The Unexpected Projection of Some Presupposition Triggers

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I. The Puzzle

Suppose John and Mary are two children who are talking to each other on the phone right before bedtime. The exchange in (1) is a coherent exchange (see Fauconnier 1984, Zeevat 1991, Heim 1992).

(1) John: Believe it or not, I am already in bed. If you tell your parents, they might start liking me.
   Mary: I might tell them that. My parents think that I’m in bed too, but I’m actually surfing the web.

Current theories of sentence embedding are not designed to predict the coherence of (1). Rather, they are designed to predict the coherence of Mary’s statement in (2), which implies that her parents think that John is in bed. But the very same assumptions that predict the coherence of (2) incorrectly predict that (1) – where Mary’s statement does not imply that her parents think that John is in bed – is incoherent.

(2) Mary to John: My parents mistakenly think that you are in bed, and they think that I am in bed too.

This paper is an attempt to resolve this conflict. We review previous proposed solutions and present our own.
1. Expected and Unexpected Presupposition Projection

Certain lexical items, such as *too*, trigger presuppositions. That is to say, *too* comes with a presupposition – a background assumption – that disappears when *too* is not present. To see this, consider the contrast between (3) and (4).

(3) Mary: I am in bed.  
    Assertion: Mary is in bed.

(4) John: I am in bed.  
    Mary: I am in bed too.  
    Presupposition: Some salient individual who is not Mary is in bed.  
    Assertion: Mary is in bed.

Mary’s utterance in (3) comes only with an assertion – that she is in bed. Her utterance in (4), which is formed by adding *too* to (3) (and is often pronounced with focus, or emphasis, on *too*), comes with a presupposition and an assertion: the presupposition is satisfied by John’s previous utterance, and the assertion is the same assertion that (3) makes. The presupposition is a background assumption that John and Mary share.

It is the hallmark of presuppositions that they survive under negation. For example, if Mary’s response is changed to *I am not in bed too*, the assertion changes, but the presupposition remains the same. For this reason, a presupposition of a sentence is often thought of as a statement that must be true for that sentence to be either true or false.

Much of the linguistic and philosophical literature on presuppositions is concerned with the following two problems (see Stalnaker 1973, 1974; Karttunen 1974; see also Beaver 2001 for a good overview): (a) what the source of presuppositions is (i.e., how *too* contributes the presupposition it contributes), and (b) what happens to presuppositions of embedded sentences. The latter problem is referred to as the projection problem for presuppositions, and is illustrated by (5) and (6): The received wisdom is that (5a), where the embedding verb is the non-factive *think*, presupposes that Mary’s parents believe that John is in bed, and that (5b), where the embedding verb is the factive *know*, presupposes what (5a) presupposes, but it also presupposes that John and Mary are in bed. This is supported by the contrast between (6a,b) and (6c): the former two may be felicitous; the latter is odd (oddity is indicated by the ‘#’ symbol).
(5) John: I am in bed, and your parents know it.
   a. Mary: Right, and they think [that I am in bed too].
   b. Mary: Right, and they know [that I am in bed too].

(6) a. Mary to John: My parents mistakenly think that you are in bed, and
    they think that I am in bed too.
   b. Mary to John: My parents mistakenly think that you are in bed, and/but they know that I am in bed.
   c. Mary to John: #My parents mistakenly think that you are in bed, and/but they know that I am in bed too.

Regarding the first problem (the source of presuppositions): for our purposes it suffices to assume that presuppositions are contributed by the lexical meanings of the triggers. For example, for current purposes, we may assume that too comes with a referential index and implies that P (in our case, P = is in bed) holds of the referent of that index regardless of whether the sentence as a whole is true or false, as shown in (7) (for a formal version of (7), see Appendix, (I); in general, the readers are advised to consult the appendix for formal definitions, as the definitions given here are meant to be informal).

(7) For any index j such that the referent of j is distinct from a:
   ‘a P too_j’ is true if
   P holds of the referent of j and P holds of a;
   ‘a P too_j’ is false if
   P holds of the referent of j and P does not hold of a;
   otherwise, ‘a P too_j’ is neither true nor false.

From now on, we refer to the presupposition – or conjoined presuppositions – that a sentence p makes as PRESUP(p), and to its assertion as ASSERT(p) (see Appendix, (II)). This is illustrated in (8), on the assumption that Mary is the speaker and John is the only other relevant individual, which makes him the referent of the index of too.

(8) PRESUP(I am in bed too_j) = ‘John is in bed’
    ASSERT(I am in bed too_j) = ‘Mary is in bed’

Regarding the second problem (the projection of presuppositions from embedded sentences): for our purposes, it suffices to attribute the difference between
(5a) and (5b) – according to the received wisdom – to a lexical difference between think and know, as shown in (10)-(11) (see Appendix, (III)). The definition of DOX – which is referred to in (10)-(11) – is given in (9).

(9) For any individual x and possible world w, DOX\textsubscript{x,w} is the set of doxastic alternatives of x in w (the set of possible worlds that x considers in w to be plausible candidates for the world he/she lives in).

(10) ‘a think p’ is true in w if

\[
\text{DOX}_{a,w} \subseteq \{w': \text{PRESUP}(p) \text{ is true in } w'\} \quad \text{and} \\
\text{DOX}_{a,w} \subseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\};
\]

‘a thinks p’ is false in w if

\[
\text{DOX}_{a,w} \subseteq \{w': \text{PRESUP}(p) \text{ is true in } w'\} \quad \text{and} \\
\text{DOX}_{a,w} \not\subseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\};
\]

otherwise, ‘a thinks p’ is neither true nor false.

My parents think that I am in bed too.

Presupposition: \hspace{1cm} \text{DOX}_{Mary's\textquotesingle\textquotesingle parents,w} \subseteq \{w': \text{John is in bed in } w'\}

Assertion: \hspace{1cm} \text{DOX}_{Mary's\textquotesingle\textquotesingle parents,w} \subseteq \{w': \text{Mary is in bed in } w'\}

(11) ‘a knows p’ is true in w if

\[
\text{PRESUP}(p) \text{ and } \text{ASSERT}(p) \text{ are true in } w, \\
\text{DOX}_{a,w} \subseteq \{w': \text{PRESUP}(p) \text{ is true in } w'\}, \text{ and} \\
\text{DOX}_{a,w} \subseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\};
\]

‘a knows p’ is false in w if

\[
\text{PRESUP}(p) \text{ and } \text{ASSERT}(p) \text{ are true in } w, \\
\text{DOX}_{a,w} \subseteq \{w': \text{PRESUP}(p) \text{ is true in } w'\}, \text{ and} \\
\text{DOX}_{a,w} \not\subseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\};
\]

otherwise, ‘a knows p’ is neither true nor false in w.

My parents know that I am in bed too.

Presupposition 1: \hspace{1cm} \text{John and Mary are in bed}

Presupposition 2: \hspace{1cm} \text{DOX}_{Mary's\textquotesingle\textquotesingle parents,w} \subseteq \{w': \text{John is in bed in } w'\}

Assertion: \hspace{1cm} \text{DOX}_{Mary's\textquotesingle\textquotesingle parents,w} \subseteq \{w': \text{Mary is in bed in } w'\}

But given (10), the fact described in connection with (1), repeated in (12), is
unexpected: (12) is coherent, but in the context described Mary’s parents are presumably agnostic regarding whether John is in bed.

(12) John: Believe it or not, I am already in bed. If you tell your parents, they might start liking me.
    Mary: I might tell them that. My parents think that I’m in bed too, but I’m actually surfing the web.

This is further supported by the fact that in the situation described, Mary’s response in (12), with too, and Mary’s response in (13), without too, are almost interchangeable.

(13) Mary: I might tell them that. They think that (either) only I am in bed or that you and I are both in bed, but I’m actually surfing the web.

The puzzle that this paper is concerned with is this: if the presupposition of too projects as prescribed by (10), how does the unexpected projection in (12) come about?

Before exploring possible explanations, let us discuss some other empirical observations that any good theory of the exceptional projection of too should explain. From now on we omit the index from too (and other triggers), because we assume, for simplicity, that John and Mary are the only relevant individuals.

2. Additional Facts to be Explained
2.1. Other Triggers Behave Like Too

Even and again are also presupposition triggers. In (14), Mary’s utterance is felicitous because John’s previous utterance satisfies the presuppositions contributed by even; in (15), Mary’s utterance is felicitous because John’s previous utterance satisfies the presupposition contributed by again.

(14) John: I am in bed, but it is unlikely that you are.
    Mary: You’ll be surprised; even I am in bed.
    Presupposition 1: John is in bed.
    Presupposition 2: The likelihood of Mary being in bed is lower than that of John being in bed.
    Assertion: Mary is in bed.
(15) John: I watered the plant.
   Mary: I just watered it again.
   Presupposition: The plant has been watered before.
   Assertion: Mary just watered the plant.

And they have the same exceptional projection as *too* (see Heim 1992, among others): as illustrated by (16), when Mary’s parents are agnostic regarding whether John is in bed and regarding the likelihood of Mary being in bed, Mary’s response to John in (i), with *even*, and Mary’s response to John in (ii), without *even*, are almost interchangeable.

(16) John: I am in bed.
   (i) Mary: That’s not surprising. My parents probably think that even I am in bed.
   (ii) Mary: That’s not surprising. My parents probably think that I am in bed, though they have no idea whether you are in bed or whether I’m likely to be.

Likewise, as illustrated by (17), when Sally is agnostic regarding whether the plant has been watered before, Mary’s response to John in (i), with *again*, and Mary’s response to John in (ii), without *again*, are almost interchangeable.

(17) John: I watered the plant an hour ago. Please don’t tell Sally; she thinks this plant should get very little water.
   (i) Mary: Sure thing. She probably thinks that I watered it again just now.
   (ii) Mary: Sure thing. She probably thinks that I watered it just now, though she has no idea whether it was watered before that at all.

2.2. Triggers that Behave Differently

The definite article *the* and the verb *stop* are also presupposition triggers. (18) is felicitous only if it is indeed the case that a murder has been committed, and Mary’s utterance in (19) is felicitous only if it is indeed the case that John used to smoke.

(18) The murderer was caught.
   Presupposition: There is exactly one murderer.
Assertion: There is exactly one murderer and that murderer was caught.

(19) Mary to John: You stopped smoking.
   Presupposition: John used to smoke.
   Assertion: John does not smoke now.

But in (20), Mary’s response in (i) (as opposed to (ii)) is odd when Mary’s parents know that a murder has been committed, but are agnostic about whether only one murderer was involved. In (21), Mary’s response in (i) (as opposed to (ii)) is odd when Mary’s parents know that John hasn’t smoked in the past two weeks, but are agnostic about whether John smoked before that.

(20) John: A murder was committed, and the police immediately caught the murderer.
   (i) Mary: #My parents were right, then; they said the police caught the murderer.
   (ii) Mary: My parents were right, then; they said the police caught whoever committed the murder.

(21) John: Up until two weeks ago, I used to smoke.
   (i) Mary: #My parents are right, then; they think you stopped smoking two weeks ago.
   (ii) Mary: My parents are right, then; they think you haven’t smoked in the past two weeks.

2.3. The Subject’s Perspective

The perspective of the subject of think regarding what too, even and again presuppose cannot be completely ignored, as evidenced by (22), (23) and (24); compare with the corresponding (12), (16) and (17) (as pointed out to us by C. Tancredi, (22) is easier to accept if the reported thought is expressed by two different attitude reports, but we do not discuss this possibility here).

(22) John: I am in bed, but your parents think I’m not.
    Mary: #Right, and they think that I am in bed too.

(23) John: I am in bed and it’s unlikely that you are, but your parents think that I’m
not.
Mary: #Right, and they think that even I am in bed.

(24) John: I watered the plant an hour ago, but Sally thinks no one did.
Mary: #Right, and she thinks that I watered it again just now.

The fact that the subject’s perspective regarding what the triggers presuppose cannot be ignored completely is also evidenced by the oddity of Mary’s response in (25), which suggests that Mary’s parents cannot be agnostic about whether John got the job (presumably, the background assumption that only one person gets the job – which is shared by the parents – is responsible for that; see Heim 1992).

(25) John: I got the job, but your parents don’t know it.
Mary: #Right, and they think that I got the job too.
Mary: #Right, and they think that even I got the job.

2.4. Other Sentence Embedding Predicates

As shown in (26), the exceptional projection of too, even and again is not unique to sentences embedded under think.

(26) a. John visited me yesterday and Mary, who doesn’t know it, promised to visit too.
    b. John visited me yesterday and Mary, who doesn’t know that the likelihood of him visiting me is greater than that of her visiting me, said that even she would visit me.
    c. John visited me yesterday, but now he doesn’t remember whether he visited me. Today he promised to visit me again.

But not all embedding environments allow this. For example, counterfactual conditionals do not: (i) in (27) need not imply that Mary is overweight, but (ii) implies it; cf. Heim (1992) and Rooth (1999) (assume that the elevator is tiny, and under normal circumstances only one person takes it). In addition, to the extent that (i) in (28) is felicitous at all (for many speakers it is not), it need not imply that Mary is overweight either, but (ii) implies it. In (27) B is not agnostic about whether John is in the elevator; in (28) he is.
(27) A: John is in the elevator.
   (i) B: Right, and if Mary were in the elevator too, the weight limit would be exceeded.
   (ii) B: Right, and if Mary were in the elevator(, alone or not), the weight limit would be exceeded.

(28) A: Is John in the elevator?
   (i) B: (#)I don’t know, but if Mary were in the elevator too, the weight limit would be exceeded.
   (ii) B: I don’t know, but if Mary were in the elevator(, alone or not), the weight limit would be exceeded.

The same effect is exhibited in (29) with even, and in (30) with again. B’s response in (29) need not imply that Mary is overweight. Likewise, B’s response in (i) in (30) need not imply that Mary’s watering is excessive, but B’s response in (ii) does.

(29) A: John is in the elevator, and it’s unlikely that Mary is.
   B: Right, but if even Mary were in the elevator, the weight limit would be exceeded.

(30) A: John watered the plant an hour ago.
   (i) B: Right, and if Mary had watered it again, it would have died from too much fluid.
   (ii) B: Right, and if Mary had watered it, it would have died from too much fluid.

2.5. The Factivity Implication

The exceptional projection of too is blocked when the presupposition of the embedded sentence is not satisfied in the actual world, even when the subject of think is agnostic about that presupposition, as evidenced by the oddity of Mary’s response in (31) (see Cohen 2009 for another effect of the factivity implication).

(31) John: I am not in bed; I’m watching TV, but your parents don’t know whether I’m in bed or watching TV.
    Mary: #Right, and they think that I’m in bed too.

The same effect is attested in the case of even and again, as shown by the oddity of
Mary’s response in (32) and (33).

(32) John: I am not in bed, although it is more likely that I am in bed than you. I’m watching TV, but your parents don’t know whether I’m in bed or watching TV, or whether I’m more likely than you to be in bed.
   Mary: #Right, and they think that even I am in bed.

(33) John: Nobody watered the plant, but Sally doesn’t know whether the plant has been watered or not.
   Mary: #Right, and she thinks that I watered it again.

To the best of our knowledge, none of the presently existing theories can account for all these observations, but we hope our own proposal (spelled out in Section III) comes closer than previous proposals (discussed in Section II).

II. Two Suggested Solutions, their Advantages and Drawbacks

1. The Scope Solution

   Geurts & van der Sandt (2004) propose a solution within the framework of Discourse Representation Theory. The solution is fairly complex, and for our purposes it suffices to introduce a simplified version, which goes like this: the projection rules, as we described them in Section I above, are too strict. In fact, the presuppositions of an embedded sentence can project “locally” (with narrow scope; i.e., they are active only in the embedded sentence) or “globally” (with wide scope; i.e., they are active only in the main sentence). “Local” projection implies that both presupposition and assertion are embedded; “global” projection implies that the presupposition is not embedded, only the assertion is (which means that the presupposition doesn’t hold in the worlds quantified over by think).

   (34) a. My parents think that I am in bed too
   b. Local projection:
      \[My\ parents\ think\ [[\text{PRESUP}(I\ am\ in\ bed\ too)]\ [\text{ASSERT}(I\ am\ in\ bed\ too)]]\]

      The parents’ thought contains both presupposition and assertion of \textit{I am in bed too}. As a result, the entire sentence implies that the parents think: “John and Mary are in bed.”
c. Global projection:

\[
[[\text{PRESUP}(I \text{ am in bed too})][\text{my parents think [ASSERT}(I \text{ am in bed too})]]]
\]

The parents’ thought contains only the assertion of \(I \text{ am in bed too}\). The presupposition of \(I \text{ am in bed too}\) is part of the meaning of \( \text{My parents think that I am in bed too} \). As a result, the entire sentence implies: (a) John is in bed; (b) the parents think: “Mary is in bed.”

This analysis provides a good explanation for the observation described in Section 1.2.1: the presuppositions of \( \text{even} \) and \( \text{again} \) have the same scope options as the presupposition of \( \text{too} \). It also provides a nice explanation for the observation regarding the factivity implication in 1.2.5: exceptional projection implies satisfaction of the presupposition of the embedded clause in the actual world.

However, the analysis is at odds with the observation in 1.2.3, because it does not require that the parents be agnostic regarding the presupposition of the embedded sentence, and we therefore expect (22) to have (34c) as one of its meanings. The analysis is also at odds with the observation in 1.2.4, because we expect presuppositions to always be able to project globally, regardless of the embedding environment. In other words, we expect (36) to be a possible structure, predicting, counter-intuitively, that both (27i) and (27ii) imply that Mary is overweight.

\[
\text{(35)} \quad \text{PRESUP}(\text{Mary is in the elevator too}) = \text{‘John is in the elevator’} \\
\text{ASSERT}(\text{Mary is in the elevator too}) = \text{‘Mary is in the elevator’} \\
\text{(36)} \quad [[\text{PRESUP}(\text{Mary is in the elevator too})][\text{if ASSERT}(\text{Mary is in the elevator too)}, \text{the weight limit would be exceeded}]]
\]

For these reasons, we do not adopt this analysis. Still, it is worth mentioning that no other analysis known to us predicts the factivity implication.

2. The ‘\text{de re}’ Ascription Solution

Heim (1992) entertains the hypothesis that \( \text{too} \) may be interpreted ‘\text{de re}’. In order to understand this idea, consider the following example (cf. Quine 1956).

\[
\text{(37)} \quad \text{John thinks that Mary is French and that she is German.}
\]
It is certainly possible to understand the sentence as attributing to John the belief that Mary has two nationalities. This meaning is expected, on the assumption that think has the meaning in (10). However, it is also possible to understand the sentence as attributing to John two beliefs about, what to him are, two distinct women: imagine a situation where he sees Mary on two distinct occasions, and fails to infer that the woman he saw on the first occasion is none other than the woman he saw on the second occasion. On the first occasion he forms the belief that the woman in question is French; on the second occasion he forms the belief that the woman in question is German. (10) doesn’t give us the tools to represent, semantically, the identification mistake that John has made.

A solution in the spirit of Quine, which is an alternative to (10) (see von Stechow 1984), attributes to (37) the meaning in (39), based on (38) (see Appendix, (IV)), where H is a contextually supplied function (for example, the function that corresponds to the definite description the woman John saw) that assigns to every possible world at most one individual, and <a1, P> is derived from the embedded sentence (for example, if the embedded sentence is Mary is French, <a1, P> is <Mary, be French>).

(38) ‘a2 thinks <a1, P>’ is true in w if H(w) = a1 and DOX_{a2, w} ⊆ {w′: P holds of H(w′) in w′},
     ‘a2 thinks <a1, P>’ is false in w if H(w) = a1 and DOX_{a2, w} ⊊ {w′: P holds of H(w′) in w′},
     Otherwise, ‘a2 thinks <a1, P>’ is neither true nor false in w.

(39) Mary = H1(w) = H2(w), and
     DOX_{John, w} ⊆ {w′: H1(w′) is French in w′ and H2(w′) is German in w′},

where H1 could be “the woman John saw wearing a blue dress” and H2 could be “the woman John saw wearing a red dress”.

H1 and H2 pick out Mary in the actual world, but may pick out other individuals in John’s doxastic alternatives.

If individuals can be acquainted, not only with concrete entities (such as other individuals), but also with abstract entities – such as properties – the following analysis of My parents think that I am in bed too suggests itself.

(40) The property of being in bed in addition to John is H3(w), and
DOX_{Mary’s parents, w} \subseteq \{w’: H3(w’) is a property that holds of Mary in w’\}

Just like John can fail to correctly identify Mary (as the woman he had seen on two different occasions), Mary’s parents can fail to correctly identify the property of being in bed in addition to John.

The analysis provides a nice explanation for the observation described in Section I.2.1: even and again can be interpreted ‘de re’, just like too, because Mary’s parents can have a belief about the property of being an x such that even x is in bed, and they can have a belief about the property of watering the plant again. It also provides a nice explanation for the observation in I.2.4: ‘de re’ ascription is unique to attitude reports (constructions whose main verb is a propositional attitude verb such as think, believe, promise, want, etc.); counterfactual conditionals are not attitude reports.

However, the analysis has some problems. Apart from the obvious philosophical concern (namely, What does it mean for an individual to be acquainted with a property?), it is at odds with the observation in Section I.2.2, because we expect My parents think you stopped smoking to mean (41).

(41) The property of having stopped smoking is H4(w), and
DOX_{Mary’s parents, w} \subseteq \{w’: H4(w’) is a property that holds of John in w’\}

The analysis is also at odds with the observation in I.2.3, because we expect My parents think that I got the job too to mean (42) (as observed by Heim herself).

(42) The property of getting the job in addition to John is H5(w), and
DOX_{Mary’s parents, w} \subseteq \{w’: H5(w’) is a property that holds of Mary in w’\}

For these reasons, we cannot adopt the ‘de re’ ascription solution as presented above. However, towards the end of Section III, we will suggest incorporating some version of this solution into our own solution.

III. The Subset-of-DOX Solution

1. The Basic Idea

Our own proposal is based on the idea that the meaning that is usually assumed for think (for example, (10)) is too demanding. This meaning presupposes that the subject of think entertains the presuppositions of its sentential complement. What if the
meaning of think is weaker, and presupposes that the subject merely entertains the presuppositions of its sentential complement as a possibility? In other words, we propose the meaning in (43), as an alternative to (10) (see Appendix, (V)).

(43) ‘a thinks p’ is true in w if

\[ \text{DOX}_{a,w} \cap \{w': \text{PRESUP}(p) \text{ is true in } w'\} \neq \emptyset \text{ and } \text{DOX}_{a,w} \subseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\}; \]

‘a thinks p’ is false in w if

\[ \text{DOX}_{a,w} \cap \{w': \text{PRESUP}(p) \text{ is true in } w'\} \neq \emptyset \text{ and } \text{DOX}_{a,w} \nsubseteq \{w': \text{ASSERT}(p) \text{ is true in } w'\}; \]

otherwise, ‘a thinks p’ is neither true nor false in w.

Both the ‘old’ and ‘new’ analyses of think assign the same meaning to My parents think that I am in bed, where the embedded clause presupposes nothing (more accurately, it presupposes that Mary exists, but we may ignore this presupposition for simplicity). This means that \{w': \text{PRESUP}(I am in bed) \text{ is true in } w'\} is W, the set of all possible worlds, so the presupposition of My parents think that I am in bed is trivially satisfied (assuming that every individual has some beliefs).

(44) Mary: My parents think that I am in bed.

\[ \text{DOX}_{\text{Mary's-parents},w} \cap W \neq \emptyset \text{ and } \text{DOX}_{\text{Mary's-parents},w} \subseteq \{w': \text{Mary is in bed in } w'\} \]

But the ‘new’ analysis of think provides a new meaning to My parents think that I am in bed too, where the embedded clause comes with a presupposition. Since \text{ASSERT}(I \text{ am in bed too}) = \text{ASSERT}(I \text{ am in bed}) (= ‘Mary is in bed’), the presupposition of I am in bed too is evaluated independently of its assertion (see Appendix, (II)).

(45) Mary: My parents think that I am in bed too.

\[ \text{DOX}_{\text{Mary's-parents},w} \cap \{w': \text{John is in bed in } w'\} \neq \emptyset \text{ and } \text{DOX}_{\text{Mary's-parents},w} \subseteq \{w': \text{Mary is in bed in } w'\} \]

When DOX is a subset of \{w': John is in bed in w'\}, the new analysis gives us the same meaning as the old analysis. However, when DOX is not a subset of \{w': John is in bed in w'\}, Mary’s parents are agnostic about whether John is in bed.

(46) \[ \text{DOX}_{\text{Mary's-parents},w} \cap \{w': \text{John is in bed in } w'\} \neq \emptyset \text{ and } \text{DOX}_{\text{Mary's-parents},w} \cap \{w': \text{John is in bed in } w'\} \]

\[ \neq \emptyset \text{ and } \text{DOX}_{\text{Mary's-parents},w} \cap \{w': \text{John is in bed in } w'\} \]
John is not in bed in \( w' \) \( \neq \emptyset \).

Let us now go through the additional observations described in Section 1.2.

2. Further Consequences

2.1. Predicting the Behavior of Similar Triggers

Recall that *even* and *again* exhibit the same behavior as *too*, as shown in (16) and (17), and in (47) and (48).

\[(47) \quad \text{John: I am in bed, it’s unlikely that you are, but your parents don’t know either of these things.} \]
\[
\text{Mary: My parents think that even I am in bed.} 
\]

\[(48) \quad \text{John: I watered the plant an hour ago, and your parents don’t know this.} \]
\[
\text{Mary: My parents think that I watered it again ten minutes ago.} 
\]

This is now predicted by (49) and (50): The assertion of a sentence with *even* and *again* is identical to the assertion of the same sentence without *even/again*, just like the assertion of a sentence with *too* is identical to the assertion of the same sentence without *too*.

\[(49) \quad \text{ASSERT(} \text{even I am in bed} \text{) = ASSERT(} \text{I am in bed} \text{) = ‘Mary is in bed’.} \]
\[(50) \quad \text{ASSERT(} \text{I watered the plant again} \text{) = ASSERT(} \text{I watered the plant} \text{) = ‘Mary watered the plant’.} \]

When the sentence appears embedded, the presuppositions of *even* and *again* need to be satisfied only in a subset of DOX. Therefore, we do not expect *even* and *again* to behave any differently from *too*.

2.2. Predicting the Behavior of Other Triggers

What makes *too*, *even* and *again* a natural class is the fact that their presupposition can be completely “divorced” from their assertion. That is to say, Mary’s being in bed (the assertion of *I am in bed too*, when uttered by Mary) is completely independent of John’s being in bed (the presupposition of *I am in bed too*). But not all presupposition triggers have this property; in particular, the definite article does not. The assertion of *The murderer was caught* is not the same as that of *Some*
murderer was caught. Rather, the presupposition and assertion of The murderer was caught are not independent of each other (see Appendix, (II)).

(51)  

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>a.</td>
<td>ASSERT(The murderer was caught) = ‘There is exactly one murderer and that murderer was caught’.</td>
</tr>
<tr>
<td>b.</td>
<td>PRESUP(The murderer was caught) = ‘There is exactly one murderer’.</td>
</tr>
</tbody>
</table>

The same holds of The police caught the murderer. Therefore in (20) above, and in (52), Mary’s first response is infelicitous when her parents don’t know how many murderers were involved: some worlds in DOX contain two murderers, making it impossible for ASSERT(The police caught the murderer) to be true throughout DOX.

(52) John: A murder was committed, and the police immediately caught the murderer.  
    Mary: #My parents were right, then; they said the police caught the murderer.

A similar effect is observed with stop. Its assertion and presupposition cannot be “divorced” from each other.

(53)  

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>a.</td>
<td>ASSERT(you stopped smoking) = ‘John has undergone a change of state from his past existing SMOKING state to a NON-SMOKING state’</td>
</tr>
<tr>
<td>b.</td>
<td>PRESUP(you stopped smoking) = ‘John has a past existing SMOKING state’</td>
</tr>
</tbody>
</table>

In the context described in (21) above, and in (54), the parents are agnostic about PRESUP(you stopped smoking). Therefore, ASSERT(you stopped smoking) is false in some worlds in DOX, contradicting what is required for My parents think you stopped smoking to be true.

(54) John: Up until two weeks ago, I used to smoke.  
    Mary: #My parents are right, then; they think you stopped smoking two weeks ago.

2.3. Predicting that the Subject’s Perspective Cannot be Completely Ignored

Recall (22) and (25), repeated in (55) and (56), where Mary’s response to John is odd.
(55) John: I am in bed, but your parents think I’m not.
Mary: #Right, and they think that I am in bed too.

(56) John: I got the job, but your parents don’t know it.
Mary: #My parents think that I got the job too.

The oddity in (55) is now predicted, because there is no (nonempty) subset of DOX where John is in bed. The oddity in (56) is also predicted: it is plausible to assume that the use of the definite article – in the job – triggers the presupposition that there is only one job, and therefore only one person can have said job. Therefore, we get the following assertion and presupposition.

(57) ASSERT(I got the job too) = ASSERT(I got the job) = ‘Mary got the job’
PRESUP(I got the job too) = ‘John got the job and only one person gets the job’

The assertion and presupposition contradict each other, with the following result.

(58) a. DOX_{Mary’s-parents,w} ⊆ \{w’: Mary got the job in w’\}.
b. \{w’: John got the job in w’ and only one person gets the job in w’\} ∩ DOX_{Mary’s-parents,w} = \emptyset.

This is not allowed by (43).

2.4. Predicting Absence of Exceptional Projection in Conditionals

Recall the contrast in (27) and in (28), repeated below as (59) and (60): (i) does not imply that Mary is overweight (in a context where the elevator normally fits one person only); (ii) does.

(59) A: John is in the elevator.
   (i) B: Right, and if Mary were in the elevator too, the weight limit would be exceeded.
   (ii) B: Right, and if Mary were in the elevator(, alone or not), the weight limit would be exceeded.

(60) A: Is John in the elevator?
(i)  B:  (#) I don’t know, but if Mary were in the elevator too, the weight limit would be exceeded.

(ii) B:  I don’t know, but if Mary were in the elevator (alone or not), the weight limit would be exceeded.

This can be predicted, assuming a meaning of conditionals as in (61) (cf. Heim 1992). Accordingly, the if-clause serves as an argument of the Sim-operator (defined in (62)), whose domain is determined by the presuppositions of the embedded sentence.

(61)  ‘if p then q’ is true in w if:

\[ \text{Sim}_{w,\{w: \text{PRESUP}(p) \text{ is true in } w\}} \subseteq \{w': \text{ASSERT}(q) \text{ is true in } w'\} \]

‘if p then q’ is false in w if:

\[ \text{Sim}_{w,\{w: \text{PRESUP}(p) \text{ is true in } w\}} \nsubseteq \{w': \text{ASSERT}(q) \text{ is true in } w'\} \]

otherwise,….

(62)  For any set S, Sim_{w,S}(p) is the set of p-worlds in S most similar to w (where ‘similarity’ is determined by the context).

What comes after “otherwise” in (61) is a controversial issue. But crucially, If Mary were in the elevator too, the weight limit would be exceeded ((64)) does not entail If Mary were in the elevator, the weight limit would be exceeded ((63)).

(63)  If Mary were in the elevator, the weight limit would be exceeded.

\[ \text{Sim}_{w,\{w: \text{Mary is in the elevator in } w'\}} \subseteq \{w': \text{the weight limit is exceeded in } w'\} \]

(64)  If Mary were in the elevator too, the weight limit would be exceeded.

\[ \text{Sim}_{w,\{w: \text{John is in the elevator in } w'\}} \subseteq \{w': \text{the weight limit is exceeded in } w'\} \]

Suppose the similarity relation favors worlds that are faithful to Mary’s actual weight, the actual weight limit, the actual small size of the elevator, and the actual laws of physics. Sim_{w,\{w: \text{Mary is in the elevator in } w'\}} (a set of worlds where Mary is in the elevator and weighs what she actually weighs) may contain worlds where John is
not in the elevator, but Sim_{w',\{w: John is in the elevator in w}\}}(\{w': Mary is in the elevator in w'\}) (a set of worlds where John and Mary are in the elevator and Mary weighs what she actually weighs) may not. If Mary doesn’t weigh much, her being alone in the elevator need not cause a weight limit violation, even when her being there together with John does cause that.

To sum up, according to our proposal not all sentence-embedding predicates allow exceptional projection, and the reason for this is that different predicates impose different requirements on the presuppositions of the embedded sentence.

2.5. Predicting the Factivity Implication

Recall the exchange in (31), repeated in (65), where Mary’s response is odd.

(65) John: I am not in bed, I’m watching TV; but your parents don’t know whether I’m in bed or watching TV.
Mary: #Right, and they think that I am in bed too.

Given the robustness of this judgment, it seems to us that the explanation should be semantic. That is to say, whatever constraints lead to this judgment, it seems that they cannot be lifted. Unfortunately, at this point we have only a pragmatic explanation, which is unsatisfactory in the sense that it leads us to expect Mary’s response in (65) to be felicitous in some contexts.

Recall Heim’s suggestion to analyze My parents think that I am in bed too as ‘de re’ ascription of some sort. In section II, we rejected this solution because it failed to make more basic predictions (for example, it failed to predict that not all presupposition triggers exhibit exceptional projection). We now explore the possibility of combining this suggestion with the idea that only a subset of DOX need satisfy the presupposition of I am in bed too.

Let us analyze My parents think that I am in bed too as a belief about Mary and John, using a version of (38) (where Mary’s parents use one description – H1 – for John and another – H2 – for Mary) that imposes the following requirement (see Appendix, (VI)): (a) the presuppositions of the embedded sentence are required to be true in a subset of DOX (just like they are in (43)), and (b) that subset is required to be the biggest subset of DOX where H1 – the description involved in the presupposition of the embedded sentence – has a value. We get the meaning in (66).
(66) ‘Mary’s parents think <John, Mary, <‘be in bed’, ‘be in bed too’>>’ is true in w if (a)-(d) hold and $\text{DOX}_{\text{Mary’s parents},w} \subseteq \{w': H2(w') \text{ is in bed in } w'\}$, ‘Mary’s parents think <John, Mary, <‘be in bed’, ‘be in bed too’>>’ is false in w if (a)-(d) hold and $\text{DOX}_{\text{Mary’s parents},w} \not\subseteq \{w': H2(w') \text{ is in bed in } w'\}$, otherwise, ‘Mary’s parents think <John, Mary, <‘be in bed’, ‘be in bed too’>>’ is neither true nor false in w.

   (a) $H1(w) = \text{John},$
   (b) $H2(w) = \text{Mary},$
   (c) $\text{DOX}_{\text{Mary’s parents},w} \cap \{w': H1(w') \text{ is in bed in } w'\} \neq \emptyset,$
   (d) $\text{DOX}_{\text{Mary’s parents},w} \cap \{w': H1(w') \text{ is in bed in } w'\}$ is the biggest subset $S$ of $\text{DOX}_{\text{Mary’s parents},w}$ such that $H1$ has a value in $S.$

The biggest subset of $\text{DOX}$ where $H1$ has a value is also the biggest subset of $\text{DOX}$ where $H1(w')$ is in bed, for all relevant $w'$ (in other words, for every $w'$ in $\text{DOX}$, $H1(w')$ is defined if and only if $H1(w')$ is in bed in $w'$). Suppose that subset is a proper subset of $\text{DOX};$ that is to say, suppose there are worlds in $\text{DOX}$ where $H1$ has no value. This makes the following function salient, and a plausible choice as the value of $H1$: “the function that maps every world $w$ in its domain to the unique individual $z$ such that $z$ is not Mary, $z$ is in bed in $w$ and Mary’s parents hear in $w$ the squeaky noise that $z$ makes” (in fact, it makes any function of the following general form salient: “the function that maps every world $w$ in its domain to the unique individual $z$ such that $z$ is not Mary, $z$ is in bed in $w$ and Mary’s parents come into cognitive contact in $w$ with $z$”). Such a function is salient because it does not have a value in some worlds of $\text{DOX}$ – namely, those worlds in $\text{DOX}$ where only Mary is in bed (and automatically yields the result that the presuppositions of the embedded clause are satisfied only in a proper subset of $\text{DOX}$). If speakers are biased to choose this function as the value of $H1$, it follows that $H1$ yields John in the actual world, as the unique individual $z$ such that Mary’s parents hear the squeaky noise that $z$ makes in the actual world and $z$ is in bed in the actual world. No such bias arises with regards to Mary, because $H2$, which picks out Mary in the actual world, has a value throughout $\text{DOX}$. Likewise, no such bias arises when the biggest subset of $\text{DOX}$ where $H1$ has a value is $\text{DOX}$ itself.

As already noted, this analysis does not guarantee the factivity implication (because it does not guarantee that the value for $H1$ is fixed in the way described above). To our knowledge the only solution that guarantees the factivity implication is Geurts & van der Sandt (2004), but as we saw in Section II, the very same assumption
that predicts the factivity implication, within that theory, also predicts *too* to have exceptional projection in counterfactual conditionals, contrary to fact.

**IV. Concluding Remarks**

We have presented an analysis of the unexpected presupposition projection of items such as *too* and *even*, as observed by Heim (1992) and others, according to which there is nothing “unexpected” about it: according to the current proposal, how presuppositions project is determined by (i) whether they can be “divorced” from the assertion; and (ii) the lexical properties of the embedding predicate. This correctly predicts that not all items project their presuppositions “unexpectedly”, and that not all embedding environments allow such “unexpected” projection.

**Appendix**

The definitions of the lexical items and terms given in the text are meant to be informal; as such, the boundaries between object- and meta-language are often blurred in them. In (I)-(VI) below we provide more formal alternatives to some of these definitions.

Some general remarks regarding (I)-(VI): We assume the definition of interpretation function, \[ \ll \] (which applies to elements of the object language), from Heim and Kratzer (1998). We also use the following conventions regarding the meta-language: (i) \( D_w \) is the set of all possible worlds, (ii) \( D_i \) is the set of all possible individuals, (iii) \( D_t \) is the set of truth values – \{True, False\}, and (iv) for any types a and b, \( D_{<a,b>} \) is the set of functions from \( D_a \) to \( D_b \). Finally, following the convention in Heim and Kratzer (1998), we take \( \lambda u: \alpha. \beta \) to stand for either (a) or (b), whichever is appropriate:

(a) the smallest function that maps every u such that \( \alpha \) to \( \beta \);
(b) the smallest function that maps every u such that \( \alpha \) to True, if \( \beta \), and to
False otherwise.

(The non-contingent constraints in $\alpha$ restrict the type of $u$; the contingent constraints are, in effect, presuppositions.)

(I) For any $y \in D_e$, any variable assignment $g$ such that $g(j) \neq y$ and any $P \in D_{\alpha, \langle s, p \rangle}$, 

$[[\text{too}]](y)(P) :=$

$[\lambda w: \begin{align*}
&\text{(a) } w \in D_s, \text{ and} \\
&\text{(b) } P(g(j))(w) = \text{True}.
\end{align*}]$

$P(y)(w) = \text{True} \]

(See Rooth 1992 for a compositional theory that accounts for the interaction of focus with the meaning of too.)

(II) For any $p \in D_{\alpha, \langle s, p \rangle}$,

(a) $\text{PRESUP}(p) := [\lambda w: w \in D_s, w \in \text{Dom}(p)]$; and

(b) $\text{ASSERT}(p)$ is the biggest $q \in D_{\alpha, \langle s, p \rangle}$ (i.e., the $q$ with the biggest domain) such that:

A. $\text{Dom}(q) \supseteq \text{Dom}(p)$, and

B. $p = [\lambda w: w \in \text{Dom}(p). q(w) = \text{True}]$.

(i)-(iii) illustrate how this definition works, assuming that Mary and John exist in all possible worlds, Mary is the referent of $I$ and John is the only other relevant individual.

(i) $\text{PRESUP}([[I \text{ am in bed}]])) = \text{PRESUP}([\lambda w: w \in D_e. \text{ Mary is in bed in } w]) = [\lambda w: w \in D_s, \text{ True}]

\text{ASSERT}([[I \text{ am in bed}]])) = \text{ASSERT}([\lambda w: w \in D_e. \text{ Mary is in bed in } w]) = [\lambda w: w \in D_s, \text{ Mary is in bed in } w]

(ii) $\text{PRESUP}([[I \text{ am in bed too}]])) = \text{PRESUP}([\lambda w: w \in D_e, \text{ and John is in bed in } w. \text{ Mary is in bed in } w]) = [\lambda w: w \in D_e. \text{ John is in bed in } w]$
\[
\text{ASSERT}(\llbracket \text{I am in bed too} \rrbracket) = \text{ASSERT}(\llbracket \lambda w: w \in D_s \text{ and John is in bed in } w. \text{ Mary is in bed in } w \rrbracket) = \llbracket \lambda w: w \in D_c. \text{ Mary is in bed in } w \rrbracket
\]

(iii) \text{PRESUP}(\llbracket \text{the murderer was caught} \rrbracket) = \text{PRESUP}(\llbracket \lambda w: w \in D_s \text{ and there is exactly one murderer in } w. \text{ there is exactly one murderer in } w \text{ and that murderer was caught in } w \rrbracket) = \llbracket \lambda w: w \in D_c. \text{ there is exactly one murderer in } w \text{ and that murderer was caught in } w \rrbracket

\text{PRESUP}(\llbracket \text{the murderer was caught} \rrbracket) = \text{PRESUP}(\llbracket \lambda w: w \in D_s \text{ and there is exactly one murderer in } w. \text{ there is exactly one murderer in } w \text{ and that murderer was caught in } w \rrbracket) = \llbracket \lambda w: w \in D_c. \text{ there is exactly one murderer in } w \text{ and that murderer was caught in } w \rrbracket

(III) The formal version of (10) given in (i) adds a presupposition that is missing from (10) (namely, (c) in (i); see Bartsch 1973 and Heim 2000) and accounts for the fact that \textit{think}, as opposed to \textit{know}, is “Neg-Raising”, as shown in (ii).

(i) For any \( p \in D_{\langle s,t \rangle} \) and \( x \in D_e \), \( \llbracket \text{think} \rrbracket(p)(x) := \llbracket \lambda w: (a) w \in D_s, (b) \text{DOX}_{x,w} \subseteq \{w' \in D_s: \text{PRESUP}(p)(w') = \text{True} \}, \text{ and } (c) \text{DOX}_{x,w} \subseteq \{w' \in D_s: \text{ASSERT}(p)(w') = \text{True} \} \text{ or } \text{DOX}_{x,w} \subseteq \{w' \in D_s: \text{ASSERT}(p)(w') = \text{False} \} \rrbracket \)

(ii) a. John doesn’t think that Mary left.

\[ \implies \text{John thinks that Mary didn’t leave.} \]

b. John doesn’t know that Mary left.

\[ \equiv \implies \text{John knows that Mary didn’t leave.} \]

(IV) For any structured proposition \( <y, P> \) (where \( y \in D_c \) and \( P \in D_{\langle e, \langle s,t, P \rangle \rangle} \)) and any \( x \in D_e \), \( \llbracket \text{think} \rrbracket(<y, P>)(x) := \llbracket \lambda w: (a) w \in D_s, (b) c \text{ supplies an individual concept, } F_c, \text{ such that } F_c(w) = y, (c) \text{DOX}_{x,w} \subseteq \{w' \in D_s: \text{PRESUP}(P(F_c(w')))(w') \}, \text{ and } \rrbracket \)
(d) \( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(P(F_c(w')))(w') = \text{True} \} \) or
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(P(F_c(w')))(w') = \text{False} \} \).
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(P(F_c(w')))(w') = \text{True} \} \)
(see (III))

(V) For any \( p \in D_{<s,s>} \) and \( x \in D_{e} \), \([\text{think}]p(x) := \)
\[ \{ w \in D_{e} : \] (a) \( w \in D_{e} \),
(b) \( \{ w' \in D_x : \text{PRESUP}(p)(w') = \text{True} \} \cap \text{DOX}_{x,w} \neq \emptyset \), and
(c) \( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(p)(w') = \text{True} \} \) or
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(p)(w') = \text{False} \} \).
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(p)(w') = \text{True} \} \)
(see (III))

(VI) For any \( <z, y, Q> \) (such that \( z, y \in D_x \) and \( Q \in D_{<s,s,<<s,>,>,>,>} \)) and \( x \in D_{e} \),
\([\text{think}]<(z, y, Q)>(x) := \)
\[ \{ w \in D_{e} : \] (a) \( w \in D_{e} \),
(b) \( c \) supplies two individual concepts, \( F_1 \) and \( F_2 \), such that \( F_1(c)(w) = z \) and \( F_2(c)(w) = y \),
(c) \( \text{DOX}_{x,w} \cap \{ w' \in D_x : \text{PRESUP}(Q(F_1(c)(w'))(F_2(c)(w')))(w') = \text{True} \} \neq \emptyset \),
(d) \( \text{DOX}_{x,w} \cap \{ w' \in D_x : \text{PRESUP}(Q(F_1(c)(w'))(F_2(c)(w')))(w') = \text{True} \} \) is the
biggest subset of \( \text{DOX}_{x,w} \) where \( F_1 \) and \( F_2 \) have a value, and
(e) \( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(Q(F_1(c)(w'))(F_2(c)(w')))(w') = \text{True} \} \) or
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(Q(F_1(c)(w'))(F_2(c)(w')))(w') = \text{False} \} \).
\( \text{DOX}_{x,w} \subseteq \{ w' \in D_x : \text{ASSERT}(Q(F_1(c)(w'))(F_2(c)(w')))(w') = \text{True} \} \)
(see (III))

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