Strengthening Conditional Presuppositions*

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Abstract

In this paper it will be shown how conditional presuppositions can be strengthened to unconditional ones if we assume that the antecedent and consequent of a conditional presupposition are *independent* of one another. Our notion of independence is very weak, and based on Lewis' (1988) notion of orthogonality of questions. It will be argued that our way to strengthen these presuppositions does not give rise to some wrong predictions Geurts (1996) argued other proposed strengthening accounts do.

1 Introduction

The satisfaction theory of presupposition, as motivated by Karttunen (1974) and Stalnaker (1974) and implemented by Heim (1983) and others, is perhaps still the most popular theory of presuppositions on the market. Indeed, it has good selling points: the theory is simple and conceptually appealing. However, the theory has serious drawbacks as well: it is not always clear how to make it consistent with empirical facts. One of the most serious empirical problems is that it gives rise to presuppositions which seem too weak. In particular, it gives rise to the *proviso problem*: weak conditional presuppositions for conditional, conjunctive, and disjunctive statements with a presupposition trigger occurring in the consequent, second conjunct, or disjunct. Gazdar (1979) already argued convincingly that we infer more than just those weak presuppositions, but more recently Geurts (1996) has given compelling arguments that simple repairs as suggested by Karttunen & Peters (1979) and others don't work. Partly on these grounds, Gazdar (1979), van

*This paper was presented at the workshop in honor of Rob van der Sandt's 60th birthday in Nijmegen in May 2006. I thank the participants to this workshop for discussion, and the organizers of this workshop (especially Bart Geurts) for allowing me to give this talk at such an occasion. I would like to thank the anonymous reviewers and Philippe Schlenker for comments on an earlier version of this paper. I thank Tikitu de Jager for correcting my English.

der Sandt (1988, 1992) and Geurts (e.g. 1996) argue for alternative theories for which this proviso problem does not arise: Gazdar's (1979) and van der Sandt's (1988) theories that might be thought of as 'Presupposition as default'-analyses, and van der Sandt's (1992) and Geurts' (1996) so-called 'Binding'-theory of presuppositions. However, in this paper I want to argue that theories that give rise to weak conditional presuppositions[1] are less inadequate than suggested by Gazdar, van der Sandt and Geurts, because conditional presuppositions can be strengthened in a simple way after all, and that this solution is not liable to the problems discussed by Geurts.

2 The standard satisfaction account

According to dynamic semantics (e.g. Heim, 1982, Veltman, 1996), the meaning of a sentence is its *context change potential*, where contexts are identified with information states that represent what is commonly assumed in a conversation. The meaning of a sentence is modelled as an *update function* that takes a context in which it can be appropriately uttered as its argument and has the updated context where the sentence is accepted as its value. Assuming that a sentence cannot be used appropriately in a context that does not entail, or *satisfy*, its triggered presupposition, this function will be *partial*.

Although in dynamic semantics every full clause will be interpreted with respect to a context, it is crucial that not every *embedded* clause need be interpreted with respect to the context that figures as the context of interpretation of the *embedding* sentence. It is assumed, for instance, that the context of interpretation of the second conjunct of a conjunction or the consequent of an indicative conditional contains *more* information than the context with respect to which the whole sentence is interpreted.

I limit myself here, and in the rest of this paper, to the propositional case, and represent a context, σ, by a set of possible worlds. A possible world is a function from atomic formulae to the two classical truth-values. I will represent (atomic) sentence ϕ with presupposition χ as ϕ_χ.[2] We might treat disjunction and implication syncategorematically, by having '$\phi \vee \psi$' and '$\phi \rightarrow \psi$' stand for '$\neg(\neg\phi \wedge \neg\psi)$', and '$\neg(\phi \wedge \neg\psi)$' respectively.[3] The update function is defined as follows (where σ $-$ undefined = undefined):

- $[\phi_\chi](\sigma) \quad = \quad \{w \in \sigma |\ w(\phi) = 1\}$, if $[\chi](\sigma) = \sigma$, undefined otherwise

[1] Not only the standard satisfaction theory of presuppositions gives rise to conditional presuppositions, the theory of Karttunen & Peters (1979) and a recent alternative due to Schlenker (2005) do so as well. My proposal can be used here too.

[2] For generality, I will assume that all atomic sentences carry such a presupposition, but some presuppositions are empty, $\top$. For readability, though, I make empty presuppositions invisible.

[3] Let me immediately point out that I don't feel the resulting analysis of disjunctions is appropriate. For a more satisfying analysis, see Van Rooij (2005).

- $[\neg\phi](\sigma) \quad = \quad \sigma - [\phi](\sigma)$
- $[\phi \wedge \psi](\sigma) \quad = \quad [\psi]([\phi](\sigma))$

The appealing feature of this analysis of presuppositions within dynamic semantics is that it seems to solve the projection problem simply by means of rules of interpretation. Assuming that context σ satisfies presupposition χ iff $[\chi](\sigma) = \sigma$, we can say that sentence ϕ presupposes χ iff for all contexts $\sigma, [\phi](\sigma)$ is defined only if σ satisfies χ. As a result, it follows that sentences of the form $\neg\phi_\chi$ and $\phi_\chi \wedge \psi$ presuppose χ, but that $\psi \wedge \phi_\chi$ need not do so.[4] In fact, the theory makes exactly the same predictions as the more informal account of Karttunen (1974).

Stalnaker (1974) explicitly rejects *defining* the notion of sentential presupposition in terms of the contexts in which the sentence is defined, or used appropriately. He suggests that one can also say, for instance, that ϕ presupposes χ just in case from the utterance that ϕ one can reasonably infer that the speaker presupposes χ. It is this more general notion that will be crucial for our analysis.

3 Conditional presuppositions

The satisfaction theory of presuppositions is well-known to be problematic, even for the simple fragment stated above. On the one hand, it is not completely clear how to account for presupposition accommodation; on the other hand, it seems to make wrong predictions. As far as the first problem is concerned, one might want to follow Beaver (1996) or Stalnaker (2002) and assume that hearers don't know what exactly is presupposed by the speaker. Accommodation is then an inference from a sentence to the set of contexts in which the sentence could be used appropriately. The second problem is perhaps more serious. It is well-known that some examples involving presupposition triggers under a negation, in a disjunction, or in the antecedent of a conditional don't give rise to the predicted presuppositions.[5] Although I believe that such examples can be accounted for on a more sophisticated version of the satisfaction theory (involving denial and modal subordination, cf. Van Rooij, 2005), I will ignore such examples in this paper. Instead, I will concentrate my attention only on a particular type of example involving conditional presuppositions.

[4] $\psi \wedge \phi_\chi$, for instance, is predicted to be satisfied in any context, if $\psi \models \chi$.

[5] The well-known examples are the following:

(i) a. John doesn't *regret* failing, because, in fact, he passed.
b. John either *stopped* or just *started* smoking. (Hausser, 1976)
c. If I *discover* later that I have not told the truth, then I will confess it to everyone. (Karttunen, 1971)

I assume it is clear which counterintuitive predictions are made by the satisfaction theory.

Notice that the satisfaction theory predicts that sentences of the form $\phi \rightarrow \psi_\chi$, $\phi \wedge \psi_\chi$, and $\neg(\phi \wedge \psi_\chi)$ can be asserted appropriately in context σ, if the conditional $\phi \rightarrow \chi$ is accepted in σ, $[\phi \rightarrow \chi](\sigma) = \sigma$. But this means that such sentences are predicted to give rise to a conditional presupposition $\phi \rightarrow \chi$. Gazdar (1979) and Van der Sandt (1988) claim these predicted conditional presuppositions are too weak. They note that the satisfaction theory (and the theory of Karttunen and Peters (1979)) predicts that the following examples[6] (1-a), (2-a), and (3-a) give rise to the *conditional* presuppositions (1-b), (2-b), and (3-b), respectively, while intuitively we conclude from these examples to the stronger *un*conditional sentences (1-c), (2-c), and (3-c) (the presupposition triggers are used in italics).[7]

(1) a. If the bottle is empty, then $[\text{John}]_F$ drinks *too*.
b. If the bottle is empty, there is someone other than John who drinks.
c. There is someone other than John who drinks.

(2) a. If I torture him, Boris *regrets* laughing at me.
b. If I torture him, Boris has laughed at me.
c. Boris has laughed at me.

(3) a. If John has sprayed DDT, he *knows* that his stick insects are dead.
b. If John has sprayed DDT, John's stick insects are dead.
c. John's stick insects are dead.

The above mentioned observations are, no doubt, correct: we normally conclude the unconditional c-sentences from the conditional a-sentences. Gazdar (1979), Van der Sandt (1988, 1992), and others have concluded from this that the satisfaction theory is *wrong*, because a conditional like (1-a) should give rise to the *unconditional presupposition* (1-c). Because their own theories *do* give rise to such unconditional presuppositions, the authors argue that they can handle conditional sentences better than proponents of the satisfaction theory can. But this reasoning is somewhat hasty, certainly if one follows Stalnaker's suggestion mentioned at the end of section 2: The fact that our intuitions are as expressed by Gazdar does by itself not mean that these examples show that a theory that states the *minimal conditions* under which a sentence is defined/appropriate makes the

[6] Like Geurts (1996), I will mostly concentrate on conditional sentences.

[7] Example (1-a) was explicitly discussed by Karttunen and Peters (1979), (2-a) is mentioned by Gazdar (1979), while (3-a) is discussed by Van der Sandt (1988). Gazdar (1979) finds the following conditional more convincing to make his point: *If gold is missing from Fort Knox, then the crooked accountants in the U.S. Treasury will be worried.* Unfortunately, this example uses a definite description, and we seem to have independence reasons to assume that restrictors of quantifiers can take 'wide scope' (either via a two-dimensional actuality operator, or by means of two-sorted type-theory) with respect to intensional operators (to account for *If every politician who is rich were poor instead, the world would be a better place*, thanks to Philippe Schlenker on this). But on such a wide scope analysis of quantifiers, Gazdar's more favorable examples are compatible with the predictions made by the satisfaction theory.

wrong predictions. If one does not identify the actual presupposition of an utterance with these minimal definedness conditions (neither Soames (1982) nor Beaver (1996) would do that), the examples (1-a)-(3-a) only show that the satisfaction theory by itself is not enough to explain the inferences we actually make.[8]

[8]Van der Sandt (1992) and Geurts (1996) suggest that the appropriateness of the following dialogue is an extra argument for the unconditional presupposition:

(i) a. If all countries have presidents, then *the president of France* probably regards himself as their cultural leader.
b. *He* is such a pompous person.

The problem for the satisfaction theory here is that the antecedent entails the presupposition of the consequent. Consequently, the satisfaction theory predicts that (i-a) does not give rise to a (substantial) presupposition. Let me first note that some of my informants don't find the discourse (or the Dutch version of it) appropriate at all. But even if we agree with Van der Sandt (1992) that the discourse (i-a)-(i-b) is appropriate, I don't think that this extra argument is very strong. First, as noticed by Geurts (1996), this anaphoric dependence can be accounted for by assuming that 'the President of France' was used referentially. Alternatively (cf. the previous footnote), we can assume that the descriptive content of the description is interpreted in the main context. Either way, this referent or descriptive material can be picked up by the (perhaps descriptive) pronoun in (i-b). But Geurts (1996) argues that sentences of the form $\phi \rightarrow \psi_\chi$ might imply χ although ϕ entails χ even if the presupposition χ is not induced by a definite descriptions. He argues that also (ii-a) has a reading in which it presupposes the presupposition of the consequent (ii-c), rather than the trivial conditional presupposition (ii-b):

(ii) a. If all the boys failed the exam, then *it was*n't only Fred *who* did so.
b. If all the boys failed the exam, Fred failed the exam.
c. Fred failed the exam.

I agree with Geurts that (ii-a) may be construed as implying that Fred failed the exam. But I wonder whether this implication is presuppositional in nature, and thus whether this is really problematic. Notice first that if it is commonly known that Fred is one of the boys, (ii-a) expresses a trivial proposition. This suggests that the conditional sentence is perhaps not used in the standard way. It is well-known that conditionals can have a *concessive* reading: on this reading 'If ϕ then ψ' means something like 'Ok, I admit that ϕ, but then you have to admit that ψ'. On such a concessive reading, the inference from (ii-a) to (ii-c) is completely unproblematic. Unfortunately, this type of inference is not only valid in concessive readings of conditionals. Another prominent reading of (ii-a) is one where it is intuitively an answer to the question 'Did only Fred fail the exam?'. I guess most would claim that this question, in turn, presupposes that Fred failed the exam. But this means that if (ii-a) answers, and thus presupposes, the above question, the inference to (ii-c) can be explained. A reference to a presupposed question is also crucial, I believe, to account for Geurts' following example:

(iii) a. If all boys left at the same time, then the janitor will not have *noticed* that Fred left.
b. Fred left.

Also (iii-a) has a reading – perhaps the prominent one – where we infer (iii-b), a presupposition of the consequent. But then, I think this conditional is most natural with stress on *at the same time*, suggesting that it is an answer to a (perhaps implicit) question like 'When did the boys leave?'. But such a question presupposes that the boys left, from which we can infer that Fred

The main point I want to make in this paper is very weak: even if we accept the satisfaction theory and assume that conditionals like (1-a), and other types of statements, give rise to conditional presuppositions, we can still account for the intuition that we infer the unconditional proposition (1-c) without making the wrong predictions that Geurts (1996) has argued such a move would commit one to. A full defense of the satisfaction theory requires something more: an argument that establishes that conditional statements sometimes give rise to conditional presuppositions that (in some contexts) cannot be strengthened to unconditional ones. Soames (1982) and Beaver (1996) have provided some examples that — at least according to them — give rise to conditional presuppositions that are not, or need not be, strengthened to unconditional presuppositions.

First, Soames (1982) argues that (4-a) can be used appropriately in contexts that entails (4-b) and that one does not automatically infer that (4-c) is true.

(4) a. If all countries have presidents, then *the president of France* probably regards himself as their cultural leader.
b. If all countries have presidents, then there is a president of France.
c. There is a president of France.

Perhaps better known are the following examples due to Beaver (1995) and Geurts (1996).[9] Beaver claims that (5-a) and (6-a) suggest that the conditional sentences (5-b) and (6-b) are true, and not their unconditional counterparts. He would, no doubt, make the same claim with respect to (7-a) and (7-b):

(5) a. If Jane takes a bath, Bill will be *annoyed* that there is no more hot water.
b. If Jane takes a bath, there will be no more hot water.

(6) a. It is unlikely that if Spaceman Spiff lands on Planet X, he'll *notice* he weigh more than on earth.
b. If Spaceman Spiff lands on Planet X, he'll weighs more than on earth.

(7) a. If Theo is a scuba diver, then he will bring *his wet suit.*
b. If Theo is a scuba diver, he has a wet suit.

These suggestions are then, of course, due to the claimed conditional presuppositions. Although perhaps not completely convinced by all these above examples,[10] I

left (as well). To conclude, I am not convinced that examples of the form $\phi \rightarrow \psi_\chi$ where ϕ entails χ but where we still infer χ show that the satisfaction theory is in trouble.

[9]Examples (5-a) and (6-a) are due to Beaver, (7-a) is mentioned in Geurts (1996) who attributes it to an anonymous reviewer.

[10]See the discussion of example (5-a) in the following section for why this doubt might depend on my (cultural) background. Merin (2003) contains a detailed discussion of some of these examples.

am sympathetic to the view Soames (1982) and Beaver (1995) argue for. However, in this paper I want to argue only for the weak claim that the strengthening of conditional presuppositions to unconditional ones is less problematic than Geurts (1996) has argued, not for the more controversial stronger claim that the examples discussed above in fact generate conditional presuppositions.[11]

4 Strengthening due to independence

In this section I will propose that conditional presuppositions can be strengthened to unconditional ones if it is presupposed that the antecedent and consequent are *independent* of each other. On first thought, this might seem impossible. According to the standard notion of independence, ϕ and ψ are independent of each other if $(\phi \wedge \psi), (\phi \wedge \neg\psi), (\neg\phi \wedge \psi)$, and $(\neg\phi \wedge \neg\psi)$ are all possible, i.e. each of $\Diamond(\phi \wedge \psi), \Diamond(\phi \wedge \neg\psi), \Diamond(\neg\phi \wedge \psi)$, and $\Diamond(\neg\phi \wedge \neg\psi)$ are true (where I say that $\Diamond\phi$ is true in σ iff $[\phi](\sigma) \neq \emptyset$). Unfortunately, however, if we assume that a speaker presupposes $\phi \rightarrow \psi$, he doesn't take it to be possible that ϕ and $\neg\psi$ are true at the same time, and thus that $\Diamond(\phi \wedge \neg\psi)$ is false. This would contradict independence as standardly defined. In the following, we propose a weaker notion of independence of sentences/propositions based on Lewis's (1988) notion of orthogonality of questions. It will be shown that for this weaker notion the above problem does not arise, and with this help conditional presuppositions can be strengthened to unconditional ones.

David Lewis (1988) assumes that questions denote equivalence relations, Q^R (where the superscript R is mnemonic for *Relation*), meaning that two worlds are related, $\langle w, v\rangle \in Q^R$, iff the same complete answer is true in w and v. He defines Q_1^R and Q_2^R to be *orthogonal* to one another iff for every two worlds w and u there is a world v such that $\langle w, v\rangle \in Q_1^R$ and $\langle v, u\rangle \in Q_2^R$. Take Q_1^R and Q_2^R to be the denotations of the questions whether John came and whether Mary came, respectively. If $W = \{w, v, u, x\}$, $[\![Came(j)]\!] = \{w, v\}$ and $[\![Came(m)]\!] = \{w, x\}$, the equivalence relations are $Q_1^R = \{\langle w, w\rangle, \langle v, v\rangle, \langle w, v\rangle, \langle v, w\rangle, \langle u, u\rangle, \langle x, x\rangle, \langle u, x\rangle, \langle x, u\rangle\}$ and $Q_2^R = \{\langle w, w\rangle, \langle x, x\rangle, \langle w, x\rangle, \langle x, w\rangle, \langle v, v\rangle, \langle u, u\rangle, \langle v, u\rangle, \langle u, v\rangle\}$. Given an equivalence relation one can, of course, define a partition: $Q_i^P = \{\{v \in W | \langle w, v\rangle \in Q_i^R\} | w \in W\}$. Equivalence relation Q_1^R, for example, corresponds one to one with the partition $Q_1^P = \{\{w, v\}, \{u, x\}\} = \{[\![Came(j)]\!], [\![\neg Came(j)]\!]\}$, while Q_R^P corresponds with $\{\{w, x\}, \{u, v\}\}$. Now we can define orthogonality in terms of partitions, which is somewhat easier to work with.

Definition 4.1 *(Orthogonality of Questions)*
Let Q_1^P and Q_2^P be two partitions, then we say that Q_1^P and Q_2^P are orthogonal with respect to each other iff $\forall q_1 \in Q_1^P : \forall q_2 \in Q_2^P : q_1 \cap q_2 \neq \emptyset$.

[11] Thus, in this paper I am not arguing against theories, like Van der Sandt's (1992) DRT account of presuppositions, that don't predict conditional presuppositions.

Notice that if seen as partitions, the question whether John came is orthogonal to the question whether Mary came, because both elements of Q_1^P are compatible with both elements of Q_2^P. More generally, one can easily prove that Q_i^R and Q_j^R are orthogonal to each other iff Q_i^P and Q_j^P are. Let us now assume that the issue whether ϕ, in context σ, gives rise to the partition $\{\phi \cap \sigma, \neg\phi \cap \sigma\}$. Let's denote this question by '$\phi?_\sigma$'. Now we say that ϕ and ψ are *independent* of each other in context σ iff the questions $\phi?_\sigma$ and $\psi?_\sigma$ are orthogonal to each other.[12]

Definition 4.2 *(Independence of ϕ and ψ in context σ)*
Formulas ϕ and ψ are independent of each other in context σ iff $\phi?_\sigma$ and $\psi?_\sigma$ are orthogonal to each other.

From our definition of independence of ϕ and ψ in context σ, one can easily prove the following lemma:[13]

Lemma 4.3 *(Independence)*
Formulas ϕ and ψ are independent of each other in context σ iff the following four conditions are satisfied (where $\Diamond\phi$ means that $[\phi](\sigma) \neq \emptyset$).

(i) *If* $\Diamond\phi$ *and* $\Diamond\psi$, *then* $\Diamond(\phi \wedge \psi)$, *and*
(ii) *if* $\Diamond\phi$ *and* $\Diamond\neg\psi$, *then* $\Diamond(\phi \wedge \neg\psi)$, *and*
(iii) *if* $\Diamond\neg\phi$ *and* $\Diamond\psi$, *then* $\Diamond(\neg\phi \wedge \psi)$, *and*
(iv) *if* $\Diamond\neg\phi$ *and* $\Diamond\neg\psi$, *then* $\Diamond(\neg\phi \wedge \neg\psi)$.

Now assume that a conditional of the form '$\phi \rightarrow \psi$' is interpreted as material implication and gives rise to the following appropriateness condition: the speaker knows (or believes) $\phi \rightarrow \psi$ and all of ϕ, $\neg\phi$, ψ, and $\neg\psi$ have to be compatible with the speaker's belief and presupposition state (Gazdar's (1979) clausal implicatures of indicative conditionals). Moreover, we will assume that the speaker's assertion of ϕ results in the update of the current presupposition state with ϕ. Then it follows that '$\phi \rightarrow \psi$' can never be appropriately asserted if the speaker presupposes that ϕ and ψ are independent of each other. By assuming that after the assertion of $\phi \rightarrow \psi$ the sentence is presupposed, it follows that in this new presupposition state it is not possible that $\phi \wedge \neg\psi$. By Lemma 4.3 it follows that $\neg\Diamond\phi$ or $\neg\Diamond\neg\psi$, meaning that the speaker's assertion had the same effect as either her assertion of $\neg\phi$, or her assertion of ψ. But the speaker could not have asserted any of those propositions, because the appropriateness conditions of the use of the conditional

[12] This notion of independence is also discussed by Humberstone (2000). In terms of his terminology, my notion of independence (in σ) requires that (with respect to σ) ψ does not *supervene* on ϕ, nor that ϕ supervenes on ψ.

[13] What is now derived as this lemma was proposed by Michael Franke (p.c.) to account for the strange way we analyze such so-called 'biscuit conditionals' as *If you are hungry, there are some biscuits in the refrigerator.* This proposal crucially influenced my analysis of strengthening conditional presuppositions presented in this paper.

require that the speaker did not believe either of them. From this we can conclude that the speaker does not presuppose that ϕ and ψ are independent of each other.[14]

But now suppose that the assertion is $\phi \rightarrow \psi_\chi$, where χ is the presupposition of ψ. The satisfaction theory then predicts the presupposition $\phi \rightarrow \chi$. Assume now that (i) the assertion is made appropriately with respect to the presupposition state σ, and (ii) that it is presupposed that ϕ and χ are independent of each other: i.e., ϕ and χ are independent of each other in presupposition state σ. Then it follows that $[\phi \wedge \neg\chi](\sigma) = \emptyset$, i.e. $\Diamond(\phi \wedge \neg\chi)$ is taken to be 'false' with respect to the presupposition state σ. Given Lemma 4.3, this means that either $\neg\Diamond\phi$ or $\neg\Diamond\neg\chi$ must be the case. Given that '$\phi \rightarrow \psi_\chi$' was made appropriately, it follows that $\Diamond\phi$ is the case, and thus that $\neg\Diamond\neg\chi \equiv \Box\chi$ holds. But this means that χ is presupposed![15,16]

Perhaps one can see our above reasoning as a formalization of Karttunen & Peters' (1979) account according to which a conditional presupposition can be strengthened in case the speaker has *truth-conditional* grounds for presupposing the conditional presupposition: which means either presupposing $\neg\phi$, or presupposing χ. On our analysis, the speaker is indeed predicted to have truth-conditional grounds for presupposing the conditional in case she presupposes antecedent and consequent to be independent of each other. Others (starting with Soames (1982), and worked out further by Beaver (1995)) suggested that a sentence of the form $\phi \rightarrow \psi_\chi$ can be satisfied in a context where just $\phi \rightarrow \chi$ holds, or where the stronger χ is already presupposed. If the latter context is more plausible than the former, the unconditional presupposition follows. This intuition can

[14]The assumption that conditionals are interpreted by material implication is not crucial. The same conclusion follows under a strict conditional account.

[15]Of course, this method of strengthening conditional presuppositions can be applied to conditional presuppositions that are triggered by non-conditional statements as well. The standard satisfaction theory as stated in section 2 of this paper predicts that the presuppositions of $\phi \wedge \psi_\chi$, $\neg(\phi \wedge \psi_\chi)$, and $\neg\phi \vee \psi_\chi$ are satisfied in any context that entails $\phi \rightarrow \chi$. By a similar reasoning, and on the same assumptions, these conditional presuppositions are also strengthened to χ. For more complex sentences we have to make more independence assumptions. For a sentence of the form $\phi \wedge (\psi \rightarrow \psi'_\chi)$, for instance, to presuppose χ, we have to assume that χ is independent of ϕ and ψ, because it is satisfied in any context that entails $(\phi \wedge \psi) \rightarrow \chi$. Similarly, if we assume that embedded sentences of belief attributions should be interpreted with respect to what (it is presupposed that) the agent believes (as proposed by Stalnaker (1988) and Heim (1992)), a sentence of the form $\phi \rightarrow Bel(a, \psi_\chi)$ presupposes $\phi \rightarrow Bel(a, \chi)$, which can be strengthened to $Bel(a, \chi)$.

[16]The editor Philippe Schlenker rightly observed that in my reasoning here and in the rest of an earlier version of this paper I only made use of conditions (ii) and (iv) of Lemma 4.3. Perhaps this means that conditions (ii) and (iv) are all we need, but I find the (stronger) notion of independence I use more natural than just the combination of (ii) and (iv). Moreover, if the consequent or second conjunct of a complex sentence with ϕ as antecedent or first conjunct gives rise to a negated presupposition $\neg\chi$ (as in *After Ferdinant Magelhaes circumnavigated the earth, he* knew *that the earth isn't flat*), we require the condition 'If $\Diamond\phi$ and $\Diamond\chi$, then $\Diamond(\phi \wedge \chi)$' anyway (even though it follows from condition (ii)).

be accounted for in terms of independence as well. We either assume that ϕ and χ are *independent*, or not. If independence is more plausible, the unconditional presupposition follows.

Consider now (5-a), an example for which Beaver (1995) argued that strengthening should not go through. According to our reasoning this means that if we represent the sentence by $\phi \rightarrow \psi_\chi$, it has to be the case that ϕ and χ are not taken to be independent of each other. Because in the reasoning we would only make use of clause (ii) of Lemma 4.3, the following conditional would have to be false: $(\Diamond\phi \wedge \Diamond\neg\chi) \rightarrow \Diamond(\phi \wedge \neg\chi)$. Now take a presuppositional context in which $\Diamond\phi$ and $\Diamond\neg\chi$, i.e., it is possible that Jane takes a bath (at time t) and it is possible that there still is hot water (at time $t+n$). Depending on your (cultural) background it might be (for somebody from the third world, or who is not used to geysers) natural to assume that in that same context it is not possible that Jane takes a bath (at time t) and that there still is hot water (at time $t+n$), i.e. $\neg\Diamond(\phi \wedge \neg\chi)$. With such a (cultural) background, it is thus natural to assume that the independence assumption between ϕ and χ is not satisfied, and thus that the conditional presupposition (5-b) cannot be strengthened to an unconditional one. In a country like the Netherlands, however, independence is perhaps more natural to assume, in which case we predict that (5-a) gives rise to the unconditional presupposition.

5 Geurts' examples revisited

We have seen above that our proposal of how to strengthen conditional presuppositions is highly reminiscent to especially Karttuten & Peters' (1979) earlier suggestion. Unfortunately, Geurts (1996) has raised problems with this approach which might carry over to our proposal as well. His first argument is that if strengthening requires independence, this might seem natural to assume for a conditional like (8-a), but it seems less plausible for (8-b), although here too the sentence gives rise to the unconditional presupposition that the problem was solved:

(8) a. If the problem was *difficult*, then *it was*n't Morton *who* solved it.
b. If the problem was *easy*, then *it was*n't Morton *who* solved it.
c. If the problem was difficult/easy, then somebody solved the problem.
d. Somebody solved the problem.

To see whether this argument is problematic for us, let us assume with Geurts (1996) that clefts give rise to existential presuppositions.[17] Then it is easy to see that Geurts' objection to strengthening analyses based on independence is valid

[17]It is, in fact, controversial whether clefts give rise to such existential presuppositions. Kripke (ms), for instance, suggests that perhaps clefts presuppose questions. But Geurts' (1996) argument does not depend on this particular presupposition trigger, so we can just take over Geurts' assumption for the sake of argument.

for strong notions of independence. In probability theory, for instance, χ is said to be independent of ϕ if the probability of χ doesn't change if one learns that ϕ is the case: $P(\chi|\phi) = P(\chi)$.[18] This notion of independence is *very strong*: if learning ϕ has *any* influence on the likelihood of χ – however small – χ and ϕ are not counted as independent anymore. The notion of independence used here, however, is *much weaker*, and thus the inference to the unconditional proposition much *more robust*. It only requires χ and $\neg\chi$ to be *possible*, whether or not ϕ is true. For the inference from (8-b) to (8-d) to go through, this means that (ignoring the trivial case) it only has to be *compatible* with what is presupposed that somebody solved the problem, even though the problem was not easy. I think we can reasonably expect (8-d) to be independent in this weak sense of the antecedent of (8-b), and that is all we need for the inference to the unconditional proposition to go through.

Geurts' second objection to strengthening accounts is that if a speaker asserts a conditional, $\phi \rightarrow \psi_\chi$, he can take the antecedent of the conditional to be false. In that case the unconditional presupposition χ is not predicted, against intuition:

(9) If the problem was difficult, then *it was*n't Morton *who* solved it. But as a matter of fact the problem wasn't difficult at all.

What is wrong with this argument is that Geurts doesn't take the distinction between presupposition and assertion, or belief, seriously. The second sentence in (9) shows that the speaker *believes* that the problem was not difficult. Because what is presupposed is that which is commonly believed, this means that it cannot be presupposed that the problem was difficult. But it does not follow from this that it is *presupposed* that the problem was not difficult. In fact, for the second sentence to be appropriate, it must be the case that the problem being difficult must be *compatible* with what is presupposed, i.e., $[\phi](\sigma) \neq \emptyset$, and this is all that is needed to guarantee that on the assumption of independence (9) gives rise to the unconditional presupposition that somebody solved the problem.

[18] Merin (2003) suggested that although we might account for strengthening of conditional presuppositions to unconditional ones if we assume that antecedent and consequent of this presupposition are probabilistically independent, Geurts' (1996) example (8-b) shows that this reasoning is not good enough to account for our intuitions. Merin's reasoning to strengthen conditional presuppositions goes as follows: We first have to assume that presupposition states should be modelled by probability functions. Now take an indicative conditional, $\phi \rightarrow \psi$, whose consequent presupposes χ. This means that according to the satisfaction theory, the conditional as a whole presupposes $\phi \rightarrow \chi$. This means that the probability distribution P that models what is presupposed is such that $P(\phi \rightarrow \chi) = 1$. Let us assume that it is commonly assumed that χ is probabilistically independent of ϕ, i.e. $P(\chi|\phi) = P(\chi)$. Combining $P(\phi \rightarrow \chi) = 1$ and $P(\chi|\phi) = P(\chi)$, we would be able to conclude that $P(\chi) = 1$, if the probability of the conditional presupposition $\phi \rightarrow \chi$, $P(\phi \rightarrow \chi)$, is the same as the conditional probability of χ given ϕ, $P(\chi|\phi)$. Although this equivalence doesn't hold in general, it holds in extreme cases: $P(\phi \rightarrow \psi) = 1$ iff $P(\psi|\phi) = 1$, which is enough for our purposes. The notion of independence I use is not of the form $P(\chi|\phi) = P(\chi)$, but rather a set of conditions of the form 'If $P(\phi) > 0$ and $P(\chi) < 1$, then $P(\chi|\phi) < 1$', which is much weaker.

But, or so Geurts could argue, we can change (9) into a counterfactual statement so as to make clear that the speaker actually *presupposed* that the problem was not difficult:

(10) If the problem *had been* difficult, then it wouldn't have been Morton who solved it. But *as we all know*, the problem wasn't difficult at all.

In this case $[\phi](\sigma) = \emptyset$, i.e. $\neg\Diamond\phi$, and so it seems that we cannot conclude $\Box\chi$ anymore by independence. However, in this case we have to analyze the conditional sentence as a counterfactual, which means that we have to take worlds into account where the problem was, in fact, difficult. So, ϕ is compatible with the context in which the antecedent of the counterfactual is evaluated. This context is now something like $\sigma \cup \sigma^*_\phi$, the context which is just like σ except that acceptance of $\neg\phi$ is given up. In the theory of belief revision (Gärdenfors, 1988), $\sigma \cup \sigma^*_\phi$ is called the *contraction* of σ with $\neg\phi$, and defined in terms of the revision of σ with ϕ, σ^*_ϕ.[19] Obviously, for the conditional to be true, there can be no world in *this context* $\sigma \cup \sigma^*_\phi$ in which ϕ and $\neg\chi$ are both true (on a strict conditional account).[20] Assuming now that with respect to this context ϕ and χ are independent of each other, it means that χ must be true in all worlds of this context via our familiar reasoning. But if χ is true in all worlds in $\sigma \cup \sigma^*_\phi$, it obviously has to be true in

[19]The easiest way to think of this revision, in turn, is to assume a context-dependent ordering $\leq_\sigma$ on worlds, and define σ^*_ϕ as $\{w \in [\![\phi]\!] |\ \forall v \in [\![\phi]\!] : w \leq_\sigma v\}$, where $[\![\phi]\!]$ denotes the set of worlds in which ϕ is true.

[20]On a Lewis/Stalnaker account, the condition is somewhat different. Suppose that we interpret all conditionals in terms of similarity relations, and that we represent such conditionals by $\phi\Box\!\!\rightarrow \psi$. We can then assume that if ψ presupposes χ, $\phi\Box\!\!\rightarrow \psi$ presupposes $\phi\Box\!\!\rightarrow \chi$. Because $\phi\Box\!\!\rightarrow \chi$ is neither stronger nor weaker than χ, Geurts (1996) argues that on this assumption the proviso problem becomes even worse: the inference to χ cannot be due to some type of strengthening. Perhaps not, but the inference would still be the same. Suppose that $\leq^\tau_w$ is the given Lewis/Stalnaker similarity relation between worlds, where τ represents the accessible worlds potentially relevant for the interpretation of counterfactuals (what Lewis describes as the restricted field of the ordering $<_w$). Let σ denote the set of worlds consistent with what is presupposed in w, assuming that $w \in \sigma$. Then we can define the following similarity relation between worlds: $u \leq^{\sigma,\tau}_w v$ iff (i) $u \in \sigma$, or (ii) $u \notin \sigma$ but $u \leq^\tau_w v$ otherwise. Notice that $\leq^{\sigma,\tau}_w$ doesn't satisfy strong centering anymore (i.e., it doesn't have to be the case that w is the unique closest ϕ-world to w, if ϕ is true in w). In fact, it follows that in case ϕ is consistent with σ, the set of selected ϕ-worlds w.r.t. $w \in \sigma$ will just be $\phi \cap \sigma$. In case ϕ is not consistent with σ, the set of selected worlds w.r.t. $w \in \sigma$ will be $\{v \in [\![\phi]\!]^\tau : \neg\exists u \in [\![\phi]\!]^\tau : u <^\tau_w v\}$, where $[\![\phi]\!]^\tau = [\![\phi]\!] \cap \tau$ (I make the limit assumption). For indicative conditionals, condition (ii) of independence requires that the *might*-conditional $\phi\Diamond\!\!\rightarrow \neg\psi$ should be true, if ϕ and $\neg\psi$ are consistent with σ (where $\phi\Diamond\!\!\rightarrow \psi$ is defined as $\neg(\phi\Box\!\!\rightarrow \neg\psi)$). For counterfactuals, however, we can demand that the new condition (ii) requires that $\phi\Diamond\!\!\rightarrow \neg\psi$ should be true, if ϕ and $\neg\psi$ are consistent with τ. Something similar holds for the other conditions of independence. Suppose now that the speaker asserts the counterfactual $\phi\Box\!\!\rightarrow \psi_\chi$. Because the presupposition $\phi\Box\!\!\rightarrow \chi$ is inconsistent with $\phi\Diamond\!\!\rightarrow \neg\chi$, it follows by independence that either (i) ϕ is incompatible with τ or (ii) $\neg\chi$ is incompatible with τ. Because we assume that (i) is not the case, it follows that χ must be true in all worlds of τ. Because $\sigma \subseteq \tau$, it follows that the speaker presupposes that χ.

all worlds in σ, and it thus will be presupposed!

Geurts' third objection is closely related with his second objection. The objection is that whereas standard conversational implicatures can be cancelled, (11-b), the unconditional presupposition cannot, (11-c):

(11) a. If there are piranhas in the Rhine, then *Theo's wife* should know about it.
b. But of course, there are no piranhas in the Rhine.
c. ?But of course, Theo isn't married.

But again, this problem is due to the fact that Geurts doesn't make a distinction between what somebody presupposes and what somebody believes. What (11-a)-(11-b) illustrates is that somebody can assert a conditional sentence without *believing* that the antecedent is possible. This doesn't mean that one can assert a conditional appropriately in the indicative mood if the antecedent is *incompatible* with what is *presupposed* by the speaker and his conversational partners. Thus, (11-b) doesn't cancel the appropriateness condition associated with (11-a) with respect to the presupposition state at all. But this means that the 'contrast' between the appropriateness of (11-b) and the inappropriateness of (11-c) doesn't show what it is supposed to show. In fact, modulo independence (which is uncontroversial here), (11-a) presupposes that Theo is married, which is inconsistent with (11-c).

Geurts's fourth, and final, problem involves knowledge attributions:

(12) Walter knows that if the problem was difficult, then somebody solved it.

Everybody agrees that this sentence gives rise to a conditional presupposition that *cannot* be strengthened to an unconditional one. Geurts (1996) wonders why that could not be done via the same procedure Karttunen & Peters (1979) propose to strengthen other conditional presuppositions.

We have seen in section 4 that the conditional 'If the problem was difficult, then somebody solved it', represented by $\phi \rightarrow \psi$, cannot be asserted appropriately, if the speaker presupposes that the antecedent and consequent are *independent* of each other. It follows that somebody who would assert a conditional sentence cannot presuppose that the antecedent and consequent are independent of each other (or presupposes that they are *not* independent of each other).[21] Now we might argue

[21]This reasoning already explains why in contrast to (3-a), the conditional (i) cannot give rise to the inference that John's stick insects are dead (assuming with Karttunen and Peters (1979) that *managed* has no truth conditional impact, i.e., that *John managed to sit through a Chinese opera* is true iff John sat through a Chinese opera).

(3-a) If John has sprayed DDT, he *knows* that his stick insects are dead.

(i) If John has sprayed DDT, he has managed to kill his stick insects.

similarly for Walter. If somebody truly makes the knowledge attribution (12), it is natural to assume that this speaker presupposes that it is not the case that Walter know whether the embedded conditional is true for purely truth-conditional reasons. For otherwise the speaker would not have used the conditional embedded sentence. Thus, the speaker presupposes that Walter doesn't know that ϕ and ψ are independent of each other, and she presupposes that Walter's knowledge state is compatible with all of $\phi \wedge \psi$, $\neg\phi \wedge \psi$, and $\neg\phi \wedge \neg\psi$. Now, why would a speaker presuppose that Walter doesn't know (or knows that it is not the case) that ϕ and ψ are independent of each other? Most naturally, because the speaker herself doesn't presuppose that ϕ and ψ are independent of each other (or presupposes that they are not independent of each other). To see why this is most natural, let us say that χ denotes the proposition that ϕ and ψ are independent of each other.[22] Moreover, let us say that $\Box\chi$ represents the proposition that the speaker presupposes χ, and that $K(w, \chi)$ represents the proposition that Walter knows χ. A (most) natural default rule has it that if the speaker presupposes χ, she also takes it to be compatible with what is presupposed (for the sake of conversation) that agents who are not participants of the discourse (including Walter) know that χ: $\Box\chi \rightsquigarrow \Diamond K(w, \chi)$. By modus tollens[23] it follows that $\Box\neg K(w, \chi) \rightsquigarrow \neg\Box\chi$, which is exactly the assumption we used.[24] But if the speaker doesn't presuppose ϕ and ψ to be independent of each other, $\neg\Box\chi$, the strengthening from $\phi \rightarrow \psi$ to ψ cannot be made, and the conditional presupposition cannot be strengthened to an unconditional one.

6 Conclusion

In this short paper I proposed a new condition under which two propositions are independent of each other and have shown how this notion can be used to strengthen conditional presuppositions to unconditional ones. I have argued that our method of strengthening these presuppositions is not liable to the problems Geurts (1996) argued other proposed strengthening accounts are. In fact, our

Thus, we can explain the falsity of Van der Sandt's (1988, p. 115) claim that if we can strengthen the conditional presupposition of (3-a) to the unconditional one via any Gricean reasoning, we are forced to accept that also (i) must suggest that John's stick insects are dead.

[22] To make sense of this, we have to assume that what is presupposed is a *fact* about a world (in a modal model). Although we haven't assumed this in our simple framework stated in section 2, it is unproblematic to do so if we think of presuppositions in terms of accessibility relations (cf. Stalnaker (2002) and van Rooij (2005)).

[23] Though valid (for simple examples) in Veltman's (1996) system, it is, to be honest, not valid in most systems of non-monotonic reasoning.

[24] Of course, if it is presupposed that Walter *knows* that ϕ and ψ are not independent, $\Box K(w, \neg\chi)$, the reasoning to the speaker's belief or presupposition state follows already from what it means to *know* a proposition. If we don't make this assumption, however, we need the argument stated in the main text.

reasoning also suggests under which circumstances conditional presuppositions $\phi \rightarrow \chi$ are natural: in case it is presupposed that ϕ and χ are *dependent* on one another.

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