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Presuppositions as Inducing Various Scope Readings

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0. Introduction

It has been observed that global accommodation of presuppositions is preferred unless they are entailed by the local context, or, in terms of van der Sandt (1992), are bound by their antecedents, but no one has explained why. By global accommodation, I mean accommodating triggered presuppositions to the main context, not accommodating presuppositions calculated from the local accommodation of triggered presuppositions. In this paper, I will propose an analysis of presupposition projection that derives this fact. My analysis does not rely on the notion of contextual satisfaction or on accommodation.

I take the meaning of a sentence to be structured into an assertive part and a presuppositional part. In the process of compositional interpretation, presuppositions get incorporated into the assertive part. I will call the locus of that incorporation the 'scope' of the presuppositions. I then show that the various scope readings form a partial order in terms of informativeness with the wide scope readings being more informative than the narrow scope readings. In this analysis so-called global accommodation corresponds to projecting a triggered presupposition so that it can have the widest scope without being canceled/suspended. I claim that the preference for global accommodation is due to Horn's R-based inference.

1. Problems with presupposition projection in Karttunen-type theories

In Karttunen-type theories of presupposition projection (Karttunen 1974, Karttunen & Peters 1979, Heim 1983, Beaver 1992), only what is minimally required to make sentences interpretable is presupposed. Presuppositions are projected in accordance with the requirement that a local context has to satisfy the presuppositions that arise in a constituent which is going to be interpreted relative to the context. The theories predict the following two presupposition projection rules among others:

(1) \( \sigma + \neg [\text{not } A] \) is defined only if \( \sigma + P_A = \sigma \) (not A' presupposes \( P_A \))
(2) \( \sigma + [\text{If } A, B] \) is defined only if \( \sigma + P_A = \sigma \) and \( (\sigma + [A]) + P_B = \sigma + [A] \)
(\'If A, B' presupposes \( P_A \) & \( [A] \rightarrow P_B \))

* I am grateful to Manfred Krifka and Cleo Condoravdi for corrections of errors, comments, and suggestions on earlier drafts. For discussion of data, I thank Ralph Blight, Michelle Moosally, Mary Shapiro, and other linguists in the department. All remaining errors in judgments and arguments are mine.
In these rules, $\sigma$ stands for a context, and $[A]$ and $[B]$ are CCPs. $P_A$ and $P_B$ are presuppositions triggered in $A$ and $B$ respectively. Thus, rule (1) says that when a context is updated with a negative sentence 'not $A$', the presupposition triggered in $A$ has to be satisfied by the main context. Similarly, when a context is updated with a conditional sentence 'if $A$, $B$' as in (2), the context has to satisfy $P_A$ and the context updated with $[A]$ has to satisfy $P_B$. This has the effect that the whole sentence presupposes that $P_A$, and that $[A] \rightarrow P_B$.

As van der Sandt (1993), among others, has pointed out, these predictions are not quite right in two respects. First, they predict presuppositions which are too weak. Consider the conditional sentences in (3a) and (4a).

(3) a. If baldness is hereditary, John's children are bald.
b. If baldness is hereditary, John has children.
c. John has children.

(4) a. If John has grandchildren, his children must be happy.
b. If John has grandchildren, he has children.
c. John has children.

(3a) is predicted to presuppose (3b) according to (2), but this presupposition is intuitively odd and unlikely. (3a) seems to presuppose (3c) instead. Similarly, (4a) is predicted to presuppose (4b). Even though (4b) is not odd, we prefer a reading where instead (4c) is projected. (4a) cannot be followed by the statement like "He doesn't have children."

To resolve this problem, Beaver (1992) proposed to exclude incoming contexts which allow odd presuppositions. He discussed this problem in terms of epistemic alternatives, which represent hearers' possible knowledge states. We can, however, discuss his proposal without including the idea of epistemic alternatives. What he tried to say can be explicated as follows: in the table below we divided possible worlds into four groups, say $W_1$, $W_2$, $W_3$, and $W_4$, according to the propositions in (3).

<table>
<thead>
<tr>
<th></th>
<th>$W_1$</th>
<th>$W_2$</th>
<th>$W_3$</th>
<th>$W_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$ &lt;br&gt; $B$</td>
<td>0 &lt;br&gt; 0</td>
<td>0 &lt;br&gt; 1</td>
<td>0 &lt;br&gt; 1</td>
<td>1 &lt;br&gt; 1</td>
</tr>
</tbody>
</table>

What makes the odd presupposition (3b) possible is the existence of the worlds belonging to $W_1$ and $W_2$. When these worlds are eliminated, the remaining possible worlds are those in $W_3 \cup W_4$. This amounts to updating the original context with the stronger presupposition (3c). Eliminating the worlds in $W_1$ and $W_2$ will result in the exclusion of the weak and odd presupposition. Beaver's proposal does not solve the problem completely, however. First, how can he show in a formal way that some presuppositions are odd, while others are not? If this cannot be determined, we do not know whether or not we have to use the strategy. Second, if weak presuppositions are not odd, is there any motivation for trying to find the preferred stronger readings? (4) is a good example of this

---

1 I use A, B as representing clauses, and $[A]$, $[B]$, $P_A$, and $P_B$ as representing propositions or CCPs for convenience, unless otherwise specified. I believe that the distinctions can be made by the contexts wherein they are used.
2 In this paper I generally assume that contexts are sets of possible worlds. Only in the discussion of Dynamic Predicate Logic, are they represented as sets of pairs of possible worlds and variable assignments.
3 I do not mean that epistemic alternatives are not necessary. See Beaver (1992) for the claim of their independence/sufficiency.
4 There can be more groups of possible worlds, but these are not relevant.
case. In Karttunen-type theories, motivations for finding preferred readings, which are generally generated from global accommodation, are excluded from the beginning.

Second, Karttunen-type theories predict presuppositions which are too strong despite efforts to minimize the repair of contexts by accommodation. The verb realize is regarded as presupposing its complement, as shown in (6a). Thus, sentence (6b) is predicted to presuppose the complement clause of the verb, but that is not the case. (7) also shows that negation is not necessarily a hole in the sense of Karttunen (1973).

(6) a. I realized later that I did not tell the truth.
    b. If I realize later that I have not told the truth, I will confess it to everyone.

(7) a. John does not regret leaving Mary.
    b. John does not regret leaving Mary, since he never left her.

(7a) presupposes that John left Mary, but the first clause in (7b) cannot presuppose it since it is overtly negated in the following clause.5

To handle the defeasibility of presuppositions, Beaver (1992) proposed Defeasible Update Logic, in which a presupposition updates the context like an assertion and at the same time changes the default ordering so that worlds where the presupposition holds are at least as plausible as worlds where it doesn't. According to this logic, sentence (7b) is explained as in (8).

(8) a. \[ A \quad W1 \quad W2 \quad W3 \quad W4 \]
    \[ A \quad 0 \quad 1 \quad 0 \quad 1 \]
    P_A \quad 0 \quad 0 \quad 1 \quad 1
    A: John regretted leaving Mary
    P_A: John left Mary

b. \[ \sigma + \neg (P_A \& A) = W1 \cup W2 \cup W3 = \sigma_1 \]

c. \[ \sigma_1 + \neg P_A = W1 \cup W2 \]

In (8a), all possible worlds are grouped into four, according to whether they verify A and P_A.6 The context is updated with the first clause in (7b), as shown in (8b). Note that the presupposition is interpreted within the scope of the negation, together with the assertion. This gives rise to \( \sigma_1 \). In this analysis, P_A makes the worlds in W3 at least as plausible as other possible worlds in \( \sigma_1 \). From this change of the default ordering between possible worlds, we infer that P_A holds in the current context unless otherwise indicated. Now we come across the second clause in (7b), and eliminate the possible worlds in W3 from \( \sigma_1 \), as shown in (8c). The default ordering between the possible worlds, which has been established by P_A, is nullified, and it has the effect of canceling the presupposition P_A. In this logic, however, presuppositions are not based on the satisfaction requirement on contexts any more. Resorting only to the satisfaction requirement is not enough for capturing the projection behavior of presuppositions.

2. Sentences as sets of context change potentials

Now we know that presupposition projections cannot be captured by the strict satisfaction condition. This is because presuppositions are interpreted with various scopes with respect to operators. This is confirmed by the examples from (9) to (11). Suppose that there is a party, and that if a married woman comes to the party, she is supposed to be

5Horn (1985) regards this as metalinguistic negation, but I am not sure if it can be extended to (6b). In my analysis, both show similar effects due to their monotonicity.

6In (8) W2 must be excluded since it is unimaginable to regret something which has not happened.
accompanied by her husband. In this situation, the definite descriptions in (9-11) show various scopes.

(9) If John did not meet her husband at the party, Mary is not married.

(10) If John did not meet her husband at the party, he was at a tavern. He is a drunkard.

(11) If John did not meet her husband at the party, he may have been at home. However, it is also possible that Mary is not married at all.

In (9), the definite description has narrower scope than negation. In (10), it has the widest scope (over the negation), which makes it an available antecedent for a pronoun. (11) shows that it has scope over negation, but narrower scope than the possibility operator expressed by may. The possibility operator is generally regarded as a hole, and it seems to behave like a hole in the first sentence. Interestingly, however, the second sentence suspends the presupposition.

Even though presuppositions allow various scope readings, the most preferred readings are always ones in which they have the widest scope, unless they are canceled/suspended by the context. I am going to claim that the motivation for preferring a so-called global accommodation comes from its high informativeness. For the comparison of alternative readings in terms of informativeness, we need to derive all the readings. So I assume that the meaning of a sentence is a set of CCPs, each of which represents one of the various scope readings. The rest of this section will deal with how to derive a set of CCPs compositionally.

The procedure for deriving a set of CCPs is roughly illustrated in (12). The structure in (12) has two operators, OP1 and OP2. I assume that a and b are associated with two presuppositions, PA and PB, respectively.

(12) \[(4)\{<\text{OP2}[B \& \text{OP1}[A]], \{P_A, P_B\}>, <\text{OP2}[B \& \text{OP1}[P_A \& A]], \{P_B\}>, \]
\[\quad \quad \quad \quad \quad \quad \text{OP2} \]
\[\quad \quad \quad \quad \quad \quad \quad \quad \quad \text{OP1} \]
\[\quad \quad \quad \quad \quad \quad \quad \quad \quad \text{A} \]

Node (4) has six readings, since the presupposition PA has three possible scopes with respect to two operators and the presupposition PB has two possible scopes with respect to OP2. The combination of these different scopes makes six possible readings.

The set of readings is derived compositionally as follows. To begin with, the meaning of CCP is a pair of a "principal" and an assertion part and a presupposition
part. Node (1) has a pair of an assertion and a presupposition part in which the presupposition part has the form of a set. B is interpreted in the same way. When node (1) combines with OP1, every subset of the presupposition part is incorporated into the assertion part, with its complement remaining in the presupposition part. Node (1) has only one presupposition. Thus, PA is optionally incorporated into the assertion part. This generates two readings. At node (3), the assertion part of B is processed in the assertion part of the two readings, and the presupposition PB is collected in the presupposition part in each of the two readings. The resulting readings are combined with OP2 at node (4), where for each of the two readings, every subset of the presupposition part is incorporated into the assertion part, with its complement remaining in the presupposition part. The number of readings expands to the number of the power set of the presupposition part. One of the two readings at node (3) has two presuppositions, and so the number of readings expands to four. The other reading has one presupposition, and so two readings are generated from that. Each reading at node (4) has the form of a pair of an assertion and a set of presuppositions.

The procedure for deriving a set of possible readings in (12) is rather simplified, but it gives a general idea of how the set is compositionally derived. The rules for Dynamic Predicate Logic are introduced at (13), which are actually used to derive the set of various readings compositionally in Dynamic Predicate Logic.

(13) Rules for Dynamic Predicate Logic

i) \[ [R(x_1,\ldots,x_n)] = \{<\lambda \sigma (\forall f e \sigma) f(x_1), \ldots f(x_n) > \in R_{\sigma}, \{\} > \}
\]
if \( x_1,\ldots,x_n \subseteq V_{\sigma} \) else \( (w e \sigma) f(x_1), \ldots f(x_n) > \in R_{\sigma} \) undefined

ii) \[ ([\neg \phi)] = \{<\lambda \sigma. \exists z e x(w e \sigma) \neg \exists g, g f, w e S_{0}(z(\sigma)), S_1 \supset X > | S \subseteq [\phi], X = (\lambda \sigma. \sigma) \} or \emptyset = X \subseteq S_1 \}
\]
if \( x e V_{\sigma} \) else \( S_{0}(w e \sigma) \exists g, g f, w e \sigma > \) undefined

iii) \[ ([\exists x \phi)] = \{<\lambda \sigma. \exists z e x(S_0(z(\forall w e \sigma) \exists g, g f, w e \sigma)), S_1 \supset X > | S \subseteq [\phi], X = (\lambda \sigma. \sigma) \} or \emptyset \subseteq X \subseteq S_1 \}
\]
if \( x e V_{\sigma} \) else \( S_{0}(w e \sigma) \exists g, g f, w e \sigma > \) undefined

iv) \[ ([\phi \land \psi])] = \{<\lambda \sigma. \exists z e x(\lambda \sigma. S_{0}(z(\phi))), S_1 \supset T_1 \supset X > | S \subseteq [\psi], T \subseteq [\phi], X = (\lambda \sigma. \sigma) \} or \emptyset \subseteq X \subseteq S_1 \}
\]
v) \[ ([\phi \rightarrow \psi)] = \{<\lambda \sigma. \exists z e x(\lambda \sigma. \sigma), S_1 \supset X > | S \subseteq [\psi], X = (\lambda \sigma. \sigma) \} or \emptyset \subseteq X \subseteq S_1 \}
\]
vii) \[ ([\neg \phi)] = \{<\lambda \sigma. \exists z e x(\lambda \sigma. \sigma), S_1 \supset X > | S \subseteq [\psi], X = (\lambda \sigma. \sigma) \} or \emptyset \subseteq X \subseteq S_1 \}
\]

Rule i) shows that atomic formulae, which have empty presupposition parts, do not expand readings. Rule ii) is a rule for the negation operator. In this rule S is one member in [\phi], and it has a form of a pair <S_0, S_1>. S_0 is the CCP of the assertion part and S_1 is a set of CCPs corresponding to triggered presuppositions. The rule says that every subset of S_1 is incorporated in the assertion part with its complement remaining as a presupposition set. By doing this, this rule expands the number of readings. Rule (iii) does not expand the number of readings even though presuppositions have different scopes with respect to the existential quantifier. Whether or not an accommodated presupposition has scope over the existential quantifier does not make any difference in its informativeness. The only relevance of this rule is whether variables in presuppositions get bound by the quantifier. The operator in rule iv) is responsible for collecting presuppositions in the presupposition part.\footnote{I think this can or cannot be dispensed with depending on how presuppositions are collected in the presupposition part when a presupposition is embedded in another. If they are collected separately, which is the way the rules are actually formulated, we need the operator. On the other hand, if they are collected as one presupposition which has an embedding structure, we do not need the operator, instead we need a rule for incorporating variables in presuppositions.}
When a free variable is allowed, (14a) is allowed to have a wrong reading. In
(14a), if the presupposition triggered by his bicycle is accommodated before a boy is
interpreted, the variable $x$, which corresponds to the pronoun his, is free, and it will have
the reading which is represented roughly as in (14b).

\[
\begin{align*}
(14) & \quad a. \quad \text{A boy is riding his bicycle.} \\
& \quad \exists x [\text{boy}(x) \land \exists y [\text{bicycle}(y) \land \text{own}(x, y)] \land \text{ride}(x, y)] \\
& \quad b. \quad *\exists y [\text{bicycle}(y) \land \text{own}(x, y)] \land \exists x [\text{boy}(x) \land \text{ride}(x, y)]
\end{align*}
\]

This is prevented by the definedness conditions in (13i) and (13iii).

The readings we have derived so far are only possible readings. There is a
condition for them to be admissible readings. Repeating the same information or making a
contradictory statement has to be excluded. This is what the Correctness Condition states

**Correctness Condition (CC):**

An assertion is correct if

it is i) informative, and ii) not contradictory.

\[(15) \quad \text{Correctness Condition (CC):} \quad \text{An assertion is correct iff}
\]

\[
\text{it is i) informative, and ii) not contradictory.}
\]

\[(16) \quad \text{If } \lambda F (\{\alpha, \beta, \ldots\} \mid (\ldots, \{s_0, s_1\}, \ldots)) = \{\gamma, \beta \cup s_1\}, \ldots),
\]

\[
\text{then } \forall \sigma \in \text{Dom}_{\alpha} \{\exists \pi \in \pi(\sigma) \land \gamma(\sigma) \subset \pi(\sigma) \land \alpha(\sigma),
\]

\[
\text{where } \pi = \lambda \sigma. \cap \gamma(\beta \cup s_1)Z(\sigma), \text{ and } \gamma = \lambda \sigma. \alpha(S_0(\sigma)).
\]

In the condition (16), $\beta \cup s_1$ means that no presuppositions in $S_1$ are incorporated into the
assertion part. Thus, $\gamma$ is the result of combining only assertion parts. Consequently, the
rule states that when no presupposition is incorporated in the assertion part, the processing
of the assertion part must reduce the context, but not to the empty set. $\pi(\sigma)$ is added to the
condition because projected presuppositions are processed before the assertion parts are.
By including this in the condition, we can capture cases where presuppositions are bound as
well as cases where assertions are not informative. It will prevent anaphoric presuppositions from
having wide scope over their antecedents by making the antecedents uninformative, as in (17).

(17) If John is married, he will come with his wife to the party.

If the presupposition triggered by the definite description is incorporated with wide
scope over the antecedent of the conditional, it will make the latter uninformative. The
Correctness Condition excludes this reading. The condition applies in every step of the
derivations.

Now that we have derived a set of admissible readings, we have to update the main
context with them. In this analysis, contexts have a form of a set of alternative contexts.
Even when we start with a single context, an utterance can generate alternative contexts
because it may be updated with a set of CCPs. So we have to assume that an utterance
updates a set of contexts. This is formulated in (18).

\[(18) \quad \Sigma + \{\phi\} = \{A(\Sigma) \mid \sigma \in \Sigma, \{A, P\} \in \{\phi\}, Y = \cap \exists \epsilon Z(\sigma)\}
\]

which says that when a presupposition with another embedded presupposition is incorporated into the
assertion part, the embedded presupposition is collected to the presupposition part. Both formulations have
to support the observational fact that when a presupposition is projected, its embedded one is, too.
In (18), $\Sigma$ is a set of contexts, and each context is represented as $\sigma$. The interpretation of a sentence $\phi$ is a set of pairs of assertions and presupposition sets of the form $<A,P>$. The remaining presuppositions in each presupposition set, each of which is represented as $Z$ in (18), are projected to the main context. The result is represented by the letter $Y$. This serves as an argument of the assertion part. In next section, however, I will assume that there is only one context regarding which utterances are interpreted, as formulated in (47).

3. **Information and posets of admissible readings**

I have claimed that the meaning of a sentence is represented as a set of admissible readings. Now I am going to show that the set is a partially ordered set (= poset) in terms of informativeness, and that the reading corresponding to global accommodation in other analyses is the most informative in it. I will begin with the negation operator. Presuppositions are usually interpreted with wide scope over the negation operator. In some cases where presuppositions are canceled by later utterances, however, we need them interpreted with narrower scope than the operator. Otherwise, the conversation does not survive since the context becomes the empty set. Thus, presuppositions need to be interpreted with wide scope over, or narrower scope than, the negation operator. Let's assume that the incoming context $\sigma$ consists of four groups of possible worlds according to the two propositions $A$ and $PA$ in (19): $\sigma = W1 \cup W2 \cup W3 \cup W4$.

(19) **John did not regret leaving Mary.**

(20) a. $\begin{array}{cccc} A & W1 & W2 & W3 & W4 \\ \hline 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ \hline \end{array}$

$A$: John regretted leaving Mary

$PA$: John left Mary

In example (19), the presupposition $PA$ can be incorporated outside or inside the scope of negation. These two options generate $R_1$ and $R_2$ in (21). The scopes of presuppositions are explicitly expressed for expository purposes.

(21) $R_1$: $[\sigma + PA] + [\neg A] = \sigma + PA - [\sigma + PA + [A]] = W4 = \sigma_1$

$R_2$: $\sigma + [\neg (PA \& A)] = \sigma - [\sigma + PA + [A]] = W1 \cup W2 \cup W4 = \sigma_2$

The two readings update the same context $\sigma$ to $\sigma_1$ and $\sigma_2$ respectively. $\sigma_1$ is a subset of $\sigma_2$. Since $R_1$ results in a smaller context than $R_2$ from the same context, $R_1$ is more informative than $R_2$. We have to note that $R_1$ is the reading in which $PA$ is globally accommodated. This shows that a so called global accommodation reading is a more informative one in negation structures.

Let's look at implication cases. First, we will see a case in which a presupposition occurs only in the consequent clause of a conditional, as in (22). Let's assume that the propositions in (22) divide the incoming context $\sigma$ into seven groups, $W1$-$W7$. This is shown in (23).

(22) **If John goes to work, Bill's children play basketball.**
In (22), the presupposition $P_B$ triggered in the consequent clause can be incorporated in the main context, in the antecedent clause of the conditional, or in the consequent clause. From these three readings we get the updated contexts $\sigma_1$, $\sigma_2$, and $\sigma_3$, as shown in (24). Their subset relation is shown in (25), and the reversed order is the informativeness order of the readings.

(24) \[
\begin{align*}
R_1: & [\sigma + P_B] + [[A \rightarrow B]] = \sigma + P_B - [[\sigma + P_B + [[A]]] - [\sigma + P_B + [[A]] + [[B]]]] = W6 \cup W7 = \sigma_1, \\
R_2: & \sigma + [[P_B \& A \rightarrow B]] = \sigma - [[\sigma + P_B + [[A]]] - [\sigma + P_B + [[A]] + [[B]]]] = W1 \cup W2 \cup W3 \cup W4 \cup W6 \cup W7 = \sigma_2, \\
R_3: & \sigma + [[A \rightarrow P_B \& B]] = \sigma - [[\sigma + [[A]]] - [\sigma + P_B + [[A]] + [[B]]]] = W1 \cup W2 \cup W6 \cup W7 = \sigma_3.
\end{align*}
\]

(25) \[\sigma_1 \subseteq \sigma_3 \subseteq \sigma_2 \implies R_2 \leq R_3 \leq R_1 \text{ in informativeness}\]

The most informative reading $R_1$ is the case where the presupposition has the widest scope. One thing to note is that the incorporation of the presupposition at the consequent clause generates a more informative reading than the incorporation at the antecedent clause. I will discuss this later in comparison with van der Sandt (1992).

Let's look at a more complicated case. (26) has two presuppositions. $P_A$ has two possible scopes: it can be projected to the main context or interpreted in the antecedent clause. These two readings are called $R_1$ and $R_2$. The antecedent clause is a monotone-decreasing domain, and it can easily be seen that $R_1$ is more informative than $R_2$. $P_B$ causes three readings according to where it is interpreted, as shown in (22-25). The three readings are called $R_a$, $R_b$, and $R_c$ in the order of informativeness. So we get six possible combinations of them. Their partial order relation with respect to information is shown as a diagram in (27).

(26) If John's children play football, Bill's children play basketball.  
\[
\begin{align*}
A = & \text{John's children play football.} \\
B = & \text{Bill's children play basketball.} \\
P_A = & \text{John has children.} \\
P_B = & \text{Bill has children.}
\end{align*}
\]
PRESUPPOSITIONS AS INDUCING VARIOUS SCOPE READINGS

The most informative reading $R_1R_a$ in (28) is the combination of the global accommodation of each presupposition.

I have shown that the possibility operator is not necessarily a hole. This is illustrated in (28) again:

(28) a. It is possible that John regret cheating in the exam.
   b. It is possible that John regret cheating in the exam and it is equally possible that he didn't actually cheat in it.

Hearers will assume from (28a) that John cheated in the exam unless a context is provided that it is not the case, as in (28b). This implies that global accommodation is preferred unless it is suspended/canceled. This can be expressed in terms of informativeness. When the presupposition updates the main context, it will reduce the context non-trivially. When it is incorporated within the scope of the possibility operator, however, the context does not reduce at all unless the presupposition reduces the context to $\emptyset$. Thus the former reading is more informative than the latter. In (28b), the second clause would reduce the local context obtained from the global accommodation to $\emptyset$. Hence only the narrow scope reading of the first clause survives.

Heim (1992) attempted to explain why presuppositions generally have wide scope over the belief operator when they occur in the complements of verbs like believe, think, etc. The presupposition that Bill cheated in the exam in (29a) is projected unless the sentence is preceded by (29b).

(29) a. John believes that Bill regrets cheating in the exam.
    b. John believes that Bill cheated in the exam.

The ambiguous scopes of presuppositions can be compared regarding informativeness. The reading with a wide scope and that with a narrow scope can be represented as follows:

(30) a. $\sigma + P_A + B_\alpha A$ (wide scope)
    b. $\sigma + B_\alpha(P_A \& A) = \sigma + B_\alpha(P_A) + B_\alpha(A)$ (narrow scope)

In (30), $B_\alpha A$ roughly means 'a believes that A'. To compare the information of the readings, I need to point out that the following does not hold. Cf. Hintikka (1962: 43, 48).

(31) If $\{w\} + \|B_\alpha \phi\| = \{w\}$, then $\{w\} + \|\phi\| = \{w\}$.

This simply means that even if $\alpha$ believes that $\phi$ holds in $w$, it is not the case that $\phi$ holds in $w$. Therefore, a possible world in $\sigma + B_\alpha(P_A)$ may or may not be in $\sigma + P_A$. Now we have to check whether a possible world in $\sigma + P_A$ is also in $\sigma + B_\alpha(P_A)$. To determine this, we have to understand the semantics of the belief operator, which was originally proposed by Hintikka (1962, 1969) and reinterpreted in dynamic semantics by Heim (1992).

(32) For any model $\bar{\sigma} = \bar{\sigma} \cup \{ w \}: F_B(\alpha,w) + \phi = F_B(\alpha,w)$
(33) For any \( w \in W \), \( F_B(\alpha, w) = \{ w' \in W \mid w' \text{ compatible with } \alpha \text{ B(believes) in } w \} \)

In (32), \( F_B \) is a function that associates to a person \( \alpha \) and to a possible world \( w \) a set of alternative possible worlds \( F_B(\alpha, w) \), as defined in (33). When we restrict our discussion to the actual world, the only condition on \( F_B \) is that there must be a non-empty set of possible worlds which are compatible with what \( \alpha \) believes in the actual world. In this condition, the actual world plays a significant role only when \( \alpha \) is the speaker.

(34) a. ??He is a doctor, but I don't believe he is.
   b. He is a doctor, but Mary does not believe he is.
   c. ??Mary believes that he is a doctor, but she doesn't believe he is.

In (34a-b) the person referred to by the pronoun is a doctor in the actual world, and this interacts with the speaker's belief context, but not with other persons' belief contexts. On the other hand, (34c) shows that the actual world in which one has an inconsistent belief is not allowed. Thus we can say that a statement \( \alpha \text{ believes } \phi \) is true in \( w \) iff there is a non-empty set of possible worlds in which \( \alpha \text{'s belief in } w \text{ is inconsistent. This also explains (34a) when we assume that it is interpreted as } K_s(\text{doctor}(x) \land -B_s(\text{doctor}(x))) \text{, where } K_s \text{ roughly means 'the s(peaker) K(nows)'. } K_s\phi \text{ entails } B_s\phi. \text{ So (34a) means } B_s(\text{doctor}(x) \land -B_s(\text{doctor}(x))) \text{, which is an inconsistent belief.}

In dynamic semantics, \( \sigma + B_\alpha(P_A) = \sigma \) iff for every candidate for the actual world in \( \sigma \), there is a non-empty set of possible worlds in which \( \alpha \text{'s belief is consistent. Therefore we can infer the following relations:}

\[
\sigma + P_A \subseteq \sigma + B_\alpha(P_A), \text{ and therefore } \sigma + P_A + B_\alpha A \subseteq \sigma + B_\alpha(P_A) + B_\alpha A
\]

This shows that a global accommodation reading is more informative than a local accommodation reading.

4. Preferred readings determined by information

Presupposing something to be accommodated is one way of conveying information with less effort. One reason why speakers take this strategy is that they know that hearers can infer from simpler expressions what they actually intended. This is generally observed in R-based implicatures.\(^{11}\) In (36), hearers make inferences on the right hand side from the utterances on the left hand side. The inferences contain more information than what is actually expressed.

(36) Horn (1984):
   a. John was able to solve the problem.  
      John solved the problem.
   b. I broke a finger yesterday.  
      The finger is mine.
   c. John had a drink.  
      John had an alcoholic drink.

In our analysis, presuppositions introduce a whole range of admissible readings. Hearers will take the most informative reading to be what the speaker intended unless the speaker, or the context, cancels/suspends it. When a presupposition is able to be associated with a stronger reading, this reading must be an unmarked reading. Otherwise, there must

\(^{11}\)In contrast, Q-based implicatures work the other way round: when weaker and stronger readings are possible, weaker readings are selected. However, there are some differences between the two implicatures. Q-based implicatures work in cases where there are explicit scales which are independent of sentence meanings and weak and strong readings are expressed in equally complex ways. Manfred Krifka (in personal communication) notes that the examples he gives are not explicit scales for Q-based implicatures. R-based implicatures seem more general.
be a simpler expression with the same amount of information so that it would make an expression with a presupposition more likely to be associated with a weaker reading. This is, however, not the case. Expressions which have the same meanings without presuppositions are always more complex or longer than expressions with presuppositions. Thus once a presupposition is allowed to have a stronger reading, this is an unmarked reading, and hearers will regard it as what the speaker intended.\(^{12}\)

I have to point out that presuppositions are not quite the same as R-based implicatures. Ordinary R-based implicatures come from the expressions in the assertion part. Therefore, if it is negated, the implicatures do not arise. On the other hand, presuppositions are not part of assertions, and their scopes with respect to the negation operator are determined by their incorporation into assertion. Another difference from other R-based implicatures is that there is an information scale formed from linguistic forms: different structures make different scales of informativeness. This makes it hard to regard global accommodation readings as just conversational implicatures from weaker readings.

If this analysis is on the right track, it is expected to make a correct prediction. Van der Sandt (1992) makes a different prediction from mine in accommodating a presupposition when it is triggered in the consequent clause of a conditional sentence. He assumes that presuppositions are anaphoric, and therefore need antecedents. If they do not find their antecedents, they are accommodated so that anaphora relations can be established. He claims that a higher position in the accessibility path is preferred as an accommodation site. This predicts that the K1-K2-K3 is the preference order in the following simplified DRS. My analysis predicts the K1-K3-K2 order: van der Sandt prefers K2 to K3, but my analysis predicts the opposite since K2 is a monotone-decreasing domain.

(37) \[\begin{array}{c}
\text{If } A, \text{ then } B, \\
\begin{array}{c}
\text{K} 1 \\
\text{K} 2 \rightarrow \text{K} 3 \\
\text{A} \\
\text{B}
\end{array}
\end{array}\]

My analysis predicts that a reading in which a presupposition is accommodated in K2 is selected only when a reading in which the presupposition is accommodated in K3 is canceled/suspended. Look at the following sentences:

(38) a. If John gets married, his children will be happy.
b. If John gets married, he will have children and they will be happy.
c. If John gets married and has children, they will be happy.

When we assume that John has no children, (38a) seems to allow two readings: (38b) and (38c). Compared with this, (3a) does not allow the same readings:

(3') a. ??If baldness is hereditary, John will have children and they will be bald.
b. If baldness is hereditary and John has children, they will be bald.

(3'b) sounds fine, but (3a) does not allow this reading. I would like to suggest that only when an accommodation at K3 is possible in (37), is an accommodation at K2 allowed. This is what my analysis would predict.

\(^{12}\)Beaver (1992) suggested the opposite regarding (3-4): weak presuppositions are primary readings and strong presuppositions are selected only when weak readings are awkward.
Another point to make is that for the anaphora view of presuppositions, van der Sandt needs variables which are not accessible to other anaphors, but only to presuppositions. In (39a) his wife cannot be accommodated in the main context since the latter entails the former. The intended reading of (39a) is the one in which his wife is accommodated in the antecedent clause.

(39)  a. If John gets married, his wife will move to Austin.  
     b. ??If John gets married and wants to live with her, his wife will move to Austin.

In order to establish an anaphora relation, the presupposition that John has a wife is accommodated in the antecedent clause so that it can bind the subject of the consequent clause in the corresponding DRS. That is, a variable for John's wife has to be introduced in the antecedent DRS of the conditional. We would expect the same thing in (39b), but (39b) shows that the newly introduced variable cannot bind the pronoun. In my analysis presuppositions are treated as information. They do not have to find overt variables.\textsuperscript{13}

5. Possible problems with admissible readings as a set.

One possible problem with deriving all admissible readings as a set and determining the most preferable reading with regard to informativeness is that there are cases where sentences are ambiguous among readings in which presuppositions are bound by their antecedents (= "anaphoric" readings), and readings where they are accommodated (= accommodation readings). Presuppositions bound by their antecedents are not informative when they are entirely anaphoric. So accommodation readings would always have to be preferred, contrary to what is actually observed. Let's look at the following sentence:

(40) If John gets married, his wife will leave soon.

In this sentence the definite description is ambiguous. It may refer to the new wife, or to the original wife. The two readings have no semantic relation to each other in the sense that the two readings have different indices for the definite description. Even though the accommodation reading is more informative, we cannot say it is preferred. This may imply that we have to handle the two kinds of readings separately. I will assume that all readings with different indices in them are regarded as independent readings. Semantics does not say which reading is preferred among them. Only when a group of related readings is selected among them, the most informative one will be preferred within the group.

There are some cases where anaphoric readings and accommodation readings are related to each other. Let's look at the following sentences:

(41)  a. If John got married recently, he will come with his wife to the party.
     b. Either the king of France is one of the few intelligent monarchs in Europe, or France does not have an intelligent king.

These two sentences have a common semantic fact that there is a presupposition, and an assertion part which may cancel/suspend it has more information. Sentence (41a) can be uttered both in a context where the speaker knows that John has a wife, and in a context where (s)he doesn't. Since these two readings have the same indices, the selection of a preferred reading should be based on informativeness. The accommodation reading, however, is not clearly preferred. In sentence (41a), the reason is that it is not clear whether or not the presupposition is suspended/canceled. The antecedent clause of (41a) implicates

\textsuperscript{13} For more discussion of the anaphoric vs. accommodation distinction, see also van der Sandt (1993) and Geurts (1992).
that the speaker does not know whether or not John got married recently. This also leaves it open whether or not the speaker knows that John got married. A hearer believes from this that whether or not John got married is still indeterminate, and so he is not sure whether he has to accommodate the presupposition. Moreover, something else is involved in interpreting this sentence. If the speaker knows that he got married, he will utter the sentence with a focus on recently. When recently is not focused, the hearer will believe that the speaker does not know whether or not John got married.

Sentence (41b) does not seem to presuppose that there is a king of France. The proposition in the second disjunct says that France does not have an intelligent king, but we generally assume that there is only one king in a country. If this restriction is eliminated, a presupposition can be projected. This is illustrated in the following sentence.

(42) Either one of his wives is intelligent, or he does not have intelligent wives.

The presupposition from the first disjunct is projected even when a relevant but more informative proposition is negated in the second disjunct.

Let’s look at another problematic example:

(43) If all countries have presidents, then the President of France probably regards himself as their cultural leader.

The utterance of the antecedent clause implicates that the speaker does not know whether all countries have presidents. One thing to note is that from the antecedent clause it is also open whether or not there is a country which has a president. This will suspend the presupposition that France has a president. This can be contrasted with the following sentence, which ensures that there are some countries which have presidents:

(44) If more countries elect presidents than they do now, then the President of France probably regards himself as their cultural leader.

This sentence presupposes that there are some countries which have presidents now. Even though it is not mentioned that France is among those worlds, the whole utterance seems to presuppose that there is a president in France. So sentence (43) is not quite neutral as to whether there is a president in France, as Soames (1982) claims.

This discussion shows that when stronger information is indeterminate, a crucial factor is whether or not its weaker information is indeterminate. When it is indeterminate whether a person has grandchildren, it does not seem that the presupposition that the person has a child is suspended, as in (4). When it is indeterminate whether all nations have presidents, it seems that it is indeterminate whether there are nations who have presidents. At this point I cannot suggest any generalization. All I can say is that when accommodation readings and anaphoric readings are related to each other and they are equally plausible, it is because there is a weak possibility for presuppositions to be suspended.

6. Motivations for interpreting sentences as sets of CCPs

One welcome result of interpreting a sentence as a set of CCPs is that backtracking is dispensable. In this analysis presuppositions introduce the whole range of admissible

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14Rooth (1992) claims that focused elements introduce presuppositions. If he is right, it is not clear which presupposition is projected in (41a), the presupposition from the focused element or that from the definite description.
readings. Defeasibility in a traditional sense is just a rejection of a stronger reading. Insofar as there is at least one admissible reading, the conversation survives. This enables us to account for the difference in (45).

(45) a. John knows that Bill is happy. *In fact, Bill is unhappy.
   b. John does not know that Bill is happy. In fact Bill is unhappy.

The reason why (45a) is not possible is that the first sentence introduces only one reading, which is rejected by the following sentence. In (45b) the first sentence introduces two readings and the second sentence only rejects the more informative reading. The other less informative reading still survives. Even though the preferred reading is canceled in the second sentence, we do not have to go back to the first sentence since the reading we would get when we have backtracked is already available.

In a complex case like (26-27), when the most informative reading $R_1 R_a$ is canceled or suspended, it may be $R_1$ or $R_a$ that is actually canceled/suspended. When it is $R_1$, the rest will be (46a). When $R_a$ is canceled/suspended, the rest will be (46b). This shows that even when some presuppositions are canceled or suspended, the partial order relation is maintained.

(46) a. $\begin{array}{c} R_a \\ R_1 \end{array}$
   b. $\begin{array}{c} R_1 \\ R_a \end{array}$

We can say the same thing about contexts. As I said above, various admissible readings generate alternative contexts. They show a subset relation between them according to the scopes of accommodated presuppositions. When a presupposition which has already been accommodated to the set of contexts is canceled/suspended at a later utterance, the contexts which have arisen from its most informative reading are all eliminated, and the rest will still maintain the partial order of a subset relation.

The question is whether backtracking is still necessary in natural language processing. In linguistic theories, it is assumed that only unambiguous structures are given as input to the semantic component. Thus cases where backtracking occurs inter sententially are lexical or semantic. Backtracking usually happens when there are two readings in which one is more readily available than the other. A question can be asked as to whether the difference in availability must be handled in linguistic theories. Another question, which is more important, is how our computational system really works in processing information. At this point, I can only say that my analysis is compatible with both computational systems. In the one with backtracking, (18) can be simplified as follows:

(47) $\sigma + [\phi] = \{ A(Y) | <A,P> \in [\phi], Y = \cap_{Z \in P} Z(\sigma) \}$

At each step of updating a context with the interpretation of a sentence, the smallest context is selected with the rest put aside for a later possible retrieval. On the other hand, in the computational system without backtracking, one possible concern may be that the alternatives of a context increase infinitely. In fact this usually does not happen. In this system we need another level of discourse analysis which governs the elimination of some alternatives which are not relevant any more at some stage of conversation. When a presupposition is accommodated and is not at issue any more, the contexts updated with weaker readings must be removed.
References


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