-(7-f): it is unclear that we want the inference from the latter to (7-b).

(7) a.   Bill thinks that Sue is here.
     b.   Bill has an opinion as to whether Sue is here
     c.   Bill doesn't think that Sue is here.
     d.   If Bill thinks that Sue is here, he will come.
     e.   Perhaps Bill thinks that Sue is here.
     f.   Does Bill think that Sue is here?

Again quoting from Gajewski (2005):

> There are certain environments linguists use to diagnose the presence of a presupposition. The most common are the antecedents of conditionals, yes/no questions, and epistemic modals. [...] If *think* introduces the presupposition that its subject is opinionated about the truth or falsity of its complement, then we expect each of the sentences to imply that Bill has an opinion as to whether Sue is here. This does not seem to be the case Gajewski (2005, p.69)

In response to this difference, that is not predicted by the presuppositional approach, Gajewski (2007) postulates that the excluded middle is a soft presupposition and that this would account for the differences with other presuppositions. In the following section, I turn to the connection between neg-raising and soft triggers and I summarize Gajewski's (2007) proposal.

2.2. The excluded middle as a pragmatic inference: connecting neg-raising and soft triggers

2.2.1. Soft triggers

Presupposition triggers can be divided into two groups, soft and hard, on the basis of whether the presuppositions they give rise to are easily defeasible (Abusch, 2002, 2010; Romoli, 2011, 2012). A paradigmatic example of a soft trigger is *win* whereas an example of a hard one is *it*-clefts: a sentence with *win* like (8-a), its negation in (8-b), and a conditional with (8-a) embedded in the antecedent like (8-c), give rise to the inference in (8-d). Analogously, (9-a)-(9-c) give rise to the inference in (9-d).

(8)   a.   Bill won the marathon.
           b.   Bill didn't win the marathon.
           c.   If Bill won the marathon, he will celebrate tonight.
           d.   Bill participated in the marathon.

(9)   a.   It was Mary who broke that computer.
           b.   It wasn't Mary who broke that computer.
           c.   If it was Mary who broke that computer, she should repair it.
           d.   Somebody broke that computer.

Another way to look at the pattern above is is by taking (8-d) and (9-d) as inferences of (8-a) and (9-a) respectively, and showing that they project regardless of whether they are embedded under negation or in the antecedent of a conditional. The examples above show that both soft and hard triggers exhibit the same projection behavior characteristic of presuppositions. However, they also differ in other respects. In particular, one way to distinguish between soft and hard triggers is what Simons (2001) calls "the explicit ignorance test". The recipe is to create a context in which the speaker is manifestly ignorant about the presupposition; triggers that do not give rise to infelicity in such contexts are soft triggers. Consider the following two examples modeled on Abusch 2010 that show that according to this diagnostic *win* and *it*-clefts are indeed soft and hard triggers respectively.[4]

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[4]Notice that the presupposition of a soft trigger can be suspended even if the speaker does not say explicitly that she is ignorant about it. However, it has to be evident from the context that she is. Consider the following example in (i) and assume it is a conversation between two people who are meeting for the first time (from Geurts (1995) reported in Simons (2001)): the presupposition of *stop*, i.e. that the addressee used to smoke, is clearly not present.

(i)   I noticed that you keep chewing on your pencil. Have you recently stopped smoking?

(10)   I don't know whether Bill ended up participating in the Marathon yesterday
         but if he won, he is certainly celebrating right now.

(11)   I don't know whether anybody broke that computer
         #but if it is Mary who did it, she should repair it.

In sum, there is a class of presuppositions that can be suspended in a context that supplies the relevant information about the speaker's epistemic state. In the next subsection, I summarize Abusch's (2010) alternatives-based account of the presupposition of soft triggers, "soft presuppositions" henceforth, and some of the problems that it faces. Then I turn to Gajewski's (2007) account of neg-raising predicates as soft triggers.

2.2.2. Abusch 2010

Abusch (2002, 2010) proposes a pragmatic account of soft presuppositions based on lexical alternatives. The architecture of her proposal is as follows: the semantics of a soft trigger does not contribute a semantic presupposition but rather it provides a set of lexical alternatives; the pragmatic side is constituted by a principle that operates on these alternatives. The flexibility and defeasibility of soft presuppositions comes from the context sensitivity of the pragmatic principle. In slightly more detail, she assumes that the alternatives of soft triggers are intuitively contrastive terms, so that, for instance, *win* and *lose* are alternatives to each other. These lexical alternatives grow compositionally similarly to what is assumed in focus semantics, ultimately giving rise to sentential alternatives. For instance (12-a), schematized in (12-b), has the alternatives in (12-c)

(12)   a.   Bill won.
         b. $\mathbf{won}(b)$
         c. $\mathcal{A}lt\text{(12-b)} = \left\{\ \mathbf{won}(b), \mathbf{lost}(b)\ \right\}$

On the pragmatic side, Abusch (2010) assumes a pragmatic default principle, which requires the disjunction of the set of alternatives, indicated as $\vee \mathcal{A}lt$, to be true. Given the alternatives assumed, their disjunction entails what is generally assumed to be the soft presupposition. For instance, disjunctive closure applied to the alternative set in (12-c) gives rise to the entailment that Bill participated - that is (13-a) entails (13-b).

(13)   a. $\vee \{\mathbf{won}(b), \mathbf{lost}(b)\} = (\mathbf{won}(b) \vee \mathbf{lost}(b))$
         b. $\mathbf{participated}(b)$

The inferences of soft triggers in unembedded cases are derived by using lexical alternatives and a pragmatic principle of disjunctive closure operating on them. Assuming that they are generated in this way, however, raises the question of how such presuppositions should project. Indeed, one of the main challenges associated with soft triggers is explaining the fact that even if they are different from hard triggers with respect to defeasibility, they appear to project in very similar ways. In other words, a theory that can account for their defeasibility, still has to provide an explanation for the projection patterns. In relation to this Abusch (2010) assumes a dynamic framework along the lines of Heim 1983 and crucially formulates her pragmatic principle in such a way as to make reference to the local contexts created by the context change potentials of the dynamic meanings that make up the sentences. The definition of the principle is in (14).

(14)   If a sentence ψ is uttered in a context with common ground c and ψ embeds a clause ϕ which contributes an alternative set $\mathcal{Alt}$, then typically c is such that the corresponding local context d for ϕ entails that some element of $\mathcal{Alt}$ is true.

The local contexts referred to in (14) are those information states created by the dynamic compositional semantics she assumes. I refer the reader to Abusch's (2010) paper for the details, but what is relevant for us is that this strategy effectively mimics the projection behavior of semantic presuppositions, by applying the pragmatic default globally, in a way that makes reference to the local context of the trigger. In other words, the principle in (14) applies to full sentences, at the global level, but makes reference to local contexts that are created during the composition of such sentences. Notice that this last assumption is at odds with standard assumptions about the semantics-pragmatics interface, whereby pragmatics only has access to the output of the semantics, generally thought to be a proposition (or a set of propositions). Here instead we would need a way to keep track of the history of the semantic composition in terms of context change potentials and then make this visible to pragmatics.

Beyond this conceptual point, there are two empirical problems connected to the way soft presuppositions project in Abusch's (2010) system: first, soft and hard presuppositions appear to pattern differently with respect to the projection behavior in quantificational sentences (Charlow 2009; Fox 2012; see also Chemla 2009b). In her system, the projection behavior of soft presuppositions exploits indirectly that of hard presuppositions, so the former is predicted to be identical to the latter, and no difference is expected between them with respect to projection. Second, a further problem for this account was pointed out by Sauerland (2008), who observed that when a soft trigger is embedded under another, the disjunctive closure of the combination of alternatives gives rise to an inference that is too weak. As he discusses, a sentence like (15-a), which contains the soft triggers *win* and *stop*, has intuitively the inference in (15-b). However, the disjunctive closure

of the alternatives in (15-c) only gives rise to (15-d).[5,6]

(15)   a.   John stopped winning
        b.   John used to win
        c. $\mathcal{A}lt$(15-a) = $\left\{ \begin{array}{l} \mathbf{stop}(\mathbf{win}(j)), \mathbf{stop}(\mathbf{lose}(j)) \\ \mathbf{continue}(\mathbf{win}(j)), \mathbf{continue}(\mathbf{lose}(j)) \end{array} \right\}$
        d.   John used to participate

As Sauerland (2008) shows, the problem generalizes to all sentences which contain more than one soft trigger.[7]

2.2.3. Gajewski 2007

Following Abusch (2002, 2010), Gajewski (2007) proposes that neg-raising predicates are also soft triggers and stipulates that the alternatives of a neg-raising predicate are the corresponding predicates with internal negation; hence, a predicate like *believe* would have *doubt* (=*believe-not*) as its alternative, while a predicate like *want* would have *want-not*. As shown in (16-a)-(16-d), once we apply the principle of disjunctive closure proposed by Abusch (2010) over these alternatives we obtain as an inference the excluded middle proposition that Bartsch (1973) postulates directly as a presupposition. Once generated, this inference is predicted to project as a presupposition, in the way described above.

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[5]Abusch (2010) does not include anymore *stop* in the list of triggers that she discusses, contrary to Abusch (2002). The problem is however general and it applies to any case of a soft trigger embedded into another. Furthermore, if her theory is not meant to apply to aspectuals or factives, it is not anymore an account of soft triggers as identified by the explicit ignorance test above, but rather an account of a subset of them, for which, however, she does not specify a criterion of identification.

[6]Notice that in this case the inference in (15-b) is an entailment of (15-a), so Abusch (2010) could appeal to this entailment to account for the intuition that (15-a) leads to the inference in (15-b). However, this would not help her in the case of (i-a), which does not entail (i-b), but still has (i-b) as an inference.

(i)   a.   John didn't stop winning
       b.   John used to win

[7]In response to this, Abusch (p.c. to Sauerland) suggests that the pragmatic principle should apply every time a soft trigger is encountered. This would ensure that there would never be a combination of the alternatives of soft triggers. However, given the assumption that the alternatives of soft triggers grow compositionally, the same problem would arise with other alternative bearers like scalar terms. For instance, in the case of (i-a) the predicted inference is only (i-b) and not the intuitively correct (i-c).

(i)   a.   (Now that he is retired), John didn't stop meeting all the students
       b.   John used to meet some of the students
       c.   John used to meet all of the students

(16)   a.   John believes that Bill left.

           b. $\textbf{believe}_j(p)$

           c. $\mathcal{A}lt(\textbf{believe}_j(p)) = \{\ \textbf{believe}_j(p), \textbf{believe}_j(\neg p)\ \}$

           d. $\vee\{\textbf{believe}_j(p), \textbf{believe}(\neg p)\} = (\textbf{believe}_j(p) \vee \textbf{believe}(\neg p))$

In sum, by adopting Abusch's (2010) account, Gajewski (2007) provides an analysis of neg-raising predicates as soft triggers. However, he inherits the extra assumptions of Abusch's (2010) system, the disjunctive closure and the non-standard semantics/pragmatics interface, and its empirical problems discussed above. The fact that the approach that I propose below does not need these extra assumptions constitutes an advantage over Gajewski's (2007) account.

3. Problematic predictions for the soft presuppositional account

As discussed above, in response to the differences between the presupposition of triggers like *it-*clefts and the excluded middle, Gajewski (2007) postulates that the latter is a soft presupposition in the sense discussed above. In other words, (17-b) would not project out of embeddings like (17-a) because it is suspended.

(17)   a.   If Mary thinks that Bill will win, she will vote for him.

           b.   Mary has an opinion as to whether Bill will win.

I argue, however, that the suspension of soft presuppositions and the non-projection behavior of the excluded middle are different. The intuition is the following: consider (18-a) and (17-a): in an out of the blue context (18-a) appears to give rise to the inference in (18-b), unless we explicitly suspend it like in (18-c) or by making clear that the speaker is ignorant about (18-b). On the other hand, (17-a) appears neutral with respect to (17-b).

(18)   a.   If Mary stopped showing up late for class, Bill must be happy.

           b.   Mary used to show up late for class.

           c.   I don't know if Mary used to show up late for class, but If she stopped, Bill must be happy.

In other words, one can understand (17-a) and not draw the inference in (17-b), without the need for clear contextual information that the inference should be suspended like in (19).[8]

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[8]Gajewski (2005) discusses another characteristics that appear to distinguish neg-raising inferences from presuppositions. The observation is that if they behaved as regular presuppositions, we would expect to find (i) hard to judge if we know that Mary has no opinion, but, as Gajewski (2005, p.69) says, "most people [...] have no problem judging this sentence false in such a scenario".

(19)   I don't know whether Mary has an opinion, but If she thinks that Bill will win, she will
         vote for him.

In sum, the suspension of soft presuppositions requires it to be evident in the context that the
speaker is ignorant about the presupposition, while this doesn't appear to be the case for the ex-
cluded middle inference; hence, if the excluded middle is a presupposition, it is a strange one: it
does not project as a presupposition and its non-projection appears to be a different phenomenon
from the suspension of suspendable presuppositions. In sum, Gajewski's (2007) approach has
problems explaining the differences between soft triggers and neg-raising predicates in embed-
dings other than negation. Furthermore adopting Abusch's (2010) account brings in some empiri-
cal issues and extra assumptions about pragmatic principles and the semantics-pragmatic interface.
In the next section, I propose a scalar implicature-based account of neg-raising inferences, which
like Gajewski's (2007) localizes the source of neg-raising in a set of lexical alternatives. How-
ever, it does not require non-standard assumptions about the semantics and pragmatics interface in
that it is only based on an independently motivated theory of scalar implicatures. Furthermore, it
straightforwardly predicts the differences between neg-raising predicates and soft triggers.

4. A scalar implicature-based approach

From the data discussed above, the generalization appears to be as follows: when neg-raising
predicates and soft triggers are embedded under negation, the inferences associated with them
arise systematically. For instance (20-a) and (21-a) are typically read as implying (20-b) and
(21-b), respectively.

(20)   a.   John didn't stop showing up late for class.
         b.   John used to show up late for class.

(21)   a.   John doesn't think that Fred left.
         b.   John thinks that Fred didn't leave.

(i)   Mary thinks that John is in town.

It is fair to say, however, that while the case of judging (ii) seems clearly different from (i), as argued by von Fintel
(2004) our judgements might not be reliable in the case of presupposition failure.

(ii)   The present King of France is bald.

Furthermore, I am not sure we would not simply judge (iii) as false, in a context in which we know that John never
showed up late for class.

(iii)   John stopped showing up late for class.

In the presupposition approach, (21-b) arises from (21-a) and the excluded-middle inference in (22), so in turn we could assume that (21-a) gives rise systematically to (22).

(22)   John has an opinion as to whether Fred left.

However, while a soft presupposition like (20-b) is also systematically drawn in the case of other embeddings, like the antecedents of conditionals, the corresponding inference in (22) is not. For instance, in the antecedent of a conditional like (23-a), the inference in (23-b) is systematic unless explicitly suspended, but it is not clear that the corresponding (24-b) is there when we utter (24-a).

(23)   a.   If John stopped showing up late for class, Bill will be happy.
        b.   John used to show up late for class.

(24)   a.   If John thinks that Fred left, he will be upset.
        b.   John has an opinion as to whether Fred left.

Notice that scalar implicatures exhibit the very same pattern. For instance, consider the scalar implicature coming from a scalar term like *every*: first, under negation, scalar implicatures like (25-b) from (25-a) are intuitively robust.[9]

(25)   a.   Not every student came.
        b.   Some student came.

The inference from (25-a) to (25-b) can be accounted for as a scalar implicature, by postulating that *every* and *some* are alternatives to each other. As Chemla (2008) observes, we can also describe the inference in (24-b) as behaving like a presupposition with respect to negation. In other words, one could describe the inference in (25-b) as projecting through negation, as both (25-a) and (26) give rise to the inference in (25-b), the former as an entailment, the latter as a scalar implicature.

(26)   Every student came.

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[9]Chemla (2009c) calls scalar implicatures coming from strong scalar terms in downward entailing contexts, like the one in (25-b), "negative implicatures". Chierchia (2004) calls them "indirect scalar implicatures" and claims that they are weaker than regular ones. I disagree with the intuition for the case of negation: I think (25-b) is an inference of (25-a) as robustly as (i-b) is an inference of (i-a).

(i)   a.   Some of the students came.
       b.   Not every student came.

Given this perspective, one might wonder whether the inference in (25-c) can "project" out of other embeddings such as the antecedent of a conditional, in parallel to what presuppositions do. In other words, one might wonder whether (27-a) can lead to the inference in (27-b).

(27)   a.   If every student came, the party was a success
        b.   Some student came

In fact, (27-b) is not predicted to be an inference of (27-a) by standard theories of scalar implicatures and, indeed, the pair (23-a) and (23-b) on one hand, and (27-a) and (27-b) on the other appear different: assuming that we can infer (27-b) from (27-a) at all we certainly do not need the explicit suspension like in (28) in order not to draw it.

(28)   I don't know whether any of the students came, but if everyone did, the party was a success.

From the data above, It appears that the behavior of neg-raising inferences in embeddings resembles scalar implicatures more than soft presuppositions. In the following, I show how we can derive this pattern: scalar implicatures and neg-raising inferences are drawn systematically when (strong) scalar terms and neg-raising predicates are embedded under negation, but not in other embeddings, like the antecedent of conditionals. Before going to the prediction, let me briefly discuss the theory of scalar implicatures that I adopt.

4.1. A Theory of Scalar Implicatures

I adopt a theory of scalar implicatures as entailments of exhaustified sentences (van Rooij and Schulz 2004, Chierchia et al.(to appear), Fox 2007 and Magri 2010 among others). In this theory an exhaustivity operator EXH, similar to *only*, applies to propositions and their associated alternatives and it affirms the proposition while negating a subset of its alternatives. The alternatives that end up being negated, sometimes called the "excludable alternatives", are all the ones that can be consistently negated without contradicting the assertion.[10]

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[10]This is a simplification that I use for convenience here. The general notion of excludability that I adopt is actually the notion of "innocent exclusion" (Fox, 2007). This is because the excludable alternatives as defined classically give rise to some well-known problems (see Fox (2007) and Magri (2010, pp.32-33)). To overcome these issues Fox (2007) proposes a new definition of exclusion, building on Gazdar 1979 and Sauerland 2004. The excludable alternatives are the alternatives that are in all maximal consistently excludable subsets of the alternatives.

(i) $\mathcal{E}xcl_{ie}(\phi)$ is the intersection of all maximal consistently excludable subsets of $\mathcal{A}lt(\phi)$

(29) $[\![\text{EXH}]\!](\mathcal{A}lt(p))(p)(w) = p(w) \wedge \forall q \in \mathcal{E}xcl(p, \mathcal{A}lt(p))[\neg q(w)]$

(30) $\mathcal{E}xcl(p, \mathcal{A}lt(p)) = \{q \in \mathcal{A}lt(p) : \lambda w[\neg q(w)] \cap p \neq \emptyset\}$

Exhaustification of a sentence with respect to its alternatives gives rise to scalar implicatures.[11] As for alternatives, I assume that certain items, like *every*, are associated with a set of lexical alternatives, which then grow to become alternatives of more complex expressions containing them (Rooth 1992; Chierchia 2004 among many others).

Consider now the case in (31-a) repeated from above and let us go through how we can derive the inference in (31-b), when (31-a) is exhaustified as in (32-a), with respect to the alternatives in (33).

(31)   a.   Not every student came
            b.   Some student came

(32)   EXH[not every student came]

(33) $\mathcal{A}lt$(32-a) = $\{$ $[\![\text{not[every student came]}]\!]$, $[\![\text{not[some student came]}]\!]$ $\}$

Notice that the alternative $[\![\text{not[some student came]}]\!]$ is not weaker than the assertion, in fact it is stronger, therefore exhaustification amounts to its negation, which is the inference in (31-b).

(34) $[\![\text{EXH}]\!](\neg\textbf{every}) = \neg\textbf{every} \wedge \neg\neg\textbf{some} = \neg\textbf{every} \wedge \textbf{some}$

4.2. The excluded middle as an alternative

The only addition specific to neg-raising has to do with the alternatives that I assume for neg-raising predicates: the proposal is that they have the excluded middle proposition as their alternative. The semantics of a neg-raising predicate P is non-presuppositional and it is given schematically in (35), while its alternatives are in (36).

The intuition behind this notion is as follows: we want to exclude as many consistently excludable alternatives as possible but we do not want to decide among them in an arbitrary way. In the following, I keep on using the simpler notion of excludability of non-weaker alternatives, while mentioning where the notion of innocent exclusion is actually needed.

[11]More precisely in this account they are entailments of sentences with exhaustification. i will continue using the standard terminology, apologizing in advance for any confusion that might arise.

(35) $[\![\mathrm{P}]\!] = \lambda p \lambda x.\mathbf{P}(p)(x)$

(36) $\mathcal{A}lt(\mathrm{P}) = \big\{\ \lambda p \lambda x.\mathbf{P}(p)(x), \lambda p \lambda x.[\mathbf{P}(p)(x) \vee \mathbf{P}(\neg p)(x)]\ \big\}$

Given the definition of alternatives' growth above a sentence like (37-a) winds up having the alternatives in (37-c).

(37)   a.   John believes that Bill left
        b. $\mathbf{believe}_j(p)$
        c. $\mathcal{A}lt(\mathbf{believe}_j(p)) = \big\{\ \mathbf{believe}_j(p), \mathbf{believe}_j(p) \vee \mathbf{believe}_j(\neg p)\ \big\}$

A question at this point is of course where these alternatives of neg-raising predicates come from. I don't offer more than Gajewski (2007) and Abusch (2010) in this respect: instead of stipulating that **believe**(p) has **believe**$(\neg p)$ as an alternative, as Gajewski (2007) does, I am encoding the excluded middle, that is [**believe**$(p) \vee$ **believe**$(\neg p)$], directly as one of the alternatives. This might seem just a technical variant of Abusch-Gajewski's approach, but as we will see in the next section, it now becomes possible to obtain neg-raising inferences via the alternatives above and just a regular theory of scalar implicatures.

5. Predictions

5.1. The basic case and negation

In the unembedded case, exhaustification is vacuous as the excluded middle alternative is entailed by the assertion. For instance, in the case of a neg-raising predicate like *believe* in (38-a), if John believes that it is raining, then he has an opinion as to whether it is raining, so none of the alternatives in (38-c) is excludable.

(38)   a.   John believes that it is raining.
        b. $\mathbf{believe}_j(p)$
        c. $\mathcal{A}lt(\mathbf{believe}_j p) = \big\{\ \mathbf{believe}_j p, \mathbf{believe}_j p \vee \mathbf{believe}_j \neg p\ \big\}$

However, when a sentence like (38-a) is embedded under negation as in (39-a), we predict the excluded middle to project out as if it was a presupposition: the alternative of (39-a), schematized in (39-b), becomes (40).

(39)   a.   John doesn't believe that it is raining.

b. $\neg\mathbf{believe}_j p$

(40) $\mathcal{A}lt(\neg\mathbf{believe}_j p) = \left\{ \ \neg\mathbf{believe}_j p, \neg[\mathbf{believe}_j p \lor \mathbf{believe}_j \neg p] \ \right\}$

The negation of the excluded middle proposition is not entailed by (39-b), hence when we exhaustify we wind up negating the negation of the excluded middle, thus obtaining the excluded middle again, from which we can conclude the neg-raising inference that John believes not-p.

(41) $[\![\mathrm{EXH}]\!](\neg\mathbf{believe}_j p) = \neg\mathbf{believe}_j p \land \neg\neg[\mathbf{believe}_j p \lor \mathbf{believe}_j \neg p] =$
$\neg\mathbf{believe}_j p \land [\mathbf{believe}_j p \lor \mathbf{believe}_j \neg p] \Rightarrow \mathbf{believe}_j \neg p$

5.2. Other embeddings and non-projection

As we just saw, in the case of negation, exhaustifying a sentence like (42-a) gives rise to the excluded middle inference in (42-b), from which we can conclude the neg-raising inference in (42-c).

(42) a. John doesn't think that Fred left
  b. John has an opinion as to whether Fred left.
  c. John thinks that Fred didn't leave.

What about the case of other embeddings? It is easy to show that the present proposal does not predict that neg-raising inferences should project out of embeddings in the same way as presuppositions. In other words, we make the same prediction for *think* and *every* in cases like (43-a)-(43-c) and (44-a)-(44-c): exhaustification of these cases does not give rise to the inferences in (43-d) and (44-d), respectively.

(43) a. If John thinks that Fred left, he will be upset
  b. Perhaps John thinks that Fred left
  c. Does John think that Fred left?
  d. ↛ John has an opinion as to whether Fred left

(44) a. If Frank met every student, he will come to our department.
  b. Perhaps Frank met every student.
  c. Did Frank meet every student?
  d. ↛ Frank met some student

For instance in the case of (43-b), schematized in (45-a), the alternatives that we have are in (45-b). It is easy to see that none of the alternatives is excludable, thus no inference is predicted from exhaustification in this case.[12]

(45)   a. $\Diamond[\textbf{think}_j(p)]$

     b. $\mathcal{A}lt(\Diamond[\textbf{think}_j(p)]) = \left\{ \begin{array}{l} \Diamond[\textbf{think}_j(p)] \\ \Diamond[\textbf{think}_j(p) \vee \textbf{think}_j(\neg p)] \end{array} \right\}$

In sum, I proposed that neg-raising predicates have their corresponding excluded middle propositions as alternatives and that neg-raising inferences arise as a scalar implicature via exhaustification of sentences containing such predicates. As we saw, the differences between neg-raising inferences and (soft) presuppositions are accounted for straightforwardly in the present approach.[13]

Finally, notice that the present proposal, like Gajewski's (2007), can accommodate the fact that neg-raising inferences are characteristics of certain predicates and not others. What distinguishes neg-raising and non-neg-raising predicates is their alternatives: the former has the excluded middle as an alternative but the latter do not.

6. Conclusion

I proposed a scalar implicatures-based approach to neg-raising inferences, which presents two advantages over Gajewski's (2007) presuppositional one. First, it provides a straightforward account of the non-presuppositional aspect of the behavior of neg-raising inferences, that is their projecting through negation but not through other embeddings. Second, it is based on an independently justified theory of scalar implicatures and it does not need to adopt the system by Abusch (2010), which, as discussed above, has conceptual and empirical problems.

Acknowledgements

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[12]More in general, when a neg raising predicate P is embedded under some upward entailing operator O_{ue}, EXH($O_{ue}[P]$) is always vacuous. When a predicate P is embedded under some non-upward entailing operator O_{non-ue}, instead, EXH($O_{non-ue}[P]$), gives rise to the negation of the excludable alternatives of $O_{non-ue}[P]$. These inferences are different from the projection of the excluded middle predicted by the presuppositional approach, hence, in principle, if one could argue for their existence, one would have a strong argument in favor of the present approach. The task, however, is not easy, see Romoli 2012, for discussion.

[13]Notice that explaining the difference depends also on the account of soft presuppositions that we assume. This is because once we have an account of neg-raising in terms of scalar implicatures we do not have to connect neg-raising and soft presuppositions anymore. In particular, if we have an account of soft presuppositions as real presuppositions, like the one proposed in Fox 2012, explaining the difference with neg-raising inferences becomes extremely easy: one can simply assume that any difference between the two comes from the fact that they are different things.

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