

Presupposition Accommodation: A Plea for Common Sense*

David Beaver
University of Stanford
dib@stanford.edu

1 Introduction

Life is short. There is not enough time to explain everything. As speakers, or writers, we are forced to make assumptions. It is common to be advised to fix in one's mind a picture of the audience, that is, to make an advance decision as to what the audience can be expected to know. Often, especially given limitations of time for speaking or space for writing, one is forced to take much for granted. As a result, cases of presupposition failure, the situation occurring when the speaker or writer takes for granted something of which the hearer or reader is not previously aware, are surely common. Somehow, hearers and readers cope, and usually without complaining.

The author, in most *genres*, assumes that the text will be read linearly, and further assumes, optimistically, that readers will gather information throughout the reading process. So what the author has is not a fixed picture of the common ground with the intended readership, but a rather rough cut and idealized movie of how this common ground should develop. Each frame in the movie approximates what is common between relevant aspects of (1) the author's beliefs at time of writing, and (2) the readers' beliefs as they reach some point in the text. At risk of straining the cinematic metaphor somewhat, it could be said that the text itself is analogous to a script, but with detailed screenplay and directorial instructions omitted. Barring a major scientific breakthrough, the corresponding film will never be put on general release, so precisely how the writer intends the information state of idealized readers to evolve as they read is never made public in all its technicolor glory. In this paper, I will describe in brief a model of how readers' information states do evolve, as they construct their own movies on the basis of the script.

*I would like to express my thanks to the organisers of the ITALLC conference, and to the anonymous referees of this paper. The paper extends work previously published as [Bea94c].

The theory to be developed in this paper can be thought of as providing a formal characterization of what Lewis [Lew79] called *accommodation*. But the model will differ markedly from existing proposals, in that most writers have taken accommodation to be a repair strategy, something that happens when the interpretation process goes wrong. Lewis seems to picture accommodation as a covert adjustment of what he calls the *conversational score*, a sort of creative accounting needed to make conversational ends meet. Van der Sandt's accommodation [vdS92], to take a more recent example, is a sophisticated cut-and-paste operation on Discourse Representation Structures (c.f. [Kam81]).

Accommodation, then, has been viewed as an essentially non-monotonic operation, overwriting our previous record of what had happened in a discourse to fit with new demands. The view espoused in this paper will be quite the contrary: accommodation will be analyzed as a *monotonic* operation, in the sense that it does not replace or destructively revise our information about a speaker or author, but further instantiates our knowledge, reducing the range of possibilities for what the speaker was assuming.

The main claim I will make is that when we accommodate, we look not only at the record of what has been said, but also behind what has been said, and consider explicitly what the author might have intended and what the author might have expected. The property of monotonicity will arise as a direct consequence of incorporating the reader's uncertainty about the authors assumptions. This type of reasoning under uncertainty will involve what is in the A.I. literature sometimes described as *common sense reasoning*. That is, the reasoning processes described will involve not only absolute knowledge of what the speaker believes or doesn't believe, but also knowledge of what is most *plausibly* believed. It will be assumed that agents are able to partially order alternative (partial) models of what another agent believes according to the plausibility of those models.

2 Theories of Presupposition and Accommodation

In this section, existing theories of presupposition will come under discussion. The reader is warned that these theories will be painted with a broad brush: for more detailed exegeses see [So89, Bea97]. Linguistic examples will be introduced which suggest that a more sophisticated notion of accommodation is needed than is found in any previous theories.

We will begin with what may be termed *semantic* theories, a large and heterogeneous class of theories which do not incorporate any notion of accommodation at all. A semantic theory of presupposition is one in which presupposition is accounted for in terms of truth and falsity conditions. Typically, in such theories truth conditions are calculated compositionally, independently of speaker

intention or discourse context.

Consider the following two sentences:

- 1 If Jane takes a bath, Bill will be annoyed that there is no more hot water.
- 2 If Jane wants a bath, Bill will be annoyed that there is no more hot water.

The predicate “annoyed that” is factive, and in these examples triggers the presupposition that there is no more hot water. Theorists proposing semantic accounts of presupposition may differ according to whether they predict that these triggered presuppositions become full presuppositions of the two sentences.¹ However, neither of the sentences “Jane wants a bath ” nor “Jane takes a bath” is logically related to the sentence “there is no hot water”, by which I mean that there are no entailment relations between these sentences. From a purely semantic point of view, there is thus no relevant difference between (1) and (2). So, in one crucial respect, I think proponents of semantic accounts will be forced to agree with each other: whatever the form of the analysis given for example (1), the same form of analysis must be used for (2).

An utterance of (1) does not suggest to me that there actually is no more hot water, but only that if Jane takes a bath, there will be no more hot water. On the other hand, (2) suggests strongly that there is no more hot water. I do not believe that any purely semantic theory of presupposition can account for this contrast.

By far the lion’s share of the existing literature on presupposition concerns semantic approaches, usually depending on some sort of multi-valued logic. None of these approaches is compatible with the claim that I will advance in this paper that the contrast between (1) and (2) is not naturally explained in terms of truth conditions but in terms of plausibility.

For those who find a contrast between the examples, the reason will presumably be that they are used to a situation where water supplies are limited. Thus it seems plausible to them that there is a causal relation between Jane taking a bath and the exhaustion of the hot-water supply. On the other hand no similarly plausible explanation suggests itself for why the hot-water supply should be dependent on Mary’s *desire* for a bath alone, and the conclusion is reached on hearing (2) that the hot-water shortage is an absolute, independent of the antecedent of the conditional.

Let us now move on to consider accounts of presupposition which incorporate a notion of accommodation. The approach developed here contrasts sharply with the formalization of Lewis’ accommodation which [Zee92] attributes to Heim, and with the DRT-based theory of presupposition accommodation developed by van der Sandt. Both the Zeevat-Heim and van der Sandt accounts

¹For instance, a semantic theory based on the Strong Kleene interpretation of the conditional would yield conditionalized presuppositions for both examples, i.e. “If Jane takes a bath then there is no more hot water” and “If Jane wants a bath then there is no more hot water” respectively. See [Bea97] for discussion.

provide notions of accommodation which might be termed *structural*: one might caricature them as involving *move- α* at the level of logical form. Let me explain. Heim [Hei83] characterizes accommodation as follows:

Suppose [a sentence] S is uttered in a context c which doesn't admit it... simply amend the context c to a richer context c', one which admits S and is otherwise like c, and then proceed to compute c' [updated with] S instead of c [updated with] S.

But how is the context to be amended? [Hei83] is unclear on this point. On Zeevat's interpretation of Heim's theory, if S is uttered in a context c which doesn't admit it, then there must be a specific unsatisfied proposition p which is presupposed by S, and the amendment consists in adding this proposition to c.² Heim says that accommodation will apply equally if S occurs in an embedded context. Thus if c admits R but does not admit a sentence "if R then S", and S presupposes the proposition α , then one way of proceeding is to add α to c, and then update this context with "if R then S". This is the alternative that she refers to as *global accommodation*: in effect the presupposition α is moved (and conjoined) to the front of the sentence, to yield " α and if R then S", and an update is then performed with the resulting formula. Heim also suggests that a presupposition may be added to some of the intermediate contexts involved in calculating an update, what she calls *local accommodation*. This has much the same effect as allowing alternative landing sites for α at the level of logical form. Thus if update with "if R then S" fails, she would offer three alternative ways of updating, corresponding to the sentences: " α and if R then S", "if (α and R) then S", and "if R then (α and S)". In van der Sandt's account, which I will not describe in detail here, the *move- α* flavor is even more obvious than in Heim's theory. Whereas in the Heim-Zeevat account α is essentially seen as a unit of propositional information, in van der Sandt's account α is found at a pseudo-syntactic, almost LF-like level of representational form, namely, as mentioned above, the Discourse Representation Structures of Kamp's DRT.

It can now be stated what I mean by a *structural* account of accommodation. A structural account is one in which any given presuppositional construction has a single conventionally presupposed proposition, and where accommodation associated with a sentence containing that construction consists of adding this proposition to some relevant context. Here the relevant contexts are the initial context, and some set of intermediate contexts which can be specified for each sentence type. The problem that I see for a purely *structural* account of accommodation is as follows: it is not possible to predict on structural grounds alone exactly what should be accommodated. In general, the exact accommodated

²Until recently I shared Zeevat's understanding of [Hei83]. However, Heim (p.c.) denies that she intended accommodation to be understood as the addition of a specific conventionally indicated proposition such as in Zeevat's interpretation, and has pointed out that her original text is quite non-committal. So what in this paper is referred to as the *Zeevat-Heim account* is probably not an account to which Heim herself would fully subscribe.

material can only be calculated with reference to the way in which world knowledge and plausibility criteria interact with the meaning of a given sentence. Let us consider another example:

3 If the North Korean ambassador turned up, then it is amazing that both the North and South Korean ambassadors are here.

If I overheard (3) at one of the high level diplomatic receptions to which I am regularly not invited, I would conclude that the South Korean ambassador was present. It is this inference — call it the SK-inference — that will now come under discussion.

It seems that the SK-inference must be related to the factive “amazed that” in the consequent of (3), which triggers the presupposition that both North and South Korean ambassadors are present. However, a speaker uttering (3) could not be taking for granted that both ambassadors were present, since the possibility of the North Korean ambassador having arrived is precisely what is under consideration. So, global accommodation of the triggered presupposition cannot be the appropriate explanation of the SK-inference.

What are the other possible readings of (3) in the van der Sandt or Heim-Zeevat theories? Accommodation in the context corresponding to the antecedent of the conditional in (3) would produce an interpretation which could be glossed as “if both ambassadors are here then that is amazing.” Accommodation in the context in which the trigger is found, i.e. in the consequent of the conditional, produces an interpretation “if the NK ambassador came, then both ambassadors are here, and that is amazing.” Of these, the latter form of accommodation comes closest to the intuitively correct interpretation. But, crucially, an account of the SK-inference is still missing.

One is tempted to formulate an analysis of (3) whereby the triggered presupposition is somehow split into two before accommodation kicks in. But such an analysis would be *ad hoc*, since there is no obvious general principle which would license splitting of the presupposition in this case, but not in others. I would advocate an alternative line of explanation for the SK-inference. Firstly, the form of sentence (3) leads to a conditional presupposition, roughly “if the NK ambassador came, then both ambassadors are here”. Secondly, world knowledge about what the speaker is likely to take for granted leads to strengthening of this presupposition. The mechanisms behind both of these steps will be detailed shortly.

If I am correct in my analysis of (3), then the failure of structural accounts of presupposition on this and related examples arises from two separate weaknesses. Firstly, such theories provide no way of accounting for conditionalized presuppositions, and secondly they provide no way of strengthening those conditionalized presuppositions where appropriate.

For the moment, the details of the analysis I will advocate are not important. What is important is the fact that structural theories can provide no account of

the SK-inference. The reason is simple: what the hearer accommodates is not the same proposition as is presupposed by any trigger in the sentence. Certainly, the accommodated information is related to what is triggered. But, in structural theories there is only one way that accommodated material can be related to triggered material: structural identity.

Here is another case where a conditional reading might be advocated:

4 If Spaceman Spiff lands on Planet X, he'll notice that he weighs more than on Earth.

The factive “notice that” in this case triggers the presupposition that Spiff’s weight is higher than it would be on Earth. Structural accounts of accommodation suggest that this proposition should be globally accommodated. However, it is questionable whether this result is appropriate. It is not normal to conclude from (4) that Spiff’s weight is definitely higher than it would be on Earth. Indeed, it seems natural for (4) to be uttered under conditions where Spiff is hanging about in space, and completely weight-less. Can non-global accommodation save the structural account? Accommodation into the antecedent produces something like “If Spaceman Spiff weighs more than on Earth and he lands on Planet X, he’ll notice he weighs more than on Earth.” I do not think this is a possible meaning of (4). Accommodation into the consequent appears to improve, yielding (after charitable adjustment of tense) “If Spaceman Spiff lands on Planet X, then he’ll weigh more than on Earth and will notice that he weighs more than on Earth.” This provides a reasonable meaning for (4), and offers hope that if only some way could be found of removing the two incorrect readings, the structural account might be saved. Unfortunately, a very slight variation on (4) produces an example where the structural account produces four incorrect (or, at the very least, non-preferred) readings, and completely fails to yield the preferred reading:

5 It is unlikely that if Spaceman Spiff lands on Planet X, he'll notice that he weighs more than on Earth.

The preferred reading of this sentence is still one involving the conditional implication, i.e. if he lands on Planet X, Spiff’s weight will be higher than it is on Earth, and quite natural assumptions about the dynamics of the “it is unlikely” construction would lead to the model presented here making the same presuppositional predictions for this example as for (4). But in this case the structural account no longer yields the right reading after accommodation into the consequent of the conditional. This would yield “It is unlikely that, if Spaceman Spiff lands on Planet X, he’ll weigh more than on Earth and notice that he weighs more.”, which does not imply that if he lands on Planet X, Spiff’s weight will be higher than it is on Earth. On the contrary, there is even a slight suggestion from this sentence that if he lands on Planet X his weight probably will not be higher than it is on Earth, which is clearly inappropriate.

There are versions of (4) in which the inability the van der Sandt and Heim-Zeevat accounts to produce the appropriate conditional presupposition are even more obvious:

6 If Spaceman Spiff is in our solar system, he'll land on Planet X, and will notice that he weighs more than on Earth.

7 If Spaceman Spiff lands on Planet X and notices that he weighs more than on Earth, he'll radio home about it.

Both of these examples seem to retain the conditional presupposition: the most likely conclusion of a reader remains that Planet X is the sort of place where one is particularly heavy, and if Spiff lands there, he will be heavy. Consider (6). Global accommodation of Spiff's weight being too high still seems wrong, and similarly accommodation into the antecedent of the conditional. But now even local accommodation fails to produce an appropriate conditional. A reading is derived along the lines of: "if Spiff is in our system, he'll weigh a lot, he'll land on planet X, and will notice that he weighs a lot." Thus the conclusion is that Spiff's weight is dependent on his being in the speaker's solar system. This, I suppose, is a possibility, but it is not the most plausible interpretation. Concerning (7), where the presupposition trigger is found in the antecedent of a conditional, structural accounts predict that only global accommodation and accommodation in that antecedent are possible. Thus there is absolutely no way to produce a reading where Spiff's being heavy is conditionalized. Global accommodation is as wrong as ever, and accommodation in the antecedent produces an interpretation of the sentence something like: "if Spiff's weight is high and he lands on our planet and he notices that his weight is high, then he'll leave." This is not a plausible interpretation of (7). These results pose a serious problem for the van der Sandt and Heim-Zeevat accounts.

What of the cancellation theory of presupposition proposed by Gazdar [Gaz79]? The basic idea is that when a sentence containing a presupposition trigger is uttered, by default the presupposed proposition will be projected. But if the presupposition is inconsistent with the previous context, with what is asserted by the sentence, with implicatures of the sentence, or with other presuppositions, then it is canceled. But the following following wonderful observation from [Hei83] shows that the cancellation account could easily be characterized as a structural theory of accommodation:

Note that by stipulating a *ceteris paribus* preference for global over local accommodation, we recapture the effect of [Gazdar's] assumption that presupposition cancellation occurs only under the threat of inconsistency.

Under Gazdar's assumption that presuppositions are also entailed by their triggers, his theory will only give one of two readings available in the accommo-

dation accounts³. Gazdar’s theory always gives one of two readings available in the accommodation accounts. If the presupposition is not canceled, then we derive the global accommodation reading, and if the presupposition is canceled, the assumption that presuppositions are also entailed by their triggers means that we obtain the same affect as local accommodation would produce. Clearly the above criticisms of structural theories of accommodation also apply to Gazdar’s superficially quite different account, for, as has been explained, neither global nor local accommodation produces the right result in the cases discussed.

In fact the prognosis for Gazdar’s theory is somewhat worse than for the van der Sandt and Heim-Zeevat accounts. The problem is that cancellation only occurs in the face of possible inconsistency, but in none of the Spiff examples (5–7) is there any entailment or implicature to threaten inconsistency with the presupposition that Spiff is heavier than he would be on Earth. Unless the context of utterance directly contradicts this proposition, Gazdar’s model will predict that utterances of all of (4–6) presuppose that Spiff is heavier than he would be on Earth. A similar point can be made concerning all the earlier examples. For instance with regard to (1) and (2), on the assumption that the utterance context does not expressly state that there is hot water, Gazdar’s model predicts that both these examples have the presupposition that there is no hot water. No account is given of the difference between these examples, this difference being too subtle for Gazdar’s “if it don’t fit, trash it” theory of presupposition to pick up.

To sum up this section, it has been argued that all purely semantic theories of presupposition, and all purely structural accommodation or cancellation based theories of presupposition are doomed to failure, for they lack common sense. The non-structural alternative to be proposed will rest on a relation of plausibility being defined across contexts (or, equivalently, across closed the-

³As for whether presuppositions are entailed by their triggers, that remains a moot point. [Bea97] argues that regarding most classes of presupposition trigger, failing to make this assumption would cause severe problems for the cancellation account. The most obvious difficulty that would arise if presuppositions were not taken to be entailed would be the lack of any explanation as to why presuppositions (at least for the vast majority of presupposition triggers) cannot be canceled when they are not embedded within a special context such as that created by negation. For instance, both “Cheese is good for you and Mary knows that it is bad for you” and “Cheese is good for you and it bothers Mary that cheese is bad for you” are odd. If the presuppositions of ‘knows that’ and ‘it bothers Mary that’ are also entailments, then the oddity is explained because the sentences are inconsistent. On the other hand, without the assumption of entailment, there is no obvious explanation, because Gazdar’s account predicts that inconsistency simply produces cancellation of presuppositions with no further effects. The same applies to other cancellation accounts such as [Mer92, vdS88, Soa82]. Dropping the assumption that presuppositions are entailed by their triggers, though it would not help with the treatment of Spaceman Spiff type examples being discussed here, would result in a model that could produce readings not found in the accommodation accounts. In that case, cancellation of a non-entailed presupposition would produce an interpretation in which the presupposition played no part whatsoever. This is impossible in the accommodation accounts, for in these theories the presupposition always ends up somewhere in the meaning, even if only within an embedded context.

ories). It will now be shown how the ordering defined by this relation might underly a model of presuppositional accommodation within a dynamic account of utterance interpretation.

3 The Writer’s View of the Common Ground

To return to the metaphor with which I began, in directing their own films readers second-guess the intentions of the original writer-director. But to understand how readers work out the writer-director’s intentions, it is firstly necessary to know more of the craft of the writer-director. In the coming section I will elaborate on how, working from an assumption as to initial conditions, the author envisages the evolution of the common ground. It will be helpful to adopt some of the formalism of recent dynamic semantics. I will build particularly on ideas of Stalnaker [Sta74], Karttunen [Kar74] and Heim [Hei83], and use formal techniques related to those discussed by Groenendijk and Stokhof, e.g. [GS91], and Veltman [Vel91]. I will present what will here be called Presupposition Logic, a simple propositional system with a dynamic semantics and dynamic notion of semantic entailment. Further discussion and motivation can be found in [Bea92, Bea93b, Bea94, Bea95].

Presupposition Logic provides a model of how a speaker or author envisages the common ground evolving. This evolution is iterative, since the common ground at any instant provides the context in which a given chunk of text is interpreted, and it is the effect of this interpretation which determines what the common ground will be prior to interpretation of the next chunk. It is no longer controversial to assert that the interpretation process relies on such iteration, but there remains some question as to the course-grainedness of the iteration. For instance in the work of Gazdar [Gaz79] (and also related proposals such as Mercer’s [Mer92]) it is whole sentences which produce a change in the context of interpretation. However in Karttunen-Heim style treatments of presupposition such as that introduced in this paper, as well as in treatments of anaphora due to Heim [Hei82], Kamp [Kam81] and Groenendijk and Stokhof [GS91], a finer grained iteration is involved, with sub-sentential constituents producing their own effects on local contexts of interpretation.

We begin by assuming some set of atomic proposition symbols. A model is a pair $\langle W, I \rangle$, where W is a set of worlds and I is an interpretation function mapping each atomic proposition symbol to a subset of W . The Context Change Potential (to borrow Heim’s terminology) of a formula ϕ , written $\llbracket \phi \rrbracket$, is a set of pairs of input and output contexts, where a context is the writer’s view of the common ground. Following Stalnaker, a context is thought of as a set of possible worlds, the set containing all and only those worlds compatible with the information supposed to be common. I will write $\sigma \llbracket \phi \rrbracket \tau$ to indicate that the pair $\langle \sigma, \tau \rangle$ is in the $\llbracket \phi \rrbracket$ relation, i.e. an input context σ updated with the information in ϕ can produce an output context τ .

Defining contexts as subsets of W introduces a natural lattice structure with union and intersection as meet and join, and this lattice provides a model-theoretic characterization of the amount of information in a given context. A minimal context (with respect to some model) may be defined as the set of all worlds (in that model): this is the state of blissful ignorance in which no information about the world is available. Similarly a maximally informative non-contradictory context would be a singleton set: the available information rules out all except one world. However, it is possible to add even more information to such a context, and in case this information contradicts previous information we will arrive at a context containing no worlds, a truly maximal but contradictory context.

Definition D1, below, gives an update semantics for the language of propositional logic. The first clause says that the result of updating a context with an atomic proposition is an output containing only those worlds in the input which are in the extension of the proposition. A context can be updated with a conjunction of two formulae (the second clause) just in case it can firstly be updated with the left conjunct to produce an intermediary context (v in the definition), and this context can be updated with the right-hand conjunct to produce the final output (τ). The third clause says that a context can be updated with the negation of a formula just in case there is some state that can be obtained by updating the context with the negated formula itself, in which case the result of updating with the whole formula is the set of worlds in the input which are not present in the update with the negated formula. In other words, the effect of updating with the negation of a formula is to remove all information compatible with the formula. The final two clauses define implication and disjunction by (carefully selected) standard equivalences.

Definition D1 (Update Semantics for Propositional Logic) *For all models $\mathcal{M} = \langle W, I \rangle$ and information states σ, τ , the relation $[\cdot]^{\mathcal{M}}$ (superscript omitted where unambiguous) is given recursively by:*

- (1) $\sigma[p_{\text{atomic}}]\tau$ iff $\tau = \{w \in \sigma \mid w \in I(p)\}$
- (2) $\sigma[\phi \wedge \psi]\tau$ iff $\exists v \sigma[\phi]v[\psi]\tau$
- (3) $\sigma[\neg\phi]\tau$ iff $\exists v \sigma[\phi]v \wedge \tau = \sigma \setminus v$
- (4) $\sigma[\phi \rightarrow \psi]\tau$ iff $\sigma[\neg(\phi \wedge (\neg\psi))]\tau$
- (5) $\sigma[\phi \vee \psi]\tau$ iff $\sigma[\neg(\neg\phi \wedge \neg\psi)]\tau$

A context σ satisfies a formula ϕ ($\sigma \models \phi$) if updating adds no new information, producing an output identical to the input. One formula entails another ($\phi \models \psi$) if any update with the first produces a context in which the second is satisfied:

Definition D2 (Satisfaction and Dynamic Entailment)

$$\begin{aligned} \sigma \models \phi & \text{ iff } \sigma \llbracket \phi \rrbracket \sigma \\ \phi \models \psi & \text{ iff } \forall \sigma, \tau \ (\sigma \llbracket \phi \rrbracket \tau \Rightarrow \tau \models \psi) \end{aligned}$$

Over the standard propositional language this notion of entailment is classical. However, we will now extend the language with a presupposition operator, written ∂ . The resulting logic will be non-classical. For example, commuting conjunctions will no longer uniformly preserve validity. The intuition behind the following definition is that a formula $\partial\phi$ (“the presupposition that ϕ ”) places a constraint on the input context, only allowing update to continue if the presupposed proposition is already satisfied.

Definition D3 (Presupposition Logic) *Presupposition Logic is defined over the language of Propositional Logic with an extra unary operator ∂ . It has the dynamic notion of semantic entailment above, and semantics consisting of the update semantics for atomic propositions and standard connectives combined with the following interpretation for ∂ -formulae:*

$$\sigma \llbracket \partial\phi \rrbracket \tau \text{ iff } \sigma \models \phi$$

As an example, the sentence “Mary realizes that John is sleepy” might be said to correspond to a formula in Presupposition Logic of the form $\partial p \wedge q$, where p is atomic proposition that John is sleepy, and q is an atomic proposition that Mary has come to believe that John is sleepy. In this paper I will not be concerned with the details of how such logical forms may be derived from natural language, or with the question of whether it is reasonable to use a representation in which presuppositions are divided explicitly from assertions using the ∂ -operator. However, both these issues are dealt with elsewhere: see [Bea93a, Bea93b, Bea95] where two sorted versions of classical type theory are used to provide a Presupposition Logic style semantics for a fragment of natural language.

Suppose a formula contains a presuppositional sub-formula. What will the presuppositions of the whole formula be? This is the presupposition projection problem of Langendoen and Savin [LS71], except applied to Presupposition Logic rather than natural language. A formula $\partial\phi$, “the presupposition that ϕ ”, defines an update if and only if ϕ is satisfied, so it is natural to say that in general a formula presupposes all those formulae that must be satisfied by the input context in order for there to be an update. We say that a context σ admits a formula ϕ (written $\sigma \triangleright \phi$) if and only if it is possible to update σ with ϕ , this being a formalization of Karttunen’s notion of admittance in [Kar74]. In that case one formula ϕ presupposes another ψ (written $\phi \gg \psi$) just in case every context that admits the first satisfies the second. Note that admittance provides a counterpart to so-called *presupposition failure*, what happens when updating cannot continue because presuppositions are not satisfied.

Definition D4 (Admits (\triangleright) and Presupposes (\gg))

$$\begin{aligned} \sigma \triangleright \psi & \text{ iff } \exists \tau \sigma \llbracket \phi \rrbracket \tau \\ \phi \gg \psi & \text{ iff } \forall \sigma \sigma \triangleright \phi \Rightarrow \sigma \models \psi \end{aligned}$$

It is clear that the definitions for the semantics of the ∂ -operator and the meta-logical \gg relation are closely related. For example we have that for any ϕ , $\partial\phi \gg \phi$. Indeed, \gg could have been equivalently defined in terms of ∂ , defining $\phi \gg \psi$ iff for some χ , $\llbracket \phi \rrbracket = \llbracket \partial\psi \wedge \chi \rrbracket$.

We can now study projection in Presupposition Logic. As detailed in F1, the system behaves just as anyone familiar with Karttunen's 1974 system would expect. In particular, note that a formula may fail to carry a presupposition of one of its component sub-formulae, but instead carry a logically weaker conditionalized variant.

Fact F1

If $\phi \gg \psi$ then:

$$\begin{aligned} \neg\phi & \gg \psi \\ \phi \wedge \chi & \gg \psi \\ \phi \rightarrow \chi & \gg \psi \\ \phi \vee \chi & \gg \psi \\ \chi \wedge \phi & \gg \chi \rightarrow \psi \\ \chi \rightarrow \phi & \gg \chi \rightarrow \psi \\ \chi \vee \phi & \gg (\neg\chi) \rightarrow \psi \end{aligned}$$

4 The Naive Reader

Readers who updated their own information state according to principles like those behind the semantics of Presupposition Logic would be stymied whenever some information was presupposed which they did not have. In this situation the reader would lack any further means of updating. So Presupposition Logic, as it stands, does not provide a good model of the evolution of the information state of a hearer or reader. But suppose that you only had a Presupposition Logic-like semantics to help you understand a text. How would you use that semantics to glean information?

If an infinite number of monkeys with typewriters were given time, some of them might produce this text. What if an infinite group of monkeys schooled in the writer-director approach to writing described above were given some rhetorical goal but no description of the intended audience? They might choose the initial common ground randomly, although after that each monkey's view of the common ground at a particular point in the text would be fully determined

by what they typed. Now although as a reader you do not know what initial common ground has been assumed when you read a text, you can reason for any particular choice of initial conditions how the common ground would evolve. And this leads me to a suggestion for how a dynamic semantics like that given for Presupposition Logic could be used to understand a text without presupposition failure being problematic.

Begin the reading process by imagining an infinite number of monkeys (or as many as you can manage) with an infinite number of assumed initial common grounds, your goal being to find out which monkey wrote the text. As you read, separately update each of these contexts. At various stages presuppositional constructions will be encountered, and these are what sort out the wheat from the chaff. For whenever something is presupposed which has not been explicitly introduced earlier in the text, a number of monkeys drop out of contention, and there remain only those monkeys for which the assumed common ground corresponding to that point in the text satisfies the presupposition. In general, this process may not tell you exactly which monkey was responsible, but it will at least limit the options, and it will simultaneously tell you quite a lot about what information you were intended to have after reading the text.

The many-monkeys strategy can easily be formalized in terms of the semantics of Presupposition Logic. A reader's information state is identified with a set of contexts — I will use the term *information set* — and is thus a subset of the powerset of worlds. A state can be updated with a formula by updating each of the member contexts separately, so producing the following definition of the update of a state I with a formula ϕ :

Definition D5 (Updating Information Sets)

$$I + \phi = \{\tau \mid \exists \sigma \in I \sigma \models \phi\}$$

By definition, let us say that an information set satisfies a formula only if its member contexts satisfy the formula:

Definition D6 (Satisfaction by an Information Set)

$$I \models \phi \quad \text{iff} \quad \forall \sigma \in I \sigma \models \phi$$

The earlier notion of entailment could easily be defined in terms of the new notion of information, as the following fact demonstrates. (Here $\mathcal{P}(W)$ is the powerset of the set of worlds W .)

Fact F2

$$\begin{aligned} \phi \models \psi & \quad \text{iff} \quad (\mathcal{P}(W) + \phi) \models \psi \\ & \quad \text{iff} \quad \forall I (I + \phi) \models \psi \end{aligned}$$

5 The Sophisticated Reader

The naive reader might imagine an infinite number of monkeys, and use only information from the text to help find out which monkey is the author. But other information is available, if not of an absolute character. We cannot initially say of any given proposal as to the assumed common ground that it is impossible, and to this extent it is necessary to consider all possibilities. But we can say that some proposals are relatively more plausible than others. The sophisticated reader considers what assumption the author is *likely* to have made as to the initial common ground.

The assumptions of an author, whatever they are, determine a Presupposition Logic context, a set of worlds. A reader's knowledge of which assumptions are most plausible determines an ordering over these contexts, what I will call a *plausibility ordering*. A plausibility ordering relative to some model is a reflexive, transitive binary relation over a subset of the powerset of the set of worlds. For an ordering π , $\sigma \geq_{\pi} \tau$ is written for $\langle \sigma, \tau \rangle \in \pi$, and $\sigma >_{\pi} \tau$ is taken to mean that both $\sigma \geq_{\pi} \tau$ and $\tau \not\geq_{\pi} \sigma$. An ordering π can be updated with a new formula by considering every pair in the ordering, and updating each element of the pair separately according to the principles of Presupposition Logic. The following definition is obtained:

Definition D7 (Updating Plausibility Orderings)

$$\pi + \phi = \{ \langle \sigma', \tau' \rangle \mid \exists \langle \sigma, \tau \rangle \in \pi \sigma \llbracket \phi \rrbracket \sigma' \wedge \tau \llbracket \phi \rrbracket \tau' \}$$

Under this definition, certain contexts may drop out of contention in the update process, just as with the naive updating process considered earlier. An example may clarify. Suppose that $\llbracket \phi \rrbracket = \{ \langle \sigma, \sigma' \rangle, \langle v, v' \rangle \}$, and that we wished to update the ordering $\pi = \{ \langle \sigma, \sigma \rangle, \langle \tau, \tau \rangle, \langle v, v \rangle, \langle \sigma, \tau \rangle, \langle \sigma, v \rangle, \langle \tau, v \rangle \}$ with ϕ . Returning to the earlier metaphor, the reader is considering three different *movies* that the writer-director might have intended, and at the current point in the text the candidates for the correct frame are σ , τ and v , with a plausibility ordering $\sigma \geq_{\pi} \tau \geq_{\pi} v$. The reader should now verify that $\pi + \phi = \{ \langle \sigma', \sigma' \rangle, \langle v', v' \rangle, \langle \sigma', v' \rangle \}$. Observe that since τ cannot be updated with ϕ , there is no next frame from the film containing τ in the new ordering, and we are left with only two candidate films, with current frames σ' and v' ordered $\sigma' \geq_{\pi+\phi} v'$. So the fact that frames σ and v were in a certain ordering relation means that the next frames in those films are in the corresponding ordering relation after update. A more sophisticated model would perhaps allow juggling of orderings in the update process, to allow for what Gricean conversational analysis might tell us about the author's knowledge and intentions.

Before considering how we might make use of plausibility orderings, let us see how the earlier notion of entailment could be defined in terms of them. The *domain* of an ordering π , written $\star\pi$, can be defined as the set of contexts which are at least as plausible as themselves in the ordering, and this allows retrieval

from a plausibility ordering of a corresponding information set. This in turn permits the definition of a notion of satisfaction of a formula by a plausibility ordering in terms of the earlier notion of satisfaction by an information set:

Definition D8 (Domain of an ordering and ‘Ordinary’ Satisfaction)

$$\begin{aligned} \star\pi &= \{\sigma \mid \sigma \geq_{\pi} \sigma\} \\ \pi \models \phi &\text{ iff } \star\pi \models \phi \end{aligned}$$

Given such a notion of satisfaction, it should be clear that it would be straightforward to define a notion of entailment equivalent to that given earlier. However, it is also possible to define alternative notions of entailment relative to any given plausibility ordering. Let us say that the set of *preferred contexts* in an ordering π , written $\uparrow \pi$, is the set of all contexts which are at least as plausible as any context in the ordering. Then we can say that an ordering π *preferentially satisfies* a formula ϕ , written $\pi \triangleright \phi$, if the set of preferred contexts in π satisfies ϕ . Preferential satisfaction is a weaker notion than satisfaction, in that an ordering may preferentially satisfy more formulae than it satisfies. We may now say that a formula ϕ preferentially entails a formula ψ relative to an ordering π , written $\phi \triangleright_{\pi} \psi$, if updating π with ϕ produces an ordering which preferentially satisfies ψ . Here are the formal definitions:

Definition D9 (Preferential Satisfaction and Entailment)

$$\begin{aligned} \uparrow \pi &= \{\sigma \mid \forall \tau \in \star\pi \sigma \geq \tau\} \\ \pi \triangleright \phi &\text{ iff } \uparrow \pi \models \phi \\ \phi \triangleright_{\pi} \psi &\text{ iff } \pi + \phi \triangleright \psi \end{aligned}$$

In the case of a trivial ordering consisting of the cross-product of the powerset of worlds $\pi_0 = \mathcal{P} \times \mathcal{P}$, for which every set of worlds is at least as plausible as every other set of worlds, this notion collapses into the earlier entailment:

Fact F3

$$\phi \models \psi \text{ iff } \phi \triangleright_{\pi_0} \psi$$

Recall the following earlier cited pair of examples:

- 1 If Jane takes a bath, Bill will be annoyed that there is no more hot water.
- 2 If Jane wants a bath, Bill will be annoyed that there is no more hot water.

On the earlier analysis, (1) is compatible with the standard CCP prediction of a conditional reading, indicating that if Jane takes a bath, there will be no more hot water. On the other hand (2) leads to a stronger conclusion not predicted by the standard CCP model, namely that there actually is no more hot water. The current revision of the CCP model will predict the contrast provided the following plausibility assumptions hold:

- At least one alternative in which it is established that there is no hot water is more plausible than all alternatives in which it is not known whether there is hot water, but in which it is known that if Jane wants a bath then there will be no hot water.
- An alternative in which it is not known whether or not there is hot water but in which it is established that if Jane has a bath then there will be no more hot water must be at least as plausible as all alternatives where it is definitely established that there is no hot water.

The contrast between (1) and (2) results from our ability to find a commonsensical explanation of the lack of hot water in terms of somebody having taken a bath, as against our inability to fully explain a lack of hot water in terms of somebody simply wanting a bath. The simple assumption that there is a finite amount of relevant hot water — about a bathful — is sufficient to allow justification of there being no more hot water in situations where Jane has just taken a bath. However, the same simple assumption would not suffice in the case of (2), and a number of other assumptions would be needed, such as the assumption that if Jane wants a bath then she will definitely take one. Thus it is the relative plausibility of assumptions not explicitly mentioned in the text of the example sentences that determines what is implicated.

Let us see how some of this analysis of (1) and (2) may be crudely formalized. For expository purposes, I will ignore many obviously relevant issues, such as temporal connections between antecedent and consequent clauses in the conditionals. Let us represent “Jane takes a bath” as “JTB”, “Jane wants a bath” as “JWB”, “there is no hot water” as “NHW”, and “Bill will be annoyed that there is no more hot water” as $\partial\text{NHW} \wedge \text{BA}$. Now suppose that our common sense knowledge of the relative plausibility of different assumptions is encoded in a plausibility ordering π . The two conditions required of π may be formalized as follows:

- $\exists \sigma \in \star\pi \sigma \models \text{NHW}$ and
 $\forall \tau \in \star\pi$ if $(\tau \not\models \text{NHW}$ and $\tau \models \text{JWB} \rightarrow \text{NHW})$ then $\sigma >_{\pi} \tau$
- $\exists \sigma \in \star\pi \sigma \not\models \text{NHW}$ and $\sigma \models \text{JTB} \rightarrow \text{NHW}$ and
 $\forall \tau \in \star\pi$ if $\tau \models \text{NHW}$ then $\sigma \geq_{\pi} \tau$

If π conforms to these requirements, then we have the following preferential entailments:

$$\begin{aligned} \text{JWB} \rightarrow (\partial\text{NHW} \wedge \text{BA}) &\triangleright_{\pi} \text{NHW} \\ \text{JTB} \rightarrow (\partial\text{NHW} \wedge \text{BA}) &\not\triangleright_{\pi} \text{NHW} \\ \text{JTB} \rightarrow (\partial\text{NHW} \wedge \text{BA}) &\triangleright_{\pi} \text{JTB} \rightarrow \text{NHW} \end{aligned}$$

In other words, with respect to π , whilst example (2) preferentially entails that there is no more hot water, example (1) preferentially entails not that there is no more hot water, but that if Jane takes a bath then there is no more hot water.

Some further comment on this analysis of examples (1) and (2) is appropriate here, for an apparent difficulty with the analysis can in fact be quite instructive as regards revealing more about the nature of presupposition accommodation. Regarding (1), there is the possibility either of accommodating that *if Jane takes a bath there is no hot water* or accommodating that *there is no hot water* period. The weaker conditional appears to be preferred. On the other hand, the treatment of (2) seems to involve the reverse situation, with a logically stronger (i.e. non-conditionalized) proposition being accommodated. How can it be that a sometimes a logically stronger proposition is considered more plausible than a logically weaker one, and sometimes *vice versa*⁴?

The enigma arises from a misidentification of the accommodation process with the addition of single propositions, and a misidentification of the ordering over epistemic alternatives as an ordering over propositions. The plausibility ordering should not be thought of as an ordering over propositions, but over logically closed sets of propositions, that is an ordering over *theories*.

I am not committed to any claim about the conditional *if Jane takes a bath there is no hot water* being more plausible than the proposition *there is no hot water*, and I am not committed to *there is no hot water* being more plausible than *if Jane wants a bath there is no hot water*. Rather, I would claim that there must be a relevant closed theory containing the first conditional which is more plausibly taken to be the common ground than every relevant closed theory containing the simple proposition. Similarly, there must be a theory containing the simple proposition which is more plausible than every theory which contains the second conditional but not the simple proposition. There is no reason to assume that any relation of inclusion (the *theory* level counterpart of propositional entailment) holds between these various theories.

So contexts could profitably be thought of as logically closed theories, and what is accommodated does not hang on the relative plausibility of alternative propositions, but on the relative plausibility of alternative theories. And this, indeed, was a theme implicit in my informal analyses of the other examples discussed in section 2 of this paper. The Spaceman Spiff examples, for instance, were explained not in terms of the plausibility of one or other presupposed proposition, but in terms of the relative plausibility of alternative theories concerning the dependence of Spiff's weight on external conditions and the nature of those conditions.

⁴This objection, that plausibility appears oddly disconnected from entailment, was first made to me by Henk Zeevat. The same objection can be found in [Ge96]. Note that some other objections of Geurts have been discussed in [Bea94b].

6 Discussion

My aim has been to show how the process of text understanding is related to our common sense knowledge of the world and of other agents, and not to account for the source of that knowledge. No theory has been provided of how agents perform the feat of ordering alternative belief models by plausibility, of why, for instance, the conditions imposed on π to explain the contrast between (1) and (2) arise. Such an analysis would certainly go beyond the intended scope of this paper.

If one takes a narrow view of linguistics, then one can see this paper as establishing firstly a negative conclusion: there are limits on how much of the data concerning presupposition can be naturally explained by linguistic argumentation alone, and previous theorists have sometimes over-stepped those limits.

Looked at programmatically, what this means is that we are now faced with an interdisciplinary task in which linguists and other cognitive scientists must cooperate to provide integrated models of text understanding and common sense reasoning. Does the model presented in this paper, which as I have said does not claim to give any account of common sense reasoning, take us any closer to a practical basis for such collaborative effort? It seems to me that, in this respect, one shortcoming of the model I have presented is that it does not provide an interface with any existing theory of common sense reasoning. Ideally, in so far as the problems of text understanding are really reducible to separate problems of a linguistic and of an inferential nature, the linguist should perhaps be providing a ‘plug-in module’ which could be bolted on top of an arbitrary theory of general reasoning. I have certainly not achieved that. But it is at least possible to see how plausibility orderings could be related to other cognitive models.

Most obviously, we might ask how plausibility orderings relate to what are sometimes called *Bayesian* models of epistemic states on which there is a large literature (see e.g. [Gar88]). In a Bayesian theory epistemic states are modeled as functions from sentences of some formal language to probabilities, with certain additional constraints on what counts as an appropriate function. In fact there is a fairly obvious way to progress towards a restatement of the model I have presented which does not assume a relative ordering of plausibility over sets of worlds, but instead utilizes an absolute assignment of probability to sentences. We could define a plausibility ordering π_p in terms of a Bayesian epistemic probability function p :

$$\begin{aligned} \pi_p = & \{ \langle \sigma, \tau \rangle \in \mathcal{P}(\mathcal{W}) \times \mathcal{P}(\mathcal{W}) \mid \\ & p(\bigwedge \{ \phi \mid \sigma \models \phi \}) \geq p(\bigwedge \{ \phi \mid \tau \models \phi \}) \} \end{aligned}$$

Defining plausibility orderings in this way raises many questions. For instance, what are the properties of plausibility orderings thus defined, and, con-

versely, which properties of probability functions would lead to attractive properties for plausibility orderings. Which properties of plausibility orderings π_p are preserved across updates on orderings as defined in the current paper? Studying this last question might in turn lead to suggestions as to how the notion of update might be modified.

More generally, I do not claim that the probability-based definition provides any deeper insight into the nature of common sense reasoning I have invoked in this paper, but at least it taps into a long and venerable tradition of analyses of reasoning under uncertainty.

And here I should perhaps add that interpreting the orderings I have used in terms of probability is not the only possibility. One could also, for instance, draw a profitable analogy between the treatment of presupposition in this paper and the common-sense driven analyses of discourse and temporal relations in the work of Asher, Lascarides and Oberlander (see e.g. [LA93]) who use a special purpose non-monotonic logic. One might take various temporal expressions (e.g. tensed verbs) as presupposing some temporal reference with accommodation then being necessary to build the most plausible link between previously introduced temporal discourse referents and the new reference point.

Hobbs and co-workers (see e.g. [HSAM93]) have presented models of the interpretation process based on *weighted abduction*. In the process of text comprehension, utterances are understood to provide only partial information as to utterance meaning, and some information must be abduced. The abducible information is assigned different weights according to both world knowledge and knowledge of grammar. So far as I know Hobbs is not committed to any direct interpretation of these weights in terms of probability: for instance one imagines that the weights could also in principle depend on processing cost. Now it should be clear that the epistemic alternatives in a plausibility ordering correspond loosely to abducible sets of propositions, with my notion of relative plausibility corresponding to Hobbs' use of absolute weight. Given this analogy, it would be of interest to further explore the possibility of recasting the model I have proposed in terms of abduction, or to attempt to build a computer implementation based on the model of presupposition I have assumed but in which an abductive inference engine served the function of the plausibility ordering.

Having mentioned processing cost, one is reminded of proposals to treat presuppositions in terms of Sperber and Wilson's *relevance theory* [SW84]. Sperber and Wilson have applied a psychologically motivated notion of the cost of an inference to explain a wide range of linguistic phenomena including presupposition. To what extent should the data I have discussed be explained in terms of plausibility and to what extent in terms of processing cost? This is a complicated empirical question, and, given the difficulties of providing psychologically plausible formal models of processing, it also brings with it methodological questions. But I would not wish to deny Sperber and Wilson's claim that processing factors are at work, and it might at least be of philosophical interest to consider reinterpreting plausibility orderings as indicating not relative plausibility but

relative cost of different inferences.

To sum up, in this paper I have claimed that when we accommodate, we look not only at the record of what has been said, but also look behind what has been said, and consider what the author might have intended and what the author might have expected. This sort of reasoning may be called *reconstructed reasoning* in the sense that it involves a reconstruction of the speaker's assumptions and intentions. In the context of existing theories of presupposition, the claim that an empirically adequate account of presupposition must take reconstructed reasoning into account appears radical. Yet the model proposed is intended to be *conservative*, in that an existing line of research (i.e. the Karttunen/Stalnaker/Lewis/Heim dynamic treatment of presupposition) is used as the basis of a model which incorporates this sort of reasoning process. Furthermore, as I have tried to show in this closing section, my proposal to model accommodation in terms of general inference processes which are dependent in large part on non-linguistic information is not made in a vacuum: a number of other researchers have come to similar conclusions with respect to both presupposition and other phenomena. I am very much in agreement with Richmond Thomason, who seeks a notion of accommodation that is yet more sophisticated than the one I have proposed here, since it takes into account not only the beliefs, but also the communicative goals of other agents: "Concentrating on accommodation means shifting to reconstructed reasoning that underlies utterances. And it suggests that certain reasoning processes, such as intention recognition and cooperation are central. Successful accommodation requires that we first recognize someone's intention to achieve a goal, and then establish goals of our own that will assist in achieving this goal." [Tho90]

References

- [Bea92] Beaver, D., 1992. *The Kinematics of Presupposition* Proceedings of the Eighth Amsterdam Colloquium, ILLC, University of Amsterdam.
- [Bea93a] Beaver, D., 1993. "Kinematic Montague Grammar", in Kamp, H. (ed.), *Presupposition*, DYANA-2 deliverable R2.2a, University of Amsterdam.
- [Bea93b] Beaver, D., 1993. *What Comes First in Dynamic Semantics*, ILLC report LP-93-15, University of Amsterdam.
- [Bea94] Beaver, D., 1994. "When Variables Don't Vary Enough", in Harvey, M. and Santelmann, L. (eds.), *SALT 4*, Cornell.
- [Bea94b] Beaver, D., 1994. "Accommodating Topics", in van der Sandt, R. and Bosch, P. (eds.), *The Proceedings of the IBM/Journal of Semantics Conference on Focus, Vol.3*, IBM Heidelberg, pp.439–448.

- [Bea94c] Beaver, D., 1994. *An Infinite Number of Monkeys*, Acta Linguistica Hungarica, Vol. 42 (3–4), pp. 253–270.
- [Bea95] Beaver, D., 1995. *Presupposition and Assertion in Dynamic Semantics*, PhD Dissertation, University of Edinburgh. To appear, Studies in Logic, Language and Information, CSLI, Stanford.
- [Bea97] Beaver, D., 1997. “Presupposition”, in van Benthem, J. and ter Meulen, A. (eds.), *The Handbook of Logic and Linguistics*, Elsevier, pp. 939–1008.
- [Gar88] Gardenförs, P., 1988. *Knowledge in Flux: Modeling the Dynamics of Epistemic States*, M.I.T. Press, Cambridge, Mass.
- [Gaz79] Gazdar, G., 1979. *Pragmatics: Implicature, Presupposition and Logical Form*, Academic Press, New York.
- [Ge96] Geurts, B., 1996. *Local Satisfaction Guaranteed: A Presupposition Theory and its Problems*, Linguistics and Philosophy 19(3), 259–294.
- [GS91] Groenendijk, J. and Stokhof, M., 1991. *Dynamic Predicate Logic*, Linguistics and Philosophy 14(1), 39–100.
- [Hei82] Heim, I., 1982. *On the Semantics of Definite and Indefinite Noun Phrases*, PhD dissertation, University of Amherst.
- [Hei83] Heim, I., 1983. “On the Projection Problem for Presuppositions”, in Barlow, M., Flickinger, D. and Westcoat, M. (eds.), *Second Annual West Coast Conference on Formal Linguistics*, University of Stanford, pp.114–126.
- [HSAM93] Hobbs, J., Stickel, M., Appelt, D. and Martin, P., 1993. *Interpretation as Abduction*, Artificial Intelligence 63, 69–142.
- [Kam81] Kamp, H., 1981. “A Theory of Truth and semantic Representation”, in Groenendijk, J., Janssen, T. and Stokhof, M. (eds.) *Formal Methods in the Study of Language*.
- [Kar74] Karttunen, L., 1974. *Presuppositions and Linguistic Context*, Theoretical Linguistics 1.
- [KP79] Karttunen, L., and S. Peters, 1979. “Conventional Implicatures in Montague Grammar”, in Oh, C. and Dineen, D. (eds.), *Syntax and Semantics 11: Presupposition*, Academic Press, NY.

- [LS71] Langendoen, D. and H. Savin, 1971. “The Projection Problem for Presuppositions”, in Fillmore, C. and Langendoen, D. (eds.), *Studies in Linguistic Semantics*, Holt, Reinhardt and Winston, New York.
- [LA93] Lascarides, A. and Asher, N., 1993. *Temporal Interpretation, Discourse Relations and Commonsense Entailment*, Linguistics and Philosophy 16:5, pp 437–495.
- [Lew79] Lewis, D., 1979. *Scorekeeping in a Language Game*, Journal of Philosophical Logic 8, pp. 339–359. Also appears in Bäuerle, R., Egli, U. and von Stechow, A. (eds.), *Semantics from Different Points of View*, Berlin.
- [Mer92] Mercer, R., 1992. *Default Logic: Towards a Common Logical Semantics for Presupposition and Entailment*, Journal of Semantics 9:3.
- [vdS88] van der Sandt, R., 1988. *Context and Presupposition*, Croom Helm, London.
- [vdS92] van der Sandt, R., 1992. *Presupposition Projection as Anaphora Resolution*, Journal of Semantics 9:4.
- [Soa82] Soames, S., 1982. *How Presuppositions Are Inherited: a Solution to the Projection Problem*, Linguistic Inquiry 13:483–545.
- [So89] Soames, S., 1989. “Presupposition”, in D. Gabbay and F. Guenther (eds.) *Handbook of Philosophical Logic*, vol. IV, Reidel, Dordrecht, pp. 553–616.
- [SW84] Sperber, D. and Wilson, D., 1984. *Relevance: Communication and Cognition*, Basil Blackwell, Oxford; Harvard University Press, Cambridge, Massachusetts.
- [Sta74] Stalnaker, R., 1974. “Pragmatic Presuppositions”, in Munitz, M. and Unger, P. (eds.) *Semantics and Philosophy*, NYP.
- [Tho90] Thomason, R., 1990. “Accommodation, Meaning and Implicature: Interdisciplinary Foundations for Pragmatics”, in Cohen, P., Morgan, J. and Pollack, E. (eds.), *Intensions in Communication*, Bradford Books, MIT Press, Cambridge, Mass., pp. 325–363.
- [Vel91] Veltman, F., 1991. “Defaults in Update Semantics”, in DYANA deliverable R2.5.C. (To appear in: Journal of Philosophical Logic).
- [Zee92] Zeevat, H., 1992. *Presupposition in Update Semantics*, Journal of Semantics 9:4, pp. 379–412.