CHAPTER 1

Presupposition

David Ian Beaver

Department of Philosophy/ILLC, University of Amsterdam

Contents

HANDBOOK OF LOGIC AND LANGUAGE
Edited by Van Benthem & Ter Meulen

1. Presuppositions and How to Spot Them

The non-technical sense of the word *presupposition* serves as a good basis for understanding many of the various technical definitions which have been given. Certainly this is true of the notion of presupposition introduced by Frege, according to whom presuppositions are special conditions that must be met in order for a linguistic expression to have a denotation. He maintained that presuppositions constitute an unfortunate imperfection of natural language, since in an ideal language every well-formed string would denote something. The possibility of what we would now call *presupposition failure*, which in a Fregean picture would mean cases when a well-formed expression failed to denote, was repugnant to him.

Many authors follow the Fregean line of relating presuppositions to assumptions that have been made, thus as concerning either the way in which utterances signal assumptions, or, conversely, the way in which utterances depend upon assumptions to be meaningful. However, some words of caution are in order. It is not the case that all technical uses of the term presupposition involve reference to assumptions. Indeed, if by *assumptions* we mean the assumptions of some agent, then the notion of an assumption is essentially a pragmatic one, whereas for some theorists presupposition is a purely semantic relation. Thus phenomena that one theorist explains in terms of what is assumed, another may explain without essential reference to assumptions, and yet both theorists may use the term *presupposition.* It is not even the case that all proponents of pragmatic accounts of presupposition take assumption as a central notion. For instance, Gazdar's influential theory of presupposition [Gaz79a, Gaz79b] does not involve a commitment to presuppositions being in any sense *assumed.*

Having mentioned the terms *semantic* and *pragmatic*, I must warn the reader that they are bandied about rather freely, and indeed confusingly, in the presupposition literature: I will attempt to clarify.

In a semantic theory presupposition is usually defined as a binary relation between pairs of sentences of a language. What makes this relation semantical is that it is defined or explicated solely in terms of the semantic valuation of the sentences, or in terms of semantical entailment. Thus a definition in terms of semantic valuation might, following Strawson, say that one sentence (semantically) presupposes another if the truth of the second is a condition for the semantic value of the first to be *true* or *false.* Other such notions will be explored in Section 2 below.

In pragmatic theories the analysis of presupposition involves the attitudes and knowledge of language users. In extreme cases such as Stalnaker's [St74] account, presupposition is defined without any reference to linguistic form: Stalnaker talks not of the presuppositions of a sentence, but of the *speaker's presuppositions*, these being just those propositions which are taken for granted by a speaker on a given occasion. Other pragmatic theories are less radical, in that linguistic form still plays an essential role in the theory. The majority of well-developed pragmatic theories concern the presuppositions not of a sentence (as in semantic theories) or of a speaker (as in Stalnaker's theory) but of an utterance. In some theories, utterances are explicated as pairs consisting of a sentence and a linguistic context, and as a result presupposition becomes a ternary relation, holding between two sentences and a context.[1] In other theories, the presuppositions of a sentence are seen as conditions that contexts must obey in order for an utterance of the sentence to be felicitous in that context.[2]

The post-Fregean philosophical study of presupposition has been dominated by an assumption-based conception, but, given the range of linguistic and philosophical theories which have been formulated during the last twenty years, such a characterisation is no longer apt.

Furthermore, saying that presuppositions are not part of what is asserted but of what is assumed does not in itself provide any practical method of identifying presuppositional constructions in language, or even of showing that there are any such constructions. If one theorist argues that a definite description asserts the existence of a (unique) object satisfying the description, and another theorist maintains that the existence of a relevant object is not asserted but presupposed, how are we to tell who is right? This issue was at the heart of the famous Russell-Strawson debate. Neither party could offer a solid empirical justification of his position, since the debate appeared to hinge on whether a simple sentence containing an unsatisfied description was false, as Russell claimed, or meaningless, as Strawson, taking his lead from Frege, maintained. Judgements on whether sentences are meaningless or false are typically hazy — indeed, it is hard even to know how to pose to a naive informant the question of whether a given sentence is meaningless or false — and the debate arguably never reached a satisfactory conclusion.[3]

So what is the defining characteristic of the recent linguistic study of presupposition? A large class of lexical items and grammatical constructions, including those identified as presuppositional by philosophers such as Frege and Strawson, produce distinctive patterns of inference. It is difficult to find any common strand to current analyses of presupposition, save that they all concern (various parts of) this class. The class is commonly depicted as including: definite noun phrases (presupposing reference or unique reference of the description); quantificational noun phrases (presupposing existence of a non-trivial quantificational domain); factive verbs such as 'regret' and 'know' (presupposing truth of the propositional complement); factive noun phrases such as 'the fact that X' and 'the knowledge that X' (again presupposing truth of the propositional complement); clefts (e.g. an it-cleft

---

[1] Strawson's account can be seen as the first such theory, although the Frege's sparse remarks on presupposition are already suggestive. See [St50] and the reconstruction in [So89]. Section 3 introduces a number of such theories, and it is there suggested that (the second version of) the theory in [Kar73] is the first in which a definition of utterance presupposition is formally realised.

[2] Keenan [Kee71, p. 49] defines pragmatic presupposition as follows: "A sentence pragmatically presupposes that its context is appropriate." On the other hand Karttunen writes: "Strictly speaking, it would be meaningless to talk about the pragmatic presuppositions of a sentence. Such locutions are, however, justified in a secondary sense. A phrase like "the sentence A pragmatically presupposes B" can be understood as an abbreviation for "whenever A is uttered sincerely, the speaker of A presupposes B" (i.e. assumes B and believes that his audience assumes B as well.)"[Kar73, pp.169–170]

[3] The main references for this debate are Strawson's [St50, St64], and Russell's [Ru05, Ru57]. Note that the 1964 Strawson paper is quite conciliatory.

'it was x that y-ed' presupposing that something 'y-ed'); counterfactual conditionals (presupposing falsity of the antecedent); *non-neutral* intonation (with destressed or unstressed material thought of as inducing a presupposition, so that e.g. 'X y-ed' with stressed 'X' might presuppose that somebody 'y-ed'); aspectual verbs such as 'stop' and 'continue' (presupposing a certain initial state); aspectual adverbs such as 'still' and 'almost' (again presupposing a certain initial state); sortally restricted predicates (e.g. 'dream' presupposing animacy of its subject, and predicative use of 'a batchelor' presupposing that the predicated individual is adult and male); wh-questions (presupposing existence of an entity answering the question, or speakers expectation of such an entity); and a rag-bag of other lexical items such as 'even', 'only', and the so-called *iterative* adverbs 'too' and 'again'. Note that although all these constructions, and others, have been termed presuppositional, there has been disagreement as to which constructions actually are presuppositional: see e.g. Karttunen and Peters' [KP77, KP79].

1.1. Projection/Heritability

Frege's 1.1 [Fr84a], has 1.2 as one of its implications, but it is no surprise, given some knowledge of classical logic, that 1.2 does not follow from any of 1.3–1.5.

(1.1)Whoever discovered the elliptic form of the planetary orbits died in misery.

(1.2)Somebody died in misery.

(1.3)Whoever discovered the elliptic form of the planetary orbits did not die in misery.

(1.4)If whoever discovered the elliptic form of the planetary orbits died in misery, he should have kept his mouth shut.

(1.5)Perhaps whoever discovered the elliptic form of the planetary orbits died in misery.

However, consider 1.6, which Frege claims to be presupposed by 1.1. Strikingly, 1.6 seems to be implied by 1.1, but also by all of 1.3–1.5. We may say that one implication of 1.1 is *inherited* or *projected* such that it also becomes an implication carried by the complex sentences in 1.3–1.5, whereas another implication of 1.1 is not inherited in this way.

(1.6)Somebody discovered the elliptic form of the planetary orbits.

This takes us to the curse and the blessing of modern presupposition theory. Certain implications of sentences are inherited more freely to become implications of complex sentences containing the simple sentences than are other implications, and such implications are called presuppositions. In its guise as curse this observation is called (following Langendoen and Savin *the presupposition projection problem*, the question of "how the presupposition and assertion of a complex sentence are related to the presupposition and assertions of the clauses it contains"[LS71, p.54]. The problem can be seen as twofold. Firstly we must say exactly what presuppositions are inherited, and secondly we must say why. But the observation is also a blessing, because it provides an objective basis for the claim that there is a distinct presuppositional component to meaning, and a way of identifying presuppositional constructions, a linguistic test for presupposition on a methodological par with, for instance, standard linguistic constituency tests.

To find the presuppositions of a given grammatical construction or lexical item, one must observe which implications of simple sentences are also implications of sentences in which the simple sentence is embedded under negation, under an operator of modal possibility or in the antecedent of a conditional. To be sure, there is nothing sacred about this list of embeddings from which presuppositions tend to be projected, and the list is certainly not exhaustive. The linguist might equally well choose to consider different connectives, such as in 1.7, or non-assertive speech acts, as with the question in 1.8 — questions having been considered as test-embeddings for presuppositions by Karttunen — or the imperative in 1.9.[4] 1.8 is not a question about whether anybody discovered elliptic form of the planetary orbits, and 1.9 does not act as a request to guarantee that somebody has discovered the elliptic form of the planetary orbits. Rather, we would take it that an utterer of either of these sentences already held the existence of a discoverer of the elliptic form of the planetary orbits to be beyond doubt. Thus the sentences could be used as evidence that 1.6 is presupposed by the simple assertive sentences from which 1.8 and 1.9 are derived.[5]

(1.7)Unless whoever discovered the elliptic form of the planetary orbits died in misery, he was punished in the afterlife.

(1.8)Did whoever discovered the elliptic form of the planetary orbits die in misery?

(1.9)Ensure that whoever discovered the elliptic form of the planetary orbits dies in misery!

Returning to projection *qua* problem rather than *qua* test, it is often forgotten that, from a semantic perspective, the projection problem for presuppositions fits quite naturally into a larger Fregean picture of how language should be analysed. The projection problem for presuppositions is the task of stating and explaining the presuppositions of complex sentences in terms of the presuppositions of their parts.

[4] The behaviour of presuppositions in imperatives is discussed by Searle [Sea:69, p. 162].

[5] Burton-Roberts suggests the following generalisation of the standard negation test for presuppositions: "Any formula equivalent to a formula that entails either p or its negation, and the negation of any such formula, will inherit the presuppositions of p."[Bu89b, p.102] Such a generalisation seems problematic. For if we allow that a contradiction entails any sentence, then it follows that a contradiction presupposes everything. But any tautology is standardly equivalent to the negation of a contradiction, so all tautologies must presuppose everything. Further, if a tautology is entailed by any other sentence, it immediately follows that every pair of sentences stands in the relation of presupposition. I fear Burton-Roberts presupposes too much.

The larger problem, which strictly contains the presupposition projection problem, could naturally be called "the projection problem for meanings", i.e. the problem of finding the meanings of complex sentences in terms of the meanings of their parts. Of course, this larger problem is conventionally referred to as the problem of *compositionality.*

1.2. From Projection Data to Theories of Projection

Much research on presupposition to date, especially formal and semi-formal work, has concentrated on the projection problem. This article reflects that perhaps unfortunate bias, and is concerned primarily with formal models of presupposition projection. Other important issues, such as the nature of presupposition itself, the reasons for there being presuppositions in language, and the place of presuppositions within lexical semantics, will be addressed here only insofar as they are relevant to distinguishing alternative projection theories. To facilitate comparison, I will present most theories in terms of an artificial language, what I will call the language of *Presupposition Logic* (henceforth *PrL*). This is just the language of Propositional Logic (*PL*) with an additional binary operator notated by subscripting: a formula ϕ_ψ should be thought of as 'the assertion of ϕ carrying the presupposition that ϕ'[6]. I will occasionally delve into modal and first order variants of PrL, and also into a presuppositional version of Discourse Representation Theory.

Translations will be very schematic. For instance, 'The King of France is bald' will be analysed as if it had the form ϕ_ψ, with ψ being understood as the proposition that there is a unique French King and ψ being understood as a (bivalent) proposition to the effect that there is a bald French King. I must make it clear that I do not wish to claim that ϕ_ψ is a good translation of 'The King of France is bald', or even that it is in general possible to isolate the presupposition of a given construction (here given as ψ) from the assertion (here ϕ): some theories do make such an assumption, and others do not. I only claim that the way in which the theories (as I will present them) treat my translations provides a fair characterisation of how the theories (as originally presented) would handle the corresponding English examples.

There are two main sources of data to use as desiderata when comparing theories of presupposition: felicity judgements, and implications between sentences. The standard tests for presupposition are, as I have said, based on the latter. To use felicity judgements, one requires a theory which divides sentences (or discourses) into good and bad, just as a generative grammar does. But theories of presupposition tend not to make such an explicit division.[7] Thus the principal goal of a theory will be seen as the formalisation of a notion of implication (en-

[6] Elsewhere (see e.g. [?]) I have preferred to use a unary presupposition connective. For most of the systems to be presented, this is not significant, since the relevant unary and binary connectives are interdefineable. Krahmer [Krah:MS] has used a binary presupposition connective with the notation adopted here, and in the case of trivalent logics the definition of that connective to be given coincides with Blamey's *transplication* connective [Blam89].

[7] One exception is the theory developed in van der Sandt's doctoral thesis [vdS82, vdS88, vdS89].

tailment/necessitation/consequence) between formulae of PrL which takes presuppositional implications into account. In some cases felicity judgements can act as desiderata within this framework, if it is supposed that the reason for a discourse's infelicity is that it implies things which hearers have difficulty accepting.

This notion of implication will be denoted $\models\!\!\!\models$ to distinguish it from classical entailment $\models$. The presuppositionally sensitive implication relation $\models\!\!\!\models$ should be expected to be weaker than $\models$, in the sense that there will be more $\models\!\!\!\models$-valid inference patterns than $\models$-valid ones. A proposition may be $\models\!\!\!\models$-implied if it follows either as a result of classically recognised patterns of reasoning, or as a result of reasoning connected to presupposition, or indeed as a result of some combination of these. Thus, for instance, we may record the fact that the presupposition of a simple negative sentence projects in the absence of extra context in terms of the following datum: $\neg(\phi_\psi)\models\!\!\!\models\phi$, where ϕ and ψ are taken to be logically independent (i.e. $\phi\not\models\!\!\!\models\psi$ and $\psi\not\models\!\!\!\models\phi$). Although theories of presupposition can generally be formulated in terms of a $\models\!\!\!\models$ relation with little or no loss of descriptive adequacy, many theorists have preferred to divorce presupposition from semantic entailment. So for various systems a relation of presupposition between sentences, denoted by $\gg$, will be directly defined. For these systems one could of course define $\models\!\!\!\models$ in terms of $\models$ and $\gg$, perhaps most obviously (under a restriction to single premise, single conclusion implications) by: $\models\!\!\!\models = (\models \cup \gg)^\star$ (i.e. the relation $\models\!\!\!\models$ is the closure under iteration of the relations $\models$ and $\gg$). [8]

Since one of the main insights of the last few decades of study of presupposition is that the phenomenon is heavily influenced by the dynamics of the interpretation process, I have divided theories according to the way in which such dynamism is manifested: Section2 "Multivalence and Partiality" concerns models in which the dynamics of the interpretation process plays no role at all, and where the possibility of presupposition failure is tied to the presence of extra truth values in a multivalent (or partial) semantics; in Section 3: "Part-Time Presuposition" models are presented in which the context of evaluation influences which presuppositions are projected, models involving an *inter-sentential dynamics* or *dynamic pragmatics* since the context of evaluation is modified with each successive utterance; Section 4 "Dynamic Semantics" concerns models which involve not only incrementation of context with successive sentences, but also *sentence internal* dynamics; finally, Section 5: "Accommodation" discusses theories of presupposition that allow for a much more sophisticated dynamic pragmatics than in the earlier chapters, which manifests itself in a process of accommodation allowing repair or modification of contexts

[8] Some might maintain that presuppositional inferences are of a quite different character to the 'ordinary' truth-functional implications formalised in classical logic, but I do not take this to be an argument against presenting the goal of presupposition theory in similar terms as might used to state the goal of classical logic. '$\models\!\!\!\models$' is just a relation between sentences (or sets of sentences), regardless of the extent to which it depends on the familiar paraphenalia of classical logic (semantic valuations, axiomatisation, etc.). In some theories, presuppositions of a sentence are analysed relative to a context. But in all of the theories that will be discussed, this context is itself linguistically supplied, and could be thought of as consisting of just the sequence of sentences Σ which are extra premises in an argument of the form $\Sigma,\phi\models\!\!\!\models\psi$.

of evaluation.

2. Multivalence and Partiality

The approaches now to be discussed are those in which the interpretation of a formula defines not only a set of worlds such that when interpreted relative to one of these worlds the formula is true (call this set T), and a set where it is false (F), but also a set where its presuppositions are satisfied (P) and a set where they are not (N).[9] There are three standard ways in which this redefinition is achieved. Firstly, there is trivalent semantics in which the Boolean domain of truth values $\{t, f\}$ may be extended to include a third value $\star$, such that the T, F and N worlds are those where the formula has the value t, f and $\star$ respectively, and $P = T \cup F$. Secondly, there is partial semantics. Here the domain of truth values is allowed to remain Boolean, but the interpretation function is partialised, such that for a given formula T is the set relative to which the valuation produces t, F is that against which the valuation produces f, P is still the union of T and F, but now the set N is not a set relative to which the formula is given some particular valuation or valuations, but rather it is the set of worlds against which the valuation function is not defined for the formula. Thirdly there are two dimensional systems, where the valuation is split into two parts, or dimensions, each of the two sub-valuations being boolean. There is some variation in how the split is made, but the approaches I will describe make a split between a presuppositional and an assertional sub-valuation. For the assertional sub-valuation T is the set of worlds where the formula has value t, and F is the remaining set where the formula has the value f, and for the presuppositional sub-valuation, P is the set of worlds where the formula has value t, and N is the remaining set where the formula has the value f.

If the trivalent, partial and two-dimensional accounts differ as to the precise refinement from classical interpretation which they utilise, they none the less share a basic approach to presupposition projection:

(i) Presuppositions are constraints on the range of worlds/models against which we are able to evaluate the truth or falsity of predications and other semantic operations, or against which this evaluation is legitimate.

(ii) If these constraints are not met, semantic undefinedness, or illegitemacy of the truth-value, results.

(iii) Presupposition projection facts associated with a given operator are explained compositionally, in terms of the relation between the definedness/legitimacy of that operator and the definedness/legitimacy of its arguments in some model, and this relation is recoverable from the semantics of the operator alone.

For the purposes of the following discussion, partial and trivalent semantics will be collapsed. This is possible because the discussion is restricted to systems where the connectives are defined *truth functionally.* Truth functionality is taken to mean that, for any compound formula the only information needed for evaluation relative

[9] Some might prefer to read *models* where I write *worlds.*

to some world is (1) the semantics of the head connective, and (2) for each argument whether there is a valuation in the given world, and, if so, what that valuation that is. Given such a restriction, from a technical point of view all systems which are presented as trivalent could be presented as partial, and *vice versa*, whilst maintaining extensionally identical relations of consequence and presupposition.[10] I will firstly consider trivalent systems, then two dimensional systems, and then discuss some of the general advantages and disadvantages, showing why most contemporary proponents of such approaches accept that presuppositional data cannot be explained in purely semantic terms, but require some additional pragmatic component.

2.1. Trivalent Accounts

In a trivalent logic, where the semantic valuation of a formula ϕ with respect to a world w (here written $[\![\phi]\!]_w$) may take any of the three semantic values, typically thought of as true, false and undefined $(t, f, \star)$, presupposition may be defined as follows:

Definition 2.1 (Strawsonian Presupposition). *ϕ presupposes ψ iff for for all worlds w, if $[\![\phi]\!]_w \in \{t, f\}$ then $[\![\psi]\!]_w = t$.*

A model here, and for most of this chapter, is taken to be a pair $\langle W, I\rangle$ where W is a set of worlds, and I is an interpretation function mapping a pair of a world and an atomic proposition letter to an element of $\{t, f\}$. Let us assume, a Tarskian

[10] This restriction to truth functional systems does exclude one important method of supplying partial interpretations, namely the *supervaluation* semantics developed by van Fraassen. See [vF69, vF75, Th72, Th79]. One advantage of the supervaluation approach is that it allows a logic, say classical first order logic, to be partialised such that logical validities remain intact. (Note that classical validities are also maintained in the two dimensional approaches which are discussed below.) I was once horrified to hear a group of presupposition theorists arguing bitterly about whether the treatment of presupposition should use a partial or a trivalent logic. There may be philosophical significance to the decision between partial and trivalent systems, and it may be that there are applications (like the treatment of the semantical paradoxes) where it really makes a difference whether the semantical universe contains only two values for the extension of a proposition or is in some way richer. But it seems unlikely that the decision to use a partial or trivalent logic has significant empirical consequences regarding presupposition projection. In general, relevant aspects of a model of presupposition projection presented in terms of either a trivalent logic or a partial logic are straightforwardly reformulable in terms of the other with no consequences for the treatment of presupposition data. See, for example, Karttunen's discussion of van Fraassen in [Kar73]. However, in saying this I am possibly taking for granted what I take to be the conventional use of the term *partial logic* by logicians (see e.g. [Blam89]), whereby, for instance, versions of both Kleene's strong and weak systems are sometimes referred to as partial logics. Seuren [Seu85, Seu90a] offers an alternative characterisation whereby only Kleene's weak system (Bochvar's internal system) would count as a gapped/partial logic. This is because he implicitly limits consideration to systems which are truth functional in a stronger sense than is given above, such that a compound formula can only have a value defined if the valuation of all the arguments is defined. On the other hand, Burton-Roberts [Bu89a] offers a system which he claims to have the only *true* gapped bivalent semantics, and which just happens to contain exactly the connectives in Kleene's strong system! Given this lack of consensus among such forceful rhetoricians as Seuren and Burton-Roberts, it is perhaps unwise to stick one's neck out.

notion of logical consequence as preservation of truth ($\phi \Vdash \psi$ iff for all worlds w, if $[\![\phi]\!]_w = t$ then $[\![\psi]\!]_w = t$) Let us further assume that a negation $\neg$ is available in the formal language which is interpreted classically with respect to classically valued argument formulae, mapping true to false and *vice versa*, but which preserves undefinedness. This defines a so-called *choice* negation (as in 2.4 below). Given these notions of consequence and negation, it is easily shown that the above definition of presupposition is equivalent to one mentioned earlier:

Definition 2.2 (Presupposition Via Negation). *ϕ presupposes ψ iff $\phi \Vdash \psi$ and $\neg\phi \Vdash \psi$*

These, then, are the standard approaches to defining presupposition in three-valued logics. One author who offers a significant deviation from these definitions is Burton-Roberts [Bu89a]. He defines two separate notions of logical consequence, *weak* consequence, which is just the notion $\Vdash$ above, and *strong* consequence. Let us denote strong consequence by $\models$, since it is closer to classical implication than is $\Vdash$ (e.g. no non trivial formulae are entailed by botyh a formula and its negation). The definition is: $\phi \models \psi$ iff (1) $\phi \Vdash \psi$, and (2) for all worlds s, if $[\![\psi]\!]_w = f$ then $[\![\phi]\!]_w = f$. Thus for one proposition to strongly entail another, the truth of the first must guarantee the truth of the second, and the falsity of the second must guarantee the falsity of the first.[11] Burton-Roberts then suggests that presuppositions are weak consequences which are not strong consequences:

Definition 2.3 (Burton-Roberts Presupposition). *ϕ presupposes ψ iff $\phi \Vdash \psi$ and $\phi \not\models \psi$*

This seems an attractive definition, and is certainly not equivalent to the standard definitions above. However, it has some rather odd properties. For example, assuming this definition of presupposition and Burton-Roberts' quite standard notion of conjunction, it turns out that if ϕ presupposes ψ, then ϕ presupposes $\psi \wedge \phi$. Let us assume that 'The King of France is bald' presupposes 'There is a King of France'. According to Burton-Roberts' definition it must also presuppose 'There is a King of France and he is bald', which seems completely unintuitive. More generally, if ϕ presupposes ψ then according to this definition it must also presuppose the conjunction of ψ with *any* strong consequence of ϕ.[12] I see no reason why we should accept a definition of presupposition with this property.

[11] Wilson [Wi75] took a definition of consequence like $\models$ as fundamental, and used it as part of her argument against semantic theories of presupposition. In a more technically rigorous discussion, Blamey [Blam89] also suggests that the strong notion should be the basic one.

[12] Burton-Robert's system uses Kleene's strong *falsity preserving* conjunction, whereby a conjunction is true if and only if both conjuncts are true, and false if and only if at least one conjunct is false. The following argument then shows that a proposition must presuppose any conjunction of a presupposition and a strong entailment:

(i) Suppose ϕ presupposes ψ in Burton-Roberts system
(ii) Then (a) $\phi \Vdash \psi$, and (b) $\phi \not\models \psi$
(iii) From 2, $[\![\psi]\!]_w = f$ and $[\![\phi]\!]_w \neq f$ for some world w
(iv) Suppose $\phi \models \chi$
(v) By definition of $\models$, we have that $\phi \Vdash \chi$

Moving back to the standard definitions, we can examine the presupposition projection behaviour of various three-valued logics. A simple picture of presupposition projection is what is known as the *cumulative hypothesis* according to which the set of presuppositions of a complex sentence consists of every single elementary presupposition belonging to any subsentence.[13] As far as the projection behaviour of the logical connectives is concerned, such a theory of projection would be modelled by a trivalent logic in which if any of the arguments of a connective has the value $\star$, then the value of the whole is also $\star$. Assuming that combinations of classical values are still to yield their classical result, this yields the so-called *internal Bochvar* or *weak Kleene* connectives:

Definition 2.4 (The Weak Kleene or Internal Bochvar Connectives).

$\phi \wedge \psi$	t	f	$\star$
t	t	f	$\star$
f	f	f	$\star$
$\star$	$\star$	$\star$	$\star$

$\phi \rightarrow \psi$	t	f	$\star$
t	t	f	$\star$
f	t	t	$\star$
$\star$	$\star$	$\star$	$\star$

$\phi \vee \psi$	t	f	$\star$
t	t	t	$\star$
f	t	f	$\star$
$\star$	$\star$	$\star$	$\star$

ϕ	$\neg\phi$
t	f
f	t
$\star$	$\star$

(vi) By 2(b), 5 and definitions of $\wedge$, $\models$, it follows that $\phi \models \psi \wedge \chi$

(vii) Relative to the same model M, where ψ is false, falsity preservation of $\wedge$ tells us that $\psi \wedge \chi$ is false

(viii) Since there is a model (M) where ϕ is not false and its weak entailment $\psi \wedge \chi$ is false, it follows that $\phi \not\models \psi \wedge \chi$

(ix) Hence ϕ must presuppose $\psi \wedge \chi$ in Burton-Roberts system. Q.E.D.

It should be mentioned that the above is not the only definition of presupposition that Burton-Roberts offers: it seems to be intended as a definition of the elementary presuppositions of a simple positive sentence. Presuppositions of compound sentences are given by a relation of *Generalised Presupposition.* This notion, which will not be discussed in detail here, is essentially the same as a notion of presupposition used earlier by Hausser [Ha76]. It says that one formula presupposes another if falsity of the second creates the possibility of undefinedness for the first.

[13] The cumulative hypothesis is commonly attributed to Langendoen and Savin. However, their view appears to have been more sophisticated than some have suggested. Regarding examples where a presupposition of the consequent of a conditional does not become an implication of the conditional as a whole, they comment [LS71]pp.58: "A conditional sentence has the property that its presupposition is presupposed in a (possibly imaginary) world in which its antecedent is true. . . and no mechanism for suspending presuppositions is required." Although the informality of their proposal makes it difficult to evaluate, it is clear that Langendoen and Savin were aware of cases where presuppositions of an embedded sentence are not implications of the whole and did not see them as counterexamples to their theory. Indeed, on a charitable reading (where it is read as a generic about a property holding of worlds which satisfy the antecedent of a conditional) the above quote seems to prefigure the inheritance properties that Karttunen later attributed to conditionals.

A naive version of the cumulative hypothesis, such as is embodied in the definition of Bochvar's internal connectives, is not tenable, in that there are many examples of presuppositions not being projected. Let us consider firstly how this is dealt with in the case that has generated the most controversy over the years, that of negation.[14] In a trivalent semantics, the existence of cases where presuppositions of sentences embedded under a negation are not projected, is normally explained in terms of the existence of a *denial* operator (here $\sharp$) such that when $[\![\phi]\!]_{w} = \star$, $[\![\sharp\phi]\!]_{w} = t$. Typically the following *exclusion* (sometimes called *weak*) negation operator results:

Definition 2.5 (Trivalent Exclusion Negation).

ϕ	$\sharp\phi$
t	f
f	t
$\star$	t

Since there apparently exist both cases where a negation acts, in Karttunen's terminology, as a *hole* to presuppositions (allowing projection) and cases where it acts as what Karttunen called a *plug* (preventing projection), the defender of a trivalent account of presupposition appears not to have the luxury of choosing between the two negations given above, but seems forced to postulate that negation in natural language is ambiguous between them. Unfortunately, convincing independent evidence for such an ambiguity is lacking, although there may at least be intonational features which mark occurrences of denial negation from other uses, and thus potentially allow the development of a theory as to which of the two meanings a given occurrence of negation corresponds.[15]

There is a frequently overlooked alternative to postulating a lexical ambiguity, dating back as far as Bochvar's original papers. Bochvar suggested that apart from the normal mode of assertion there was a second mode which we might term *meta-assertion.* The meta-assertion of ϕ, $A\phi$, is the proposition that ϕ is true: $[\![A\phi]\!]_{w} = t$ if $[\![\phi]\!]_{w} = t$ and $[\![A\phi]\!]_{w} = f$ otherwise. Bochvar showed how within the combined

[14] Horn's article [Horn85]) provides an excellent overview of treatments of negation and considers cases of presupposition denial at length. For a longer read, his [Horn89] is recommended. Extensive discussion of negation within the context of contemporary trivalent accounts of presupposition is found in the work of Seuren [Seu85, Seu88], and Burton-Roberts [Bu89c, Bu89a]. These latter publications produced considerable debate, to a degree surprising given that Burton-Roberts, though innovative, presents what is essentially a reworking of a quite well worn approach to presupposition. This refreshingly vehement debate provides the definitive modern statements of the alternative positions on negation within trivalent systems: see Horn's [Horn90] and Burton-Roberts' reply [Bu89b], Seuren's [Seu90a] and Burton-Roberts' reply [Bu90], and Seuren and Turner's reviews [Seu90b, Tu92].

[15] If the *raison d'etre* of a trivalent denial operator is to be yield truth when predicated of a non-true and non-false proposition, then in principle some choice remains as to how it should behave when predicated of a simply false proposition. Thus the denial operator need not necessarily have the semantics of the exclusion negation, although, to my knowledge, only Seuren has been brave enough to suggest an alternative. Seuren's preferred vehicle for denial is an operator which maps only $\star$ onto t, and maps both t and f onto f. Seuren has also marshalled considerable empirical evidence that negation is in fact ambiguous, although the main justification for his particular choice of denial operator is, I think, philosophical.

system consisting of the internal connectives and this assertion operator a second set of *external* connectives could be defined: for instance the external conjunction of two formulae is just the internal conjunction of the meta-assertion of the two formulae (i.e. $\phi \wedge_{\text{ext}} \psi =_{\text{def}} A(\phi) \wedge_{\text{int}} A(\psi)$), and the external negation of a formula is just the exclusion negation given above, and defined in the extended Bochvar system by $\sharp\phi =_{\text{def}} \neg A(\phi)$.[16] Thus whilst the possibility of declaring natural language negation to be ambiguous between $\neg$ and $\sharp$ exists within Bochvar's extended system, another possibility would be to translate natural language negation uniformly using $\neg$, but then allow that sometimes the proposition under the negation is itself clad in the meta-assertoric armour of the A-operator.

There is no technical reason why the Bochvarian meta-assertion operator should be restricted in its occurrence to propositions directly under a negation. Link [Li86] has proposed a model in which in principle any presupposition can be *co-asserted*, where coassertion, if I understand correctly, essentially amounts to embedding under the A-operator. Such a theory is flexible, since it leaves the same logical possibilities open as in a system with an enormous multiplicity of connectives: for instance if the A operator can freely occur in any position around a disjunction, then the effects of having the following four disjunctions are available: $\phi \vee \psi$, $A(\phi \vee \psi)$, $A(\phi) \vee \psi$ and $\phi \vee A(\psi)$. It is then necessary to explain why presuppositions only fail to project in certain special cases. Link indicates that pragmatic factors will induce an ordering over the various readings, although he does not formalise this part of the theory. Presumably a default must be invoked that the A operator only occurs when incoherence would result otherwise, and then with narrowest possible scope.[17]

So far we have only considered cases where presuppositions of each argument are either definitely projected to become presuppositions of the whole, or definitely not projected. Fittingly, in the land of the *included* middle, there is a third possibility. The presupposition may, in effect, be modified as it is projected. Such modification occurs with all the binary connectives in Kleene's *strong* logic:

[16] External negation, given that it can be defined as $\neg A(\phi)$ where A is a sort of truth-operator, has often been taken to model the English paraphrases 'it is not true that' and 'it is not the case that'. Although it may be that occurrence of these extraposed negations is high in cases of presupposition denial — I am not aware of any serious research on the empirical side of this matter — it is certainly neither the case that the construction is used in all instances of presupposition denial, nor that all uses of the construction prevent projection of embedded presuppositions. Thus the use of the term *external* for the weak negation operator, and the corresponding use of the term *internal* for the strong, is misleading, and does not reflect a well established link with different linguistic expressions of negation.

[17] Observe that in Link-type theory the lexical ambiguity of negation which is common in trivalent theories is replaced by an essentially structural ambiguity, and in this respect is comparable with the Russellian scope-based explanation of projection facts. Horn [Horn85, p.125] provides a similar explication to that above of the relation between theories postulating alternative 3-valued negations and theories involving a Russellian scope ambiguity.

Definition 2.6 (The Strong Kleene Connectives).

$\phi \wedge \psi$	t	f	$\star$
t	t	f	$\star$
f	f	f	f
$\star$	$\star$	f	$\star$

$\phi \to \psi$	t	f	$\star$
t	t	f	$\star$
f	t	t	t
$\star$	t	$\star$	$\star$

$\phi \vee \psi$	t	f	$\star$
t	t	t	t
f	t	f	$\star$
$\star$	t	$\star$	$\star$

ϕ	$\neg\phi$
t	f
f	t
$\star$	$\star$

To see that under this definition it is not in general the case that if ϕ presupposes π then $\psi \to \phi$ presupposes π, we need only observe that if $[\![\psi]\!]_w = f$ then $[\![\psi \to \phi]\!]_w = t$ regardless of the valuation of ϕ. Presuppositions of the consequent are weakened, in the sense that in a subset of worlds, those where the antecedent is false, undefinedness of the consequent is irrelevant to the definedness of the whole. However, in those worlds where the antecedent is not false, the presuppositions of the consequent are significant, so that presupposition failure of the consequent is sufficient to produce presupposition failure of the whole.

To complete the definition of a trivalent PrL semantics we must consider the binary presupposition connective. A formula ϕ_ψ introduces undefinedness whenever ψ is not true:

Definition 2.7 (Trivalent Presupposition Operator).

ϕ_ψ	t	f	$\star$
t	t	$\star$	$\star$
f	f	$\star$	$\star$
$\star$	$\star$	$\star$	$\star$

The presuppositional properties of the strong Kleene logic may be determined in full by inspection of the truth tables, and can be summed up as follows:

Fact 2.8. *Under the strong Kleene interpretation, if $\phi \gg \pi$ then :*

$$\neg\phi \gg \pi$$
$$\phi \wedge \psi \gg \psi \to \pi$$
$$\psi \wedge \phi \gg \psi \to \pi$$
$$\phi \to \psi \gg (\neg\psi) \to \pi$$
$$\psi \to \phi \gg \psi \to \pi$$
$$\phi \vee \psi \gg (\neg\psi) \to \pi$$
$$\psi \vee \phi \gg (\neg\psi) \to \pi$$

If models are restricted to those where ψ is bivalent, 2.8 gives the maximal presuppositions in the sense that the right hand side represents the logically strongest presupposition, all other presuppositions being $\models$-entailed by it. Of interest is the occurrence of what may be called *conditionalised* presuppositions, cases where although a presupposition is not projected *per se*, a logically weaker conditional presupposition does occur. For example, consider 2.1, in which the factive noun phrase 'the knowledge that' triggers a presupposition in the consequent of a conditional:

(2.1) If David wrote the article then the knowledge that no decent logician was involved (in writing the article) will confound the editors.

If this sentence has the form $\phi \rightarrow \psi_{\chi}$, then Strong Kleene predicts a presupposition $\phi \rightarrow \chi$, i.e. 'if David wrote the article then no decent logician was involved'.

2.2. Supervaluations

Of all the method's of introducing partiality discussed here, van Fraassen's *supervaluation* semantics allow us to remain most faithful to classical logic, although in fact the technique is of sufficient generality that it could equally be used to introduce partiality into non-classical logics.[18] The name *supervaluation* reflects the idea that the semantics of a formula reflects not just one valuation, but many valuations combined. Suppose that we have some method, let us call it an *initial partial valuation*, of partially assigning truth values to the formulae of some language. Van Fraassen's idea is to consider all the ways of assigning total valuations to the formula which are compatible both with the initial partial valuation and with principles of classical logic: call these total valuations the *classical extensions* of the initial partial valuation. A new partial valuation, let us call it the *supervaluation*, is then defined as the intersection of the *extensions*, that valuation which maps a formula to t iff all the extensions map it to t, and maps a formula to f iff all the extensions map it to f. To justify the approach, it is helpful to think of $\star$ as meaning not "undefined", but "unknown": the values of some formulae are unknown, so we consider all the values that they *might* conceivably have, and use this information to give the supervaluation.

It will now be shown how this technique can be used in the case of PrL, but it should be noted that the application will be in some respects non-standard, since supervaluation semantics is normally given for systems where partiality arises in the model. Here it will be assumed that the model provides a classical interpretation for all proposition letters, and that partiality only arises in the recursive definition of the semantics, specifically with regard to the binary presupposition connective. To simplify, let us restrict the language by requiring that both arguments of any compound formula ϕ_{ψ} are atomic proposition letters. The notion of an *extension* to a world which will be used is odd in the sense that a world is already total wrt. interpretation of atomic proposition letters. The extension provides a valuation for

[18] Supervaluations are introduced by van Fraassen in [vF69, vF75]. There are a number of good presentations designed to be accessible to linguists, e.g. in Mc.Cawley's [?], Martin's [Ma79] and Seuren's [Seu85]. For an application of supervaluations see Thomason's [Th72].

presuppositional formulae: it is as if we were considering formulae ϕ_ψ to be 'extra' atomic formulae. Since there are many such presuppositional formulae, and two ways of providing a classical value to each one, there are many extensions for each world. The following three definitions give a set of extension functions for a world, a recursive redefinition of the semantics in terms of these extensions, and the resulting supervaluations.

Definition 2.9 (Extensions of a world). *The set of extensions of w is denoted $EX(w)$, where $EX(w) = \{\langle w, \pi\rangle \mid \pi$ maps every formula of the form ϕ_ψ, for atomic ϕ and ψ, to an element of $\{t, f\}$ under the restriction that if the interpretation of ψ wrt. w is t (i.e. $I(w, \psi) = t$), then π $\pi(\phi_\psi) = i(w, \phi)$ $\}$.*

Definition 2.10 (Total Valuation Functions). *A classical extension $\langle w, \pi\rangle$ provides a total valuation function $TV_\langle w, \pi\rangle$ according to the following recursive semantics: atomic formulae are valued using the interpretation function (supplied by the model) with respect to w, formulae of the form ϕ_ψ have value $\pi(\phi_\psi$, and other compound formulae are interpreted using the classical truth-tables in terms of the $TV_\langle w, \pi\rangle$ valuation of their parts.*

Definition 2.11 (Supervaluations). *The supervaluation wrt. the world w, $SUP(w)$, is a partial valuation defined by $SUP(w) = \bigcap TV_\langle w, \pi\rangle$.[19] The set of supervaluations S wrt. a model is $\{s \mid \exists w \in W \ s = SUP(w)\}$.*

To see that supervaluations are partial, consider the formula $A \wedge A_B$ with respect to SUP(w), where A is true and B is false in the world w. Some of the extensions of w will make B_A true, and others will make it false, and likewise some valuations will make $A \wedge A_B$ true and others will make it false. Thus the intersection of the extensions will map $A \wedge A_B$ to the third value, $\star$. On the other hand, undefinedness does not always project. For example SUP(w) gives $A \vee A_B$ the value t, since the left disjunct is true in w, and thus also true in all extensions, from which it follows that the disjunction is true in all extensions.

The supervaluation semantics is non-truth-functional. That is, the supervaluation of a compound cannot be calculated from the supervaluation of its parts. Consider SUP(w) for the formulae (i) $A_B \vee \neg(A_B)$ and (ii) $A_B \vee (A_B)$, again supposing that A is true and B is false in w. Although SUP(w) makes both A_B and $\neg(A_B)$ undefined, it gives $A_B \vee \neg(A_B)$ the value t. The reason for this is that in all the extensions where A_B is true, $\neg(A_B)$ is false, and *vice versa.* Thus in every extension to w one of the disjuncts of formula (i) is true, so the formula as a whole is true in every

[19] If F is a set of valuation functions, $\bigcap F$ is that function such that:

$$
\begin{aligned}
(\bigcap F)(\phi) &= t \text{ if } \forall f \in F \ f(\phi) = t \\
&= f \text{ if } \forall f \in F \ f(\phi) = f \\
&= \star \text{ otherwise}
\end{aligned}
$$

extension, and thus in SUP(w) as well. On the other hand, formula (ii) is given the supervaluation $\star$ wrt. w, since there are some extensions where both disjuncts are false, so that the formula as a whole is false, and some extensions where both disjuncts are true, so that the whole formula is true. Since the extensions do not maintain a concensus as to the value of (ii), it cannot be bivalent. Thus both (i) and (ii) are disjunctions where the disjuncts have the same value wrt. SUP(w), but the disjunctions have different values wrt. SUP(w). This establishes the non-truth-functionality of the supervaluation semantics for PrL.

Despite this non-truth-functionality, some general principles of truth-value inheritance are followed, and an imprecise truth-tabular characterisation of the supervaluation semantics is sometimes given: this can be helpful when comparing to other partial and trivalent approaches.

Definition 2.12 (Truth-table Approximation to Supervaluation Semantics).

$\phi \wedge \psi$	t	f	$\star$
t	t	f	$\star$
f	f	f	f
$\star$	$\star$	f	$(f/\star)$

$\phi \rightarrow \psi$	t	f	$\star$
t	t	f	$\star$
f	t	t	t
$\star$	t	$\star$	$(t/\star)$

$\phi \vee \psi$	t	f	$\star$
t	t	t	t
f	t	f	$\star$
$\star$	t	$\star$	$(t/\star)$

ϕ	$\neg\phi$
t	f
f	t
$\star$	$\star$

These tables show that for the most part supervaluation semantics resembles the Strong Kleene semantics, providing a value whenever there are classical truth-functional grounds for assigning a value. For instance, a disjunction is true if one of the disjuncts is true, regardless of the value of the other disjunct. But the supervaluation semantics differs from the Strong Kleene when both arguments to a connective are undefined. In this case, the supervaluation semantics takes the principle of maximising bivalence to its limit, sometimes managing to attribute bivalence even though both argument values are undefined.

To what logic does supervaluation semantics lead? It is natural to define $\models$ using preservation of truth wrt. supervaluations, i.e. $\phi \models \psi$ iff for every supervaluation s in S, if $s(\phi) = t$ then $s(\psi) = t$. The resulting logic is distinctly presuppositional. For instance, it is easily verified that both $\phi_\psi \models \psi$ and $\neg(\phi_\psi) \models \psi$. Further, the presuppositional properties are comparable with those of the Strong Kleene system, so that presuppositional implications are commonly weakened. But what marks the supervaluation definition of $\models$ out from all the others considered in this chapter is that all classical argument patterns remain valid. For instance the law of the excluded middle $\models \phi \vee \neg\phi$ holds for any choice of ϕ[20]. This takes us to one commonly

[20] I write $\models \psi$ if for all χ, $\chi \models \psi$.

made observation which never ceases to amaze me: supervaluation semantics can yield a system in which bivalence fails, but the law of the excluded middle holds.

2.3. Two Dimensions

There are no obvious empirical reasons for using more than three truth values in the treatment of presupposition, and thus Occam's razor commonly makes trivalent semantics the preferred basis for a multivalent treatment of presupposition.[21] However, quite apart from the fact that four valued logics are sometimes thought to be technically more elegant than their three valued cousins, the use of four truth values affords theorists the space to pursue a *divide and conquer* strategy, separating issues of presupposition from those of classical truth and entailment. The idea was developed independently, but in rather different forms, by Herzberger [Her73] and Karttunen and Peters [KP79], Herzberger's formulation having been further developed by Martin [Ma77] and Bergmann [Ber81]. The semantic domain is considered as consisting of two two-valued coordinates (*dimensions*), which I will call *assertion* and *presupposition*.[22] Thus, if the four values are represented using a pair of binary digits, with the first representing the assertion, and the second the presupposition, then, for instance, $\langle 0, 1 \rangle$ will mean that the assertion is not satisfied, although the presupposition is.

Treating a four valued semantics as consisting of two boolean coordinates allows for a straightforward introduction of the tools of classical logic to study an essentially non-classical system, and this enabled Karttunen and Peters to provide compositionally derived two-dimensional interpretations for a fragment of English using the classical IL of Montague (familiarity with which I assume). To illustrate the approach, let us suppose that expressions of English are associated with two translation functions, $\mathcal{A}$, and $\mathcal{P}$. $\mathcal{A}$ maps expressions to IL formulae representing its assertion, and $\mathcal{P}$ likewise maps to an IL representation of the presupposition. Given that the assertion and presupposition of an expression are assumed by Karttunen and Peters to have identical IL types, and that for English sentences this type is that of truth values, the two dimensional interpretation of a sentence S relative to an IL model M and assignment g will be $\langle [\![\mathcal{A}(S)]\!]_{\mathrm{M,g}}, [\![\mathcal{P}(S)]\!]_{\mathrm{M,g}} \rangle$. Now we might associate with conditionals, for instance, the following translation rule pair:

[21] Cooper [Co83] presents an interesting empirical justification for the use of a fourth value, suggesting that whilst the third value is used to represent presupposition failure, a fourth value is required to signal acts of presupposition denial. This idea, which enables Cooper to give some explanation of cancellation effects without postulating an ambiguity of negation (or other operators) has not, to my knowledge, been taken up elsewhere.

[22] What are here called *assertion* and *presupposition* are for Herzberger *correspondence* and *bivalence*, and for Karttunen and Peters *entailment* and *conventional implicature*. The theories differ considerably in philosophical motivation, in that whilst Herzberger's could be reasonably termed a semantic account, Karttunen and Peters' is not presented as such. However, the fact that Karttunen and Peters give a pragmatic explication of their second dimension of evaluation is irrelevant to most of the technicalities.

$$\mathcal{A}(\textsf{If S1 then S2}) = \mathcal{A}(\textsf{S1}) \rightarrow \mathcal{A}(\textsf{S2})$$
$$\mathcal{P}(\textsf{If S1 then S2}) = \mathcal{P}(\textsf{S1}) \wedge \mathcal{P}(\textsf{S2})$$

This particular rule pair, defines a notion of implication comparable with the Bochvar internal implication. If we associate the value $\langle 1, 1\rangle$ with t, $\langle 0, 1\rangle$ with f, and the remaining two values both with $\star$, then a sentence 'If S1 then S2' will take the value $\star$ just in case either S1 or S2 takes this value, and otherwise will take the standard classical value.[23]

The same approach is extendible to other types. Let us suppose that a sentence of the form 'The guest Xs' involves the assertion of the existence of a guest with property X and presupposition of the uniqueness of the guest, and that a sentence of the form 'y curtsied' carries the assertion that y performed the appropriate physical movement, and the presupposition that y is female. Then assuming appropriate basic translations, constants *guest, curtsied* and *female*, and meaning postulates guaranteeing that, for instance, the constant *curtsied* stands in the correct relation to other constants relevant to the physical act of curtseying, part of the derivation of the meaning of the sentence 'The guest curtsied' might run — departing somewhat from Karttunen and Peters' original system — as follows:

$$\begin{aligned}
\mathcal{A}(\textsf{the guest}) &= \lambda X[\exists y guest(y) \wedge X(y)] \\
\mathcal{P}(\textsf{the guest}) &= \lambda X[\exists y guest(y) \wedge \forall z[guest(z) \rightarrow x = z] \wedge X(y)] \\
\mathcal{A}(\textsf{curtsied}) &= curtsied \\
\mathcal{P}(\textsf{curtsied}) &= female \\
\mathcal{A}(\textsf{the guest curtsied}) &= \mathcal{A}(\textsf{the guest}).\mathcal{A}(\textsf{curtsied}) \\
&= \lambda X[\exists y[guest(y) \wedge X(y)]](curtsied) \\
&= \exists y[guest(y) \wedge curtsied(y)] \\
\mathcal{P}(\textsf{the guest curtsied}) &= \mathcal{P}(\textsf{the guest}).\mathcal{P}(\textsf{curtsied})
\end{aligned}$$

[23] This two dimensional version of Bochvar's internal implication is found in the first systems proposed in [Her73]. Note that the other Bochvar internal connectives can be defined similarly, such that in each case the assertion is defined entirely in terms of the assertion of the arguments, and the presupposition is defined entirely in terms of the presuppositions of the arguments. This yields what is termed (following Jankowski) a cross-product logic. However, both Herzberger and Karttunen and Peters also define operators for which this property does not hold. For instance, the two dimensional version of Bochvar's assertion operator considered by Herzberger, thought of as a semantics for the English 'it is the case that' locution, could be defined:

$$\mathcal{A}(\text{it is the case that } S) = \mathcal{A}(S) \wedge \mathcal{P}(S)$$
$$\mathcal{P}(\text{it is the case that } S) = T$$

Here the assertion is defined in terms of both the assertion and presupposition of its argument.

$$= \lambda X[\exists y[guest(y) \land \forall z[\mathsf{guest}(z) \rightarrow x = z] \land X(y)]](female)$$
$$= \exists y[guest(y) \land \forall z[guest(z) \rightarrow x = z] \land female(y)]$$

Thus we derive the assertion that a guest curtsied, and the presupposition that there is exactly one guest and that guest is female. The approach seems quite general, but Karttunen and Peters observe, in a by now infamous footnote, that there is a problem associated with their interpretation of existentially quantified sentences. According to their theory, a sentence of the form 'An X Ys' carries the assertion that an individual in the assertional extension of X has the property given by the assertional component of Y. Further, the sentence carries the presuppositions (1) that some individual is in the presuppositional extension of X, and (2) that some individual in the assertional extension of X is in the presuppositional extension of Y. What might be referred to as *the binding problem* is that there is no link between the variables bound in the assertion and in the presupposition. In particular, there is no guarantee that any entity satisfies both the assertional and the presuppositional requirements.

For instance, the sentence 'Somebody curtsied' will be given the assertion $\exists y\, person(y) \land curtsied(y)$, i.e. that somebody performed the physical act of curtseying, and the presupposition $\exists y\, person(y) \land female(y)$, i.e. that somebody is female. Crucially, this fails to enforce the common-sensical constraint that the person who curtseyed is female. One possible fix would amount to making all presuppositions also assertions, which is standard in some of the accounts to be considered in the next section. In fact, as will be discussed there, there is a separate reason to make presuppositions also part of the asserted content, for without this one cannot easily explain why although presuppositions are commonly defeasible, presuppositions of simple positive sentences are not. If the presupposition is also part of the assertion, then the reason for this indefeasibility has nothing to do with the presuppositional dimension itself, but derives from the fact that one cannot ordinarily deny one's own assertions, or make assertions which one knows to be false.

2.4. Pragmatic Extensions

Little if any recent work has advocated a pure multivalent/partial account of presupposition. Rather, even where multivalence/partiality is taken as the core of a treatment of presupposition, it is usually assumed that some pragmatic component will be required in addition:

- Karttunen and Peters [KP79] assume that conversational implicatures will strengthen some of the weak presuppositions generated.
- Link [Li86] assumes a cancellation-like mechanism whereby a presuppositional expression can sometimes be *co-asserted.* Whether an expression is indeed co-asserted must be controlled by pragmatic factors (c.f. discussion of the floating-A theory, above).
- Seuren [Seu85] embeds a strong Kleene system (with an additional negation) within a general theory of discourse interpretation. Further, he supposes that a

mechanism of *backward suppletion* (similar to that which is below called *accommodation*) will repair the discourse context in cases of presupposition failure.

– Burton-Roberts [Bu89a] discusses a *meta-linguistic* use of negation which he argues enables treatment of cancellation cases without postulation of a lexical ambiguity of negation. He also provides essentially pragmatic argumentation to establish whether the falsity of a sentence's presupposition leads to the undefinedness of the sentence.
– Kracht [Krac94] argues that processing considerations can influence the way in which a connective is interpreted, and in this way reasons to each connective having multiple (trivalent) realisations.

3. Part-time Presupposition

The theories to be discussed in this section have two things in common. Firstly, they are, in a sense, the only true projection theories: the set of presuppositions associated with the utterance of a complex sentence is a subset of the set of elementary presuppositions of that sentence. We can thus say that these theories define (relative to a context) a projection function which determines for each elementary presupposition whether it is projected or not. Secondly, this projection function is context sensitive. Thus whereas for the theories discussed in the previous section presupposition was understood as a binary relation between sentences, the theories to be discussed now involve definitions of presupposition as a three place relation between a pair of sentence and a context of evaluation. Alternatively, if an utterance is defined as a pair of a sentence (or set of sentences) and a linguistic context, then presupposition becomes a two place relation between an utterance and a sentence.

A *part-time* theory (the term is used in Karttunen's [Kar74]) is one where unwanted presuppositions simply vanish. One can identify two means of producing this effect, which may be termed *cancellation* and *filtering.* These are commonly regarded as opposing approaches to the treatment of presupposition, but the two are closely related variations on a single theme:

(i) The grammar and lexicon together encode a way of calculating for each simple sentence a set of *potential presuppositions.*

(ii) The set of presuppositions of a complex sentence is a subset of the union of the potential presupposition sets of the simple subsentences. Call this subset the *projection set.*

(iii) The calculation of the projection set is sensitive to linguistic context (conceived of as a set of sentences), and relies on one or both of the following two strategies:

Local filtering For each subsentence S consisting of an operator embedding further subsentences as arguments, S not only carries its own potential presuppositions, but also inherits a subset of the potential presuppositions of the arguments.

Global cancellation Pragmatic principles determine a function from tuples consisting of the context, the set of potential presuppositions, the assertive content of the sentence, and (except in the version in [vdS88]) a set of Gricean implicatures of the sentence, to that subset of the potential presuppositions which is projected.

3.1. Plugs, Holes and Filters

Karttunen [Kar73, p.178] introduced the following taxonomy:

Plugs: predicates which block off all the presupposition of the complement sentence [examples include 'say', 'mention', 'tell, ask'];

Holes: predicates which let all the presuppositions of the complement sentence become presuppositions of the matrix sentence [examples include 'know', 'regret', 'understand', 'be possible', 'not']; ;

Filters: predicates which, under certain conditions, cancel some of the presuppositions of the arguments [examples include if-then, 'either-or', 'and'].

Karttunen's 1973 paper provides two related models of projection: the second model can be seen formally as a generalisation of the first. Definition 3.1, below, gives a function $\mathcal{P}$ which maps every formula of a language onto a set of formulae which are its presuppositions relative to a context C. This context, what Karttunen calls "a set of assumed facts" should here be a set of formulae, and the first version of Karttunen's model (which he defined without reference to this extra parameter) is obtained simply by assuming the context to be empty. The language over which 3.1 is given is PrL with the addition of two sets of sentential operators $\mathbf{H}$ and $\mathbf{P}$, corresponding to hole predicates and plug predicates respectively.

Definition 3.1 (Karttunen '73 Presuppositions wrt. a Context).

$$
\begin{array}{lrcl}
(3.1) & \mathcal{P}_C(p) & = & \emptyset \quad \textit{(for atomic p)} \\
(3.2) & \mathcal{P}_C(\phi_\psi) & = & \{\psi\} \cup \mathcal{P}_C(\phi) \cup \mathcal{P}_C(\psi) \\
(3.3) & \mathcal{P}_C(O\phi) & = & \emptyset \quad \textit{(for } O \in \mathbf{P}\textit{)} \\
(3.4) & \mathcal{P}_C(O\phi) & = & \mathcal{P}_C(\phi) \quad \textit{(for } O \in \mathbf{H}\textit{)} \\
(3.5) & \mathcal{P}_C(\neg\phi) & = & \mathcal{P}_C(\phi) \\
(3.6) & \mathcal{P}_C(\phi \wedge \psi) & = & \mathcal{P}_C(\phi \rightarrow \psi) \\
(3.7) & & = & \mathcal{P}_C(\phi) \cup \{\chi \in \mathcal{P}_C(\psi) \mid C, \phi \not\models \chi\} \\
(3.8) & \mathcal{P}_C(\phi \vee \psi) & = & \mathcal{P}_C(\phi) \cup \{\chi \in \mathcal{P}_C(\psi) \mid C, \neg\phi \not\models \chi\} \\
(3.9) & \phi \gg_C \psi & \textit{iff} & \psi \in \mathcal{P}_C(\phi) \\
(3.10) & \phi \gg \psi & \textit{iff} & \phi \gg_\emptyset \psi
\end{array}
$$

The first five clauses of this definition are straightforward: atomic formulae, by assumption, have no presuppositions; a formula ϕ_ψ presupposes ψ and anything that

ϕ or ψ presupposes; a plug embedding a formula carries no presuppositions, whilst a hole (of which internal negation is an example) carries just the presuppositions of its sentential argument. The binary connectives, which act as filters, are more interesting. Firstly, conjunction and implication. These carry all the presuppositions of the first argument, but only those presuppositions of the second argument which are not entailed by a combination of the context and the first argument. Consider the following:

(3.11)If David wrote the article and the knowledge that ([i] he wrote it/[ii] no decent logician was involved) disturbs the editors, they'll read the manuscript very carefully.

The presupposition that David wrote the article triggered in the right hand conjunct of the antecedent of 3.11(i) is cancelled. Even ignoring the context (i.e. setting it to the emptyset so as to get the first version of Karttunen's 1973 model), this result is predicted. The LF of 3.11(i) has the general form $(\phi \wedge \psi_\phi) \rightarrow \chi$. Since the left conjunct of the antecedent entails the presupposition of the right conjunct, the presupposition is filtered.

It is easy to find formulae for which, in the absence of a special context, filtering does not occur. For instance on definition 3.1 we have (for independent ϕ, ψ, χ, ω) that $(\phi \wedge \psi_\omega) \rightarrow \omega \gg \omega$. Thus, in the absence of a special context, 3.11(ii) is predicted to presuppose that no decent logician was involved (in writing the article). But if the context contains (or entails) $\phi \rightarrow \omega$, then the presupposition is filtered: $(\phi \wedge \psi_\omega) \rightarrow \omega \gg_{\phi \rightarrow \omega} \omega$. In the absence of a special context, it is not immediately obvious whether the presupposition in 3.11(ii) does simply disappear. However, it does seem to be the case that if it is established in the context that David is not a decent logician (which presumably entails the conditional $\phi \rightarrow \omega$, i.e. that if David wrote the article then no decent logician was involved), then the presupposition that no decent logician was involved does not project.

There remains unclarity. What is the status of the "set of assumed facts"? Should this set contain only propositions which are commonly known to all interlocutors, or can it contain propositions which only the hearer, or perhaps only the speaker, take to be common? And what is the status of a presupposition: is it also some sort of assumed fact? What makes it even harder to say what presuppositions really are in this account, as well as providing some empirical problems, is that a formula may have contrary presuppositions. For instance the following sentence (of a type originally discussed by Hausser [Ha76]) contains two instances of factive constructions, '**knows**' and '**is upset**', but the presuppositions conflict with each other, and are not projected:

(3.12)Either Fred knows he's won or he's upset that he hasn't.

If we analyse 3.12 as having the form $\phi_\psi \vee \chi_{\neg\psi}$, the set of presuppositions predicted by the above definition is $\{\psi, \chi\}$.

3.2. Global Cancellation

The model presented by Gazdar in [Gaz79a], like Karttunen's revised filtering model, is context sensitive, provides an account of the presuppositions of utterances rather than sentences, and predicts the presuppositions of an utterance to be a subset of the potential presuppositions of the component sentences. Unlike Karttunen's model, the presuppositions are not calculated by bottom-up filtering but by a global cancellation mechanism. All the potential presuppositions of component sentences are collected together into one set, and from that set are removed any members which conflict with (1) propositions in the previous context, (2) the entailments of the utterance, (3) various implicatures associated with the utterance, or (4) each other. Those potential presuppositions surviving this tough selection process go on to become full presuppositions of the utterance.

The basic idea that something cannot be presupposed if that would conflict with implicatures of the utterance is already found in Stalnaker's discussion of Karttunen's full-factive/semi-factive distinction [St74, pp.207–210]. Further, Soames proposed independently of Gazdar that defeat by implicature should be the central notion of a theory of presupposition projection: "A speaker who utters a truth-functional compound, question or epistemic modal indicates that he is presupposing all of the presuppositions of its constituents unless he conversationally implicates (or explicitly states) otherwise."[So79, p.653]. Kempson [Kem75], Wilson [Wi75] and Atlas [At76, At77] (see also [AL81]) had all recognised that conversational factors determine whether or not a presupposition is projected, although their general strategy was of trying to find implicature-based explanations of all cases where presuppositions do project, rather than assuming by default that they project and only seeking implicature-based explanations of cases where presuppositions are canceled.

Gazdar's theory of presupposition, however, provides the first formalisation of this type of account. It is set within a dynamic model of meaning, in which discourse contexts — sets of propositions — are progressively updated with the information in succeeding utterances. Note that the dynamism is found only at the level of texts, and does not extend downwards to the interpretation of the constituents of sentences. In this respect Gazdar's model contrasts with the accounts of presupposition proposed by Karttunen [Kar74] and Heim [Hei83a], as well as with the accounts of anaphora proposed by Kamp [Kam81], Heim [Hei82, Hei83b] and Groenendijk and Stokhof [GS91a], all of which employ dynamic interpretation at the subsentence level.

Central to Gazdar's model is his notion of *satisfiable incrementation*. The satisfiable incrementation of a context X with a set Y of propositions is just the original context plus all those propositions in Y which cannot introduce inconsistency, where a proposition y *cannot introduce inconsistency* just in case all consistent subsets of $X \cup Y$ are still consistent after addition of y. The following definition (almost identical to Gazdar's) results:

Definition 3.2 (Consistency, Satisfiable Incrementation).

$$\begin{aligned} &cons(X) \text{ iff } X \not\models \bot \\ &X \cup! Y \;=\; X \cup \{y \in Y \mid \forall Z \subseteq (X \cup Y)\ \ (\,cons(Z) \rightarrow cons(Z \cup \{y\})\,)\} \end{aligned}$$

For example, if $X = \{p, q\}$ and $Y = \{\neg p, r, s, \neg s\}$, with all atomic formulae assumed logically independent, then $X \cup! Y = \{p, q, r\}$. The proposition $\neg p$ cannot be added because it is inconsistent with X, s cannot be added because there are consistent subsets of $X \cup Y$ (e.g. $\{p, q, \neg s\}$) which become inconsistent when s is added to them, and similarly for $\neg s$.

Gazdar is concerned with reasoning about the hearer's knowledge of the speaker. For that reason a Gazdarian context is just a set of epistemic formulae, formulae of Hintikka's logic of knowledge and belief [Hi62]. The symbol $\models$ will now represent entailment in this logic, and K can be thought of as 'the speaker knows that'. The need for an epistemic logic arises from the treatment of implicatures, some of which are inherently epistemic. The discussion below, unlike Gazdar's original theory, will be restricted to one class of epistemic implicatures, so-called *clausal* implicatures. For instance, a sentence 'if Mary's happy then she is singing' carries a clausal implicature that the speaker does not know whether Mary is in fact happy (or whether she is happy), and more generally when an utterance does not decide the truth of some embedded sentence there is an implicature that the speaker does not know whether that embedded sentence is true. Definition 3.3, below, begins with the potential presuppositions PP(ϕ) of a formula ϕ and the potential implicatures PI: both of these definitions utilise a function 'sub' which is assumed to map a formula onto the set of all its subformula. The potential presuppositions is just the set of subformulae occurring as subscripts (i.e. as second argument to the presuppositional connective), and potential implicatures are triggered by any subformula for which the formula as a whole neither entails the subformula nor its negation.

Using the notation ϕ' to mean a formula of PrL with all the instances of formulae ϕ_ψ replaced by $\phi \wedge \psi$, what we may call *the assertion of* ϕ, a function $\star\phi$ is defined. This maps a context C onto a new context which is just C with the proposition that the speaker knows ϕ' added, and then all the compatible potential implicatures added. The full update of C with a formula ϕ is given by $C + \phi$, which is just $C \star \phi$ with all the compatible presuppositions added. Finally, we arrive at definitions of presupposition, $\phi \gg_C \psi$ holds just in case ψ is added to the context in the presuppositional stage of the update of C with ϕ, and $\phi \gg \psi$, if that is so for an empty context. Additionally we define a presuppositionally sensitive notion of implication, $\models\!\!\!\models$:

Definition 3.3 (Gazdarian Presuppositions).

$$
\begin{aligned}
PP(\phi) &= \{K\psi \mid \textit{for some } \chi, \chi_\psi \in sub(\phi)\} \\
PI(\phi) &= \{\neg K\psi \wedge \neg K\neg\psi \mid \psi \in sub(\phi) \wedge \phi \not\models \psi \wedge \phi \not\models \neg\psi\} \\
C \star \phi &= C \cup \{K\phi'\} \cup ! PI(\phi) \\
C + \phi &= C \star \phi \cup ! PP(\phi) \\
\phi \gg_C \psi &\textit{ iff } C + \phi \models \psi \textit{ and } C \star \phi \not\models \psi \\
\phi \gg \psi &\textit{ iff } \phi \gg_\emptyset \psi \\
\phi \Vdash\!\!= \psi &\textit{ iff } \emptyset + \phi \models \psi
\end{aligned}
$$

The reader should verify that under these definitions presuppositions project in simple cases of embedding. Further, cancellation is correctly predicted in a wide range of cases, for instance the following:

(3.13)The King of France is not bald: there is no King of France.

(3.14)If the King of France is bald, then I'm a Dutchman: there is no King of France.

(3.15)I don't know that Louis is bald.

(3.16)If David wrote the article then the knowledge that he wrote it will confound the editors.

Let ψ be the proposition that there is a French King, and ϕ be the proposition that this individual is bald. Then the first example, 3.13, becomes $\neg(\phi_\psi) \wedge \neg\psi$. Cancellation is correctly predicted: $\neg(\phi_\psi) \wedge \neg\psi \quad \not\Vdash\!\!= \psi$. Note that in the absence of further information presuppositions project from negative sentences, so that the first clause alone does imply the existence of a French King: $\neg(\phi_\psi) \Vdash\!\!= \psi$.

In 3.14 (as uttered by, say, an Englishman) the presupposition of the definite in the first sentence, that there is a French King, is once again canceled. On the assumption that the consequent of the conditional is intended as obviously false, and may be translated as if it were simply a contradictory proposition represented by $\perp$, we derive a translation $\phi_\psi \rightarrow\perp) \wedge \neg\psi$. The Gazdarian account again correctly predicts cancellation: $\phi_\psi \rightarrow\perp) \wedge \neg\psi; \not\Vdash\!\!= \psi$. Under the translations given here it is scarcely surprising that 3.13 and 3.13 manifest similar projection properties, but note that under some accounts this could be seen as problematic. I am thinking here of theories (like the partial and multivalent theories considered earlier) that explain the occasional failure of presuppositions to project from under negations, as in 3.13, by postulating an ambiguity of negation, so that the ordinary presupposition-projecting translation of the first clause of 3.13 alone would in fact use a different negation to that involved in the cancellation reading of the whole example. This is a quite consistent position to take, but as the beginnings of a general account of the phenomenon of cancellation it is at least tested by examples like 3.14. For to explain cancellation in 3.14, the supporter of an ambiguity hypothesis would presumably have to postulate ambiguity of the English conditional. One then wonders where this multiplication of homonyms will end: could all embedding constructions end up ambiguous between projecting and cancelling interpretations? This would be an unattractive result.

Example 3.15 is a historically interesting type of cancellation sentence which led some theorists, starting with Karttunen [Kar71], to postulate that there is a class of attitude verbs, the so-called *semi-factives*, which in some cases fail to carry a presupposition. Gazdar [Gaz79a, pp.153–154] was able to show that his theory could be used to formalise an alternative explanation arising with Stalnaker [St74]. Take K to be a modal operator translating 'I know', and translate 'I know that Louis is bald' as $K(\phi)_\phi$, where ϕ is the proposition that Louis is bald. Updating with the formula's assertion results in a context containing $\neg(\phi \wedge K(\phi))$, which in Hintikka's logic entails $\neg K(\phi)$. This is sufficient to prevent the potential presupposition $K(\phi)$ from being projected. It is crucial to the argumentation that the formula explicitly concerns the speaker's beliefs, and it is correctly predicted that whilst cancellation takes place in 3.15, it does not in the structurally similar 'Marie doesn't know that Louis is bald'. Likewise, no cancellation is predicted if 'know' is substituted for a factive verb that does not assert something about the speaker's knowledge: 'I don't regret that Louis is bald' does imply that the speaker takes Louis to be bald. So the cancellation in 3.15 does not take place because of any special non-presuppositional meaning of 'know', as Kartunnen would suggest, but because the ordinary lexical semantics of 'know' means that it can be used to address issues relevant to projection.

In example 3.16, translated as $\phi \rightarrow \psi_\phi$, a potential implicature is generated by the occurence of ϕ in the antecedent of the conditional, which results in $\neg K\phi$ being added to the context. This is sufficient to block projection of the potential presupposition $K\phi$. A similar cancellation effect would be derived for the earlier example 3.11(i), but, as will be seen later, this type of clausal-implicature dependent cancellation does not always produce the right results.

3.3. The Pre- in Presupposition

In what sense is Gazdar's theory an account of 'presupposition'? I do not mean to suggest that it does not provide an account of presuppositional data. I merely mean that the account does not bear any relation to the fairly intuitive notion of presuppositions as previous assumptions. Indeed, since presuppositions are the last things to be added in Gazdar's definition of update, perhaps it would be more natural to call them *post-suppositions.* To me, at least, the major achievement of the theory first presented in van der Sandt's thesis [vdS82], which only appeared in English somewhat later in [vdS88], is that it does succeed in reconciling ideas from Gazdar's cancellation account with what I take to be the intuitive notion of presupposition. I will term van der Sandt's 1982/87 account his *cancellation* theory, to distinguish it from his later DRT-based theory.

One crucial but disarmingly simple insight could be said to drive van der Sandt's cancellation theory. Suppose a sentence S can be coherently uttered in a context σ, and that one of the constituents of S carries a potential presupposition expressible using the sentence P. If in σ the text made up of P followed by S is coherent, then utterances of S in σ will carry the presupposition P, i.e. P is projected, and otherwise P is canceled (see [vdS88, pp.185–189]). For example, the sentence S= 'If Mary is married then her husband is away.' does not presuppose that Mary has a husband, since the the discourse consisting of 'Mary has a husband.' followed by S is strange.

Coherence of a discourse, what van der Sandt expresses as "acceptability in a context", here comes down to the requirement that every clause is both consistent and informative. And it is in this definition that we see a synthesis of ideas of context change originating with Stalnaker and Karttunen with an otherwise quite Gazdarian account. Acceptability of a sentence S in a context σ is the requirement that for each clause S' appearing in S (other than within a presuppositional expression) σ neither entails S' nor entails the contrary of S'. If this requirement is not met, then S will not be a maximally *efficient* (i.e. compact) way of communicating whatever information it conveys in that context. I simplify by taking a context to be a set of sentences, although van der Sandt allows for contexts to contain certain additional information.

Definition 3.4 (Presuppositions in van der Sandt's Cancellation Account).
Given that all the potential presuppositions (or elementary presuppositions *in van der Sandt's terminology) of* S *are collected in the set* π*, the presuppositions of* S *in context* σ *are those propositions* ϕ *such that:*

(i) $\phi \in \pi$
(ii) *For any* $\psi \in \pi$, $\sigma \cup \{\phi, \psi\} \not\models \bot$
(iii) S *is acceptable in the context* $\sigma \cup \{\phi\}$

Although there are problems associate with this definition[24], the intuition is clear, as the treatment of as treatment of 3.17 should illustrate:

[24] The definition is essentially that given by van der Sandt as "D-7" [vdS88, p.203]. There appear to be two major errors. A first problem is that the second clause only checks for consistency of pairs of potential presuppositions. It is easy to manufacture an example where all pairs are consistent but the triples are not. Suppose the context σ contains the proposition that exactly two people whistled, and that S= 'Sherlock has discovered that Watson whistled, or he's discovered that Mycroft whistled, or he's discovered that Moriaty whistled'. Now we might take π to be the set { 'Watson whistled', 'Mycroft whistled', Moriaty whistled}. Any pair of elements of this set is consistent with σ although, assuming non-identity of Watson, Mycroft and Moriaty, the three elements together are inconsistent with σ. The above definition would incorrectly predict that all elements of π become full presuppositions even in a context where their joint addition produces inconsistency.

A similar problem ensues from the third clause, which checks that addition of each presupposition to σ would not make S unacceptable, but does not ensure that if all the presuppositions are added to σ the resulting context accepts S. Again we can manufacture a rather artificial example to illustrate the point. Suppose σ is empty, and S = 'If John is an only child then he doesn't regret that he has no brothers and he doesn't regret that he has no sisters.' It seems plausible that π should be the set {John has no brothers, John has no sisters}. Since these are consistent with each other, and since S is acceptable in either of the contexts produced by adding an element of π to σ, van der Sandt predicts that both members of π become full presuppositions. This is inappropriate, (3.17)' If Mary is sleeping then Fred is annoyed that she is sleeping.

Suppose that the context is empty. For 3.17, π is just the singleton set $\{$*Mary is sleeping*$\}$, the one potential presupposition being triggered by the factive 'annoyed'. We can test whether the potential presupposition is actually presupposed by adding it to the context and checking that all the subsentences in 3.17 not appearing in presuppositional expressions are neither entailed nor contradicted in the resulting context. Since the resulting context $\{$*Mary is sleeping*$\}$ entails one of the subsentences, i.e. the antecedent of the conditional, we can conclude that the proposition that Mary is sleeping is not being presupposed, for if it were then 3.17 would be inefficient, and hence unacceptable.

Aside from van der Sandt's proposal, there are by now a number of other theories which utilise Gazdar's approach of making presuppositions true by default. Mercer's cancellation account [Me87, Me92] takes Gazdar's insight that presuppositions *normally* project, and are only canceled as a result of conflict with context or implicatures, and formalises that by explicitly encoding Gazdar's potential presuppositions as default inference rules within Reiter's Default Logic. Mercer's formulation is closer to the general framework I have espoused here than Gazdar's, in that Mercer explicitly formulates his theory in terms of a notion of presupposition sensitive implication, that notion of implication being drawn directly from Default Logic. Indeed, Mercer describes his theory as not being a theory of presupposition projection *per se*, but as a theory of presuppositional inference. Other recent cancellation accounts include those of Bridge [Br91], Gervas [Ger95], Horton **??**, Marcu [Ma94], Morreau [Morr95], and Schöter [Schö95, Schö:MS]. These accounts exhibit considerable technical and descriptive variation, but all centre on presuppositions being defeasible inferences.

4. Dynamic Semantics

All of the major contemporary theories of presupposition projection are in one way or another dynamic theories, making crucial use of the way in which the epistemic state of an agent changes as the interpretation process proceeds. We have already seen that the cancellation theory of Gazdar [Gaz79a], although based on a classical static semantics, involves pragmatic mechanisms controlling the evolution of a set of accepted propositions. In such a theory we may say that the static interpretation of a sentence acts as a middleman between the syntax of language and pragmatic processes controlling the changing state of the language user. In this section we

since both elements of π taken together entail that John is an only child, so that if both are being assumed then the antecedent of the conditional is uninformative. In a context to which those presuppositions have been added, S will convey only the same information as the sentence 'John doesn't regret that he has no brothers and he doesn't regret that he has no sisters.'

Clearly the technical apparatus proposed by van der Sandt does not quite square up with what I take to be the intuition behind that apparatus, namely that in a context containing the presuppositions, S should be maximally efficient. See also Burton-Roberts review article, [Bu89c], for some quite different criticisms of van der Sandt's D-7.

will be concerned with theories which cut out this middleman, so that language is interpreted directly into a domain of state-changing operations. The term *dynamic semantics* will be used, meaning that there is some composition-preserving map from a domain of syntactic objects to a domain of meanings, such that objects of sentential category are mapped onto a certain class of operations. These operations must be such that they can act on the state of information of some agent to produce a new state.

In general, the successful performance of an operation may require certain preconditions to be met. Open heart surgery requires a steady hand and a fair amount of equipment, and the operation of buttering toast also requires both a steady hand and a certain minimal set of ingredients. The central idea of the dynamic semantic approach to presupposition is that the operation of modifying an information state may require certain of the *ingredients* to be already present. For instance "Oh no! I've dropped the knife." may be understood as an operation to update a state which in some way determines a salient knife (the crucial ingredient) with the information that the object in question has been lost. This will lead to a formal model of *presupposition* which is intuitive in the sense that it accords closely with the everyday usage of the term as *a proposition taken to be accepted in advance.* The outline of the model runs as follows:

- An information state is comparable to a partial model, with respect to which some propositions are satisfied, some are falsified, and others are neither satisfied nor falsified.
- Sentences are interpreted as update operations mapping states to states. However, it may be that for some state the update operation cannot succeed, in which case the sentence is said to be inadmissable in that state. One sentence presupposes another if all states admitting the first satisfy the second.
- When evaluating a complex syntactic expression in a certain input context, the semantics of the functor should determine what input states are used locally in the evaluation of the argument expressions. Basic projection facts are explained by assuming that a complex expression is only admissable in a state if the the argument expressions are all admitted in their local input states.

To reiterate, the use of the term *dynamic semantics* is not meant to imply that the models to be discussed will be *semantical* in the classical sense of concerning a static relation between *the word* and *the world*, for the chief philosophical advance of the models to be discussed is the combination of what had been thought of as distinct pragmatic and semantic aspects of meaning and interpretation into unitary theories. Rather, the term *semantic* will be applied to aspects of meaning which are naturally incorporated into the compositional description of a grammar, and aspects of meaning will be termed *pragmatic* if they are not naturally folded into the compositional grammar. Of course, in using the term *natural* here, I am already implicitly accepting that the distinction is not hard and fast.

4.1. From Projection to Satisfaction

The [Kar73] definition of presupposition involved a special contextual parameter for "a set of assumed facts", utterance presuppositions being calculated relative to such a set. However, it is not clear in this theory how the set of assumed facts and the set of (utterance) presuppositions are to be understood, and what, from a philosophical perspective, is meant to be the relation between them. In [Kar74] Karttunen brilliantly resolved these difficulties, essentially by turning the projection problem, as then conceived, on its head. Instead of considering directly how the presuppositions of the parts of a sentence determine the presuppositions of the whole, he suggests we should first consider how the global context of utterance of a complex sentence determines the local linguistic context in which the parts of the sentence are interpreted, and derive from this a way of calculating which global contexts of utterance lead to local satisfaction of the presuppositions. He gives a formal definition of when a context satisfies-the-presuppositions-of — or *admits* — a formula. A simple sentence p will be admitted in a context A (here written $A \rhd p$) if and only if the primitive presuppositions of p are satisfied in A, where the natural notion of contextual satisfaction is just classical entailment. When a complex sentence is evaluated in some context, however, presuppositions belonging to the parts of the sentence need not necessarily be satisfied in that context. For example, if a sentence s of the form "p and q" occurs in a context A, the conditions for s to be admitted in A are that p is admitted in A and q is admitted in a new context produced by adding p to C. Note that essentially the same idea was independently developed by Stalnaker, who comments, in the case of conjunction: "If one asserts a proposition using a conjunctive sentence ... the presuppositions will change in the middle of the assertion. The first conjunct will be added to the initial presuppositions before the second conjunct is asserted."**??**p.455]stalnaker:pres In reading this quote it is perhaps illuminating to substitute *information state* for *presuppositions*, since Stalnaker's notion of presupposition is intended to capture something like the set of propositions assumed by the speaker to be in the common ground, and not any specific set of propositions attached to a sentence. Definition 4.1, below, shows how such ideas can be applied to PrL:

Definition 4.1.

(4.1) $A \rhd \phi_\psi$ *iff* $A \models \psi$ *and* $A \rhd \phi$

(4.2) $A \rhd p$ *for any atomic* p

(4.3) $A \rhd \neg\phi$ *iff* $A \rhd \phi$

(4.4) $A \rhd \phi \wedge \psi$ *iff* $A \rhd \phi$ *and* $A \cup \{\phi\} \rhd \psi$

(4.5) $A \rhd \phi \rightarrow \psi$ *iff* $A \rhd \phi$ *and* $A \cup \{\phi\} \rhd \psi$

(4.6) $A \rhd \phi \vee \psi$ *iff* $A \rhd \phi$ *and* $A \cup \{\neg\phi\} \rhd \psi$

Presupposition may be formally defined as follows:

Definition 4.2.

$$\phi \gg \psi \ \textit{ iff } \forall A \ \ A \rhd \phi \ \Rightarrow \ A \models \psi$$

The empirical motivation Karttunen presents for this theory is much the same as for his earlier theory as considered in the previous section. For instance, consider the formula $(\phi \wedge \psi_\phi) \rightarrow \chi$, which was given as a translation for 3.11(i). Admittance of the whole formula in a context A depends on admittance of the formula ψ_ϕ in a local context $A \cup \{\phi\}$: but this is guaranteed irrespective of A. Thus the formula as a whole is admitted in all contexts, and there is no non-trivial presupposition.

This is more or less the result that would have obtained in the earlier Karttunen theory [Kar73] discussed in the previous section, but the "more or less" caveat is significant. Whereas Karttunen's 1973 theory predicts no presupposition for this example, the 1974 theory predicts that all tautologies are presupposed by every formula. Furthermore, when the 1974 theory does predict a non-trivial presupposition, all the entailments of that presupposition are also presuppositions themselves, unlike in the 1973 theory. This difference is revealing, for it shows that [Kar74] is not a filtering model at all, for the presuppositions of a sentence are not in general a subset of the elementary presuppositions of its parts (although this would be the case for the part of the theory in **??** if π always mapped propositions onto sets of elementary presuppositions closed under logical consequence). Furthermore, the difference is not just that entailments of presuppositions are predicted to be presupposed. More interestingly, we will see that there is a whole class of cases where **??** predicts a non-trivial presupposition which is not a member of the elementary presupposition set at all, when the earlier Karttunen model would predict no presupposition at all.[25] Here is a summary of the presupposition projection properties arising from definitions **??** and 4.2:

Fact 4.3.
If ϕ presupposes ψ then:

(i) $\neg\phi$, $\phi \wedge \psi$, $\phi \rightarrow \psi$ *and* $\phi \vee \psi$ *all presuppose* ψ

(ii) $\chi \wedge \phi$, $\chi \rightarrow \phi$ *and* $\chi \vee \phi$ *all presuppose* $\chi \rightarrow \phi$

(iii) $\chi \vee \phi$ *presupposes* $\neg\chi \ \rightarrow \ \phi$

It can be seen that when a presupposition trigger is found on the right-hand side of a connective, a conditional presupposition results, although this conditional will not in general be one of the elementary presuppositions itself. So a concrete cases where the 1973 and 1974 theories vary is the formula $\phi \rightarrow \psi_\chi$, given as the translation of the earlier example 2.1. The 1973 model predicts, in the absence of a special set of "assumed facts", the presupposition χ, whereas the 1974 theory predicts the presupposition $\phi \rightarrow \chi$.

[25] A similar point is made By Geurts in [Geu95].

4.2. Context Change Potential

Although Karttunen's 1974 model resolved the tension created by the simultaneous presence in his earlier work of distinct notions of assumption and utterance presupposition, it left unresolved one crucial issue: what is supposed to be the relationship between the definition of admission for an expression and the semantics of that expression. Judging from the developments in Karttunen and Peter's later work [KP79], one might conclude that admission conditions and semantics are separate and unrelated parts of a grammar, but some authors see this as a weakness of the theory. Gazdar [Gaz79b, pp. 58–59], who does not distinguish between the Karttunen's 1973 and 1974 accounts, caricatures Karttunen's justification for why presuppositions sometimes disappear as "Because those presuppositions have been filtered out by my filter conditions." Gazdar suggests that an explanatorily adequate model should not only stipulate filtering conditions, but provide independent motivation for why those conditions are as they are. Although it is difficult to give any definitive characterisation of exactly when a theory of presupposition is explanatorily adequate — and Gazdar's rhetoric provides no such characterisation — it is at least clear that it would be desirable to justify a particular choice of filtering or admittance conditions. Heim [Hei83a] attempts to provide such a justification, and at the same time to clarify the relationship between admittance conditions and semantics. In particular, Heim provides a method of stating semantics, based on the approach developed in [Hei82], in such a way that admittance conditions can be read off from the semantic definitions without having to be stipulated separately. Crucially, Heim's semantics involves a significant deviation from the classical Tarskian approach, in that rather than viewing meaning as a static relation holding between language and truth in the world, she takes the meaning of an expression to be a method of updating the information state of communicating agents. I will now present Heim's insights in terms of PrL, the reader being referred to [**?**, dynamics chapter] for a more careful discussion of the dynamic semantic approach.[26]

In definition 4.4 a dynamic semantics is given for a small propositional language. Formulae are interpreted as relations between pairs of information states, the intuition being that if a pair $\langle\sigma, \tau\rangle$ is in the denotation of a formula, then it is possible to update the state σ with the formula to produce the state τ. Information states are fashioned after the conception in [St79] as sets of possible worlds, the idea being that the set of worlds in an information state represents the set of different ways the world could be whilst maintaining consistency with all the available information. There are several ways we could answer the question of exactly what an information state is supposed to be a state of, it being left open for the moment whether a state represents the information of some particular agent, such as a hearer, or represents the commonly agreed information of a group of communicating agents, that is to say, *the common ground.* The clause for atomic propositions in 4.4 says

[26] The move to a dynamic semantic style of presentation for Karttunen-Heim type theories was made by van Eijck [Ei93], Zeevat [Ze92] and myself [**?**]. More recent work along these lines may be found in my [Bea95, Bea94a], Chierchia's [Ch:MS], and Krahmer's [Krah93] — the presentation given here strongly resembles Krahmer's.

that to update a state with an atomic proposition, all the worlds incompatible with the proposition must be removed, it being assumed that we have an interpretation function giving us for each proposition letter a corresponding set of worlds. The next clause says that to update with a conjunction it is necessary to update sequentially with the left and then the right conjunct, and the final clause says that to update with the negation of a formula one must find the set of worlds that is compatible with the formula, and remove these from the information state.

Definition 4.4. *Semantics of an Update Logic For all models $\mathcal{M}$ and information states σ, τ, the relation $[\![.]\!]^{\mathcal{M}}$ (sub-script omitted where unambiguous) is given recursively by:*

$$\sigma[\![p_{\text{atomic}}]\!]\tau \;\; \textit{iff} \;\; \tau = \{w \in \sigma \mid w \in F(p)\}$$
$$\sigma[\![\phi \wedge \psi]\!]\tau \;\; \textit{iff} \;\; \exists \upsilon \;\; \sigma[\![\phi]\!]\upsilon[\![\psi]\!]\tau$$
$$\sigma[\![\neg\phi]\!]\tau \;\; \textit{iff} \;\; \exists \upsilon \;\; \sigma[\![\phi]\!]\upsilon \;\wedge\; \tau = \sigma\backslash\upsilon$$

One may add extend this language with clauses for implication and disjunction using, for example, the following classical equivalences[27]

Definition 4.5.

$$\sigma[\![\phi \rightarrow \psi]\!]\tau \;\; \textit{iff} \;\; \sigma[\![\neg(\phi \wedge (\neg\psi))]\!]\tau$$
$$\sigma[\![\phi \vee \psi]\!]\tau \;\; \textit{iff} \;\; \sigma[\![\neg(\neg\phi \wedge \neg\psi)]\!]\tau$$

Let us say that a state σ satisfies a formula ϕ (written $\sigma \models \phi$) if and only if the state is a fixed point of the formula, which means that updating the state with the formula will add no new infrmation, and that one formula ϕ entails another ψ (written $\phi \models \psi$) if any update with the premise formula produces a state in for which updating with the second adds no more information — see [**?**, dynamics chapter] for discussion of alternative notions of entailment.

Definition 4.6.

$$\sigma \models \phi \;\; \textit{iff} \;\; \sigma[\![\phi]\!]\sigma$$
$$\phi \models \psi \;\; \textit{iff} \;\; \forall \sigma, \tau \sigma[\![\phi]\!]\tau \Rightarrow \tau \models \psi$$

At this point, the logic is competely classical, but that changes when presuppositional constructions are introduced. The following definition attempts to capture the intuition that presuppositions place constraints that an input context must satisfy in order for there to be an update:

[27] It will be crucial exactly which classical equivalences are used, since when we extend the language still further certain other equivalences, such as commutativity of conjunction, will fail.

Definition 4.7.

$$\sigma[\![\phi_\psi]\!]\tau \;\; \textit{iff} \;\; \sigma \models \psi \;\; \textit{and} \;\; \sigma[\![\phi]\!]\tau$$

It is readily seen that the logic is no longer classical. For instance conjunction is not commutative: the denotations of $\phi \wedge \phi_\psi$ and $\phi_\psi \wedge \phi$ are different, and the first may be entailed by a formula which does not entail the second. The following justifies the claim that Karttunen's admittance conditions, and thus his notion of presupposition can be read off from the semantics:

Fact 4.8.

$$\phi \rhd \psi \;\; \textit{iff} \;\; \forall\sigma, (\exists\tau\sigma[\![\phi]\!]\tau) \;\; \textit{iff} \;\; \sigma \models \phi$$

Suppose we were to make the philosophically controversial claim that a statement "X knows S" presupposes S and asserts that X believes S. Then 'Elspeth knows that Fred is happy' might be represented as *bel(e, happy(f)*$_{happy(f)}$ $(= \phi)$, where *happy(f)* and *bel(e, happy(f)* are just atomic propositions. Let the model contain only four worlds, $1--4$, such that Fred is happy in the first two (ie. $\mathcal{I} = \{1,2\}$), and Elspeth believes that Fred is happy in the first and the third. Consider update of the state $\{1,2\}$ with ϕ. It is necessary firstly to check that *happy(f)* is satisfied, which it is: $\{1,2\} \models$ *happy(f)*. The state must then be updated with *bel(e, happy(f)*. Since this proposition holds in world 1 but not in world 2, the final output is the state $\{1\}$. In contrast, the formula ϕ does not define an update from input state $\{1,3,4\}$ in this model, since $\{1,3,4\}\neg \models$ *happy(f)* and if a presupposition is not satisfied, updating is blocked. In fact in this model the update relation corresponding to the denotation of ϕ defines only the updates $\{1,2\} \Longrightarrow \{1\}, \{1\} \Longrightarrow \{1\}\{2\} \Longrightarrow \{\}$. There are no updates from states containing worlds 3 or 4, since the presupposition is not satisfied in any of these states. More generally, if 4.8 and 4.2 are taken as the definition of presupposition for this sytem, then for arbitrary models it will be the case that *bel(e, happy(f)*$_{happy(f)} \models$ *happy(f)*.

Note the distinction between presupposition failure and update with contradictory information: whereas there is no state that can be obtained by updating $\{1,3,4\}$ with ϕ, there is a state which can be obtained by updating $\{2\}$ with ϕ. However, this output state is the empty set, there being no worlds in the model compatible with all the information the agent has. It is also worth noting that for this system the Karttunen definition of presupposition is equivalent with one of the standard semantic notions of presupposition introduced above:

Fact 4.9. *ϕ presupposes ψ iff $\phi \models \psi$ and $\neg\phi \models \psi$*

The reason for this lies in the clause for the interpretation of negation, from which it may be seen that the negation of a formula defines an update just in case its positive counterpart does. It is thus obvious that if "Elspeth doesn't know that Fred is happy" is represented as $\neg\phi$, then "Elspeth doesn't know that Fred is happy" has the same presuppositions as "Elspeth knows that Fred is happy". The reader may care to verify that in the above model, the denotation of $\neg\phi$ defines only the updates $\{1,2\} \Longrightarrow \{2\}, \{1\} \Longrightarrow \{\}\{2\} \Longrightarrow \{2\}$, mapping states in which it is established that Fred is happy, but not necessarily established whether Elspeth believes this, to states where it is both established that Fred is happy and that Elspeth does not believe this.

4.3. Quantifying-in to Presuppositions

It is not obvious how to extend the cancellation accounts considered in the previous section to enable them to deal with open presuppositions, that is, presuppositions containing a free variable. Heim showed how this might be achieved in the Context Change model. We will consider her approach presented in terms of an extension to the above propositional dynamic logic, and then look at a well known problem with that approach, and, briefly, some possible solutions.

One could imagine introducing variables into the above system in a relatively conservative fashion, maintaining classical notions of scope and binding[28]. The approach Heim took, developed from that in her thesis, was more radical, and allows for binding of variables which fall outside of the conventional scope of their introducing quantifier. This non-standard treatment of variables was originally motivated in terms of pronomina in donkey and intersentential anaphora, but given the tight relationship between presupposition and anaphora, to which we shall turn later, it is also of relevance to crucial classes of presupposition triggers, most obviously definite descriptions.

Models will now be triples $\langle W, \mathcal{D}, \mathcal{I}\rangle$, where W is a set of worlds, $\mathcal{D}$ is a domain of individuals (here assumed constant across worlds) and $\mathcal{I}$ maps n-ary predicates onto sets of (n+1)-ary tuples, where the first element of the tuple is understood as a world index. Heim utilises *sequences*, such that given a set of variables $\mathcal{V}$, a sequence is just a partial assignment function mapping a subset of $\mathcal{V}$ onto elements of $\mathcal{D}$. A Heimian information state is a set of sequence-world pairs where each sequence has the same domain of variables. Each pair encodes one possibility for how the world is and which objects in that world are under discussion.

Before coming to the technicalities, let us consider a simple example: update with "a woman curtsied", which will be represented as $+x\ (woman(x) \wedge curtsied(x)_{female(x)})$. Suppose that there are only two worlds in the model, w_1 and w_2, and that the domain contains only two individuals *elspeth* and *fred*, such that in both worlds *elspeth* is a *woman* and *female* but *fred* is not. Thus, for example, $\mathcal{I}(woman) = \{\langle w_1, elspeth\rangle, \langle w_2, elspeth\rangle\}$. Suppose that *elspeth curtsied* in

[28] Assuming the model provided appropriate interpretation functions $\mathcal{I}$ and domains $\mathcal{D}$, we might add the following clauses:

$$\sigma[\![P(x_1,\ldots,x_n)]\!]_f\tau \text{ iff } \tau = \{w \in \sigma \mid \langle w, f(x_1),\ldots,f(x_n)\rangle \in \mathcal{I}(P)\}$$
$$\sigma[\![+x\phi]\!]_f\tau \text{ iff } \exists d \in \mathcal{D}\ \sigma[\![\phi]\!]_{f[x \mapsto d]}\tau$$

Here interpretation is with respect to an assignment function, and $f[x \mapsto d]$ denotes the interpretation function differing from f maximally through mapping x onto the object d in the domain.

w_1 but not w_2. A minimal state of information with respect to this model will be one where both worlds are still possible and where no individuals have been introduced. If we represent a sequence as a list of mappings of the form "var$\mapsto$object", such that the empty sequence is just an empty list [], then such a minimal state will be $\{\langle[], w_1\rangle, \langle[], w_2\rangle\}$. Update of this state begins with extension with valuations for x, which produces a state $\{\langle[x \mapsto \mathit{elspeth}], w_1\rangle, \langle[x \mapsto \mathit{elspeth}], w_2\rangle, \langle[x \mapsto \mathit{fred}], w_1\rangle, \langle[x \mapsto \mathit{fred}], w_2\rangle\}$, a state in which although the value of x is under discussion, there is no information about what this value is. Updating this state with $\mathit{woman}(x)$ removes sequence-world pairs which do not map x onto an object in the extension of *woman*, to produce $\{\langle[x \mapsto \mathit{elspeth}], w_1\rangle, \langle[x \mapsto \mathit{elspeth}], w_2\rangle\}$, a state which still contains the same information about what the world is like as the initial state, but which additionally determines that the variable x is mapped to *elspeth*. Given that x is now established to be *female*, the presuppositional formula $\mathit{female}(x)$ is satisfied. If there had been any sequence-world pairs which did not map x onto a *female*, this would not have been the case, and consequently update would have failed. Finally, updating with $\mathit{curtsied}(x)$ removes one sequence world pair to produce the state $\{\langle[x \mapsto \mathit{elspeth}], w_1\rangle\}$.

Following earlier formulations of Heim's insights into DPL-like systems[29], we arrive at definitions for predications and for existential quantification like those in 4.10 below. The clause for predication is analogous to that for atomic propositions in 4.4. Those sequence-world pairs are removed which are incompatible with the predication, that is, those where the extension of the predicate does not contain the tuple made up of the world and the objects onto which the argument variables are mapped by the sequence. The interpretation of statements "$+x\phi$" involves extending a state with all possible valuations for that variable, and then removing all those sequence-world pairs which are incompatible with ϕ. One sequence-world pair $i = \langle f, v\rangle$ extends another $j = \langle g, w\rangle$ with respect to the variable x (written $i >_x j$) if $v = w$, f and g agree on all variables apart from x, but f additionally provides a valuation for x. An information state can be updated with $+x\phi$, by extending each of the sequence-world pairs in the state with x and updating the result with ϕ.

[29] See the Dynamics chapter for details of DPL, introduced in [GS91a]. Dekker (see eg. [?]) provides a reformulation using partial assignments, and [?] draws in the presuppositional aspects of Heim's proposal.

Definition 4.10. [30]

$$\sigma[\![P(x_1,\ldots,x_n)]\!]\tau \;\; \textit{iff} \;\; \tau = \{\langle f,w\rangle \in \sigma \mid \langle w, f(x_1),\ldots,f(x_n)\rangle \in \mathcal{I}(P)\}$$
$$\sigma[\![+x\phi]\!]\tau \;\; \textit{iff} \;\; \{i \mid \exists j \in \sigma \wedge i >_x j\}[\![\phi]\!]\tau$$

As things stand the definitions for satisfaction of a formula in a state and for the interpretation of negation are inadequate, since they fail to account for cases where the formula introduces a new variable[31]. If R is a Context Change Potential (ie. a binary relation between information states) then call $\downarrow R$ the closure of R, a CCP like R except for not introducing any new variables. Let us say that one sequence-world pair extends ("$>$") another if some finite sequence of extensions of the first produces the second. Now we can define $\sigma \downarrow R\tau \;\; \textit{iff} \;\; \exists v \sigma R v \wedge \tau = \{i \in \sigma \mid \exists j > i\; j \in v\}$: that is, the closure of an update relation allows update of a state to that subset of sequence-world pairs in the state which have extensions in some update with the unclosed relation. This leads to the modified definitions for negation and satisfaction in 4.11. The propositional clause for conjunction in **??** still makes sense at the first order level, and the definitions for entailment (4.6) and for the semantics of implications, disjunctions (4.5) and the presupposition operator (4.7) also being preserved except that they are defined in terms of the new clauses for negation and satisfaction.

Definition 4.11.

$$\sigma[\![\neg\phi]\!]\tau \;\; \textit{iff} \;\; \exists v \;\; \sigma \downarrow [\![\phi]\!] v \;\wedge\; \tau = \sigma \backslash v$$
$$\sigma \models \phi \;\; \textit{iff} \;\; \sigma \downarrow [\![\phi]\!]\sigma$$

The "+ x" operator can be used to provide neat definitions of existential and universal quantifiers obeying the standard duality: $\exists x\ \phi \;\; =_{\text{def}} \;\; +x \;\wedge \phi$, and $\forall x\ \phi \;\; =_{\text{def}} \;\; +x \;\rightarrow \phi$. There is a problem in Heim's approach regarding the interaction of quantifiers with presuppositions appropriately, and in the current presentation this problem manifests itself as the following fact:

[30] As observed in [?], the logic of the resulting system is simplified if requantification over the a variable is forbidden. In the current set up, we might define a function "dom" which mapped a state onto the set of variables given valuations in that state, and then add an extra constraint on the clause for addition of a discourse marker. Similarly, the predication clause in 4.10 seems innappropriate in case a predication is evaluated in a state that does not provide valuations for all the predicated variables, and an extra clause can be added requiring this. We arrive at the following:

$$\sigma[\![P(x_1,\ldots,x_n)]\!]\tau \;\; \textit{iff} \;\; \{x_1,\ldots,x_n\} \subseteq \text{dom}(\sigma) \wedge \tau = \{\langle f,w\rangle \in \sigma \mid \langle w, f(x_1),\ldots,f(x_n)\rangle \in \mathcal{I}(P)\}$$
$$\sigma[\![\exists x\phi]\!]\tau \;\; \textit{iff} \;\; x\neg \in \text{dom}(\sigma) \wedge \{i \mid \exists j \in \sigma \wedge i >_x j\}[\![\phi]\!]\tau$$

[31] To see the problem, observe that the negation of a formula is defined in terms of set subtraction of the set resulting from update with the formula from the input state. But if the formula introduces a new variable, then the result of updating with it will be a disjoint set from the input, so that a negation could only define an identity update.

Fact 4.12. *If ϕ presupposes φ, then $\exists x\ \psi \wedge \phi$ presupposes $\forall\ x\ \psi \rightarrow \varphi$*

Suppose that 11 is given the crude translation in 11.

(1) – A plane just landed
  – $\exists x$ plane(x) $\wedge$ on-ground$(x)_{(\text{was-airborne}(x))}$.

The previous fact means that 11 will be predicted to carry the presupposition $\forall x$ plane(x) $\rightarrow$ was-airborne(x) . So, contrary to intuition, the sentence is predicted to carry the presupposition that *every* plane, and not just the one that landed, was airborne. To understand why the universal presupposition occurs, consider how a state I would be updated with 11. Firstly the variable x is initialized, to produce a state J in which there are assignments mapping x onto every object in the domain. Then the proposition plane(x) is added, removing all those world-assignment pairs where x is not mapped onto a plane to produce a state K. Next we arrive at the presupposition was-airborne(x), and update can only continue if this is satisfied in K. For this to be the case every world-assignment pair in K must map x onto an object that was airborne. But since for any world still in contention, there are assignments in K mapping x onto every plane in that world, the proposition was-airborne(x) will only be satisfied if in every world in K, every object which is a plane in that world is an object which was airborne. Thus we arrive at a universal presupposition.

To some extent this problem is idiosyncratic. There are dynamic systems combining treatments of presupposition and quantification, such as those of van Eijck [Ei93] and Chierchia [Ch:MS], where existential sentences do not lead to universal presuppositions. In these systems the notion of an information state is quite different from Heim's, and this is at the heart of the different predictions that arise. However a Heimian semantics like that presented above can be adapted so as to avoid problematic universal presuppositions without any alteration to the notion of an information state. It suffices to make alterations to the semantics of the quantifiers or to the presupposition operator. As discussed in my [Bea94a], the former option can be motivated on independent grounds. However the latter alternative, discussed in my [?], is perhaps the simpler. Suppose that the function *worlds* maps a Heimian context onto the set of worlds involved in that context: $\mathit{worlds}\,(\sigma)\ =\ \{w \mid \exists f \langle w, f\rangle \in \sigma\}$. Then one possibility would be to redefine the presupposition connective as in 4.13, such that a formula ϕ_ψ allows update to continue just in case update with ψ would not remove any worlds from the input context: the earlier definition required that ψ would not remove any world-assignment pairs.

Definition 4.13.

$$\sigma[\![\phi_\psi]\!]\tau \text{ iff } \exists v \sigma[\![\psi]\!]v \text{ and } \mathit{worlds}(\sigma) = \mathit{it\ worlds}(v) \text{ and } v[\![\phi]\!]\tau$$

Under this definition 4.12 no longer holds, and existential sentences only yield existential presuppositions.

4.4. Projection from Propositional Complements

4.1 omits Karttunen's 1974 account of how presuppositions triggered within propositional complements are projected. Karttunen divides lexical items taking a propositional complement into three classes: verbs of saying (eg.*say*, *announce*), verbs of propositional attitude (eg. *believe, want*), and others. On Karttunen's account, the simplest cases are the first and the third: presuppositions triggered within the complement of a verb of saying do not impose any constraint on the context of utterance, whilst for members of the third class all presuppositions must be satisfied. Thus "John says that the king of France is bald" should be acceptable in any context, and "John knows that the king of France is bald" should only be acceptable in contexts where there is a (unique) king of France. For a sentence with propositional attitude verb as matrix, Karttunen argues that it is the beliefs of the subject of the sentence which are crucial: for a context A to admit the sentence, the beliefs of the subject in that context must satisfy all the presuppositions of the propositional complement. Thus "John hopes that the king of France is bald" should be satisfied in contexts where it is satisfied that John believes there to be a king of France. In favour of this analysis is the fact that the sentence "Although France is not a monarchy, John believes that there is a reigning French king: he hopes that the King of France is bald", although contrived, is felicitous.

Let us enrich the syntax of our artificial language with formulae $\alpha(x, \phi)$ for x any variable, ϕ any formula, and α taken from one of three sets of predicates $\mathcal{S}$, $\mathcal{A}$ and $\mathcal{F}$ (for *Saying, Attitude* and *factive*, respectively). I will ignore members of the *other* class apart from factives. Assuming that *believes*$\in \mathcal{A}$, and further assuming that neither verbs of saying nor verbs of propositional attitude induce any new presuppositions, the following are essentially Karttunen's acceptability conditions:

Definition 4.14.

$$A \rhd \alpha(x, \phi) \qquad \textit{for } \alpha \in \mathcal{S}$$
$$A \rhd \alpha(x, \phi) \qquad \{\psi \mid A \models \textit{believes}(x, \phi)\} \rhd \phi \quad \textit{for } \alpha \in \mathcal{A}$$
$$A \rhd \alpha(x, \phi) \;\; \textit{iff} \;\; A \models \phi \quad \textit{for } \alpha \in \mathcal{F}$$

For definitions of dynamic semantics which embody such admittance conditions, the reader is advised to see Heim's [Hei83a]. Note, however, that the semantics presented there involves essentially a stipulation of Karttunesque admittance conditions within the definitions of the context change potentials associated with attitude verbs. It is not the case that Karttunen's admittance conditions have been motivated independently of presuppositional phenomena, through any "deep" understanding of the concepts associated with such verbs. Zeevat[Ze92], however, does include a dynamic semantics for "believe" in which Karttunen type admittance conditions arise quite naturally.

4.5. Anaphoricity

Over the last decade a number of authors, most notably van der Sandt [vdS89, vdS92] and Kripke [Krip:MS] (which unfortunately remains unpublished), have argued that there is a tight connection between presupposition and anaphora. Van der Sandt has pointed out that for every example of what might be called *discrepant* anaphora, by which I mean those cases where the anaphoric link is not naturally treated using standard binary quantifiers to interpret determiners and bound variables for pronouns, parallel cases of *discrepant* presupposition can be found. In the following four triples, the (a) examples exemplify discourse anaphora, donkey anaphora, bathroom sentences and modal subordination, respectively. In each case, a corresponding example is given, as (b), in which a presupposition is triggered (by the adverb 'still') in the same structural position as the anaphor occurred, but in which this presupposition is satisfied.[32] The third member, (c), completes the circle, showing that the argument of the presupposition trigger can itself be pronominalised with no change of meaning.

(4.7)a. A farmer owns a donkey. He beats it.

b. Wanda used to beat Pedro. She still beats him.

---

[32] Although I have defined formal notions of presupposition satisfaction, I have not said what it means as a description of a text to say that in the text a certain (elementary) presupposition is satisfied. Indeed, such terminology is commonplace in recent presupposition literature, but I do not know of any pre-theoretic analysis of satisfaction. Perhaps a direct test for satisfaction could be developed. To start the ball rolling, I propose the following method of determining whether an elementary presupposition P in a text segment T uttered in a context C is satisfied (where the presence of an elementary presupposition must be determined by standard embedding tests applied to the clause containing the putative elementary presupposition):
If the dialogue consisting of
A: I don't know whether P
B: I see. Well, T
is felicitous in context C, then the elementary presupposition P is satisfied in the text T in this context.
For example, set T = 'If Mary is vigilant, then she knows that someone ate a biscuit', and P = 'A biscuit was eaten'. I find it hard to imagine a context in which the following dialogue would be felicitous:
A: I don't know whether a biscuit was eaten.
B: I see. Well, if Mary is vigilant, then she knows that someone ate a biscuit.
On the other hand set T = 'If John ate a biscuit, then Mary knows that someone did', and P = 'A biscuit was eaten'. The dialogue
A: I don't know whether a biscuit was eaten.
B: I see. Well, if John ate a biscuit, then Mary knows that someone did.
is, if still rather strained, more acceptable than the previous one, especially if B's reply is followed by 'Perhaps she can help you.' Similarly, applying the test to the (c) example in 4.7 we obtain a felicitous text, and so conclude that the presupposition is satisfied:
A: I don't know whether Wanda beats Pedro.
B: I see. Well, Wanda used to beat Pedro. She still does.
I leave it to the reader to apply the test to the remaining (b) and (c) examples.

c. Wanda used to beat Pedro. She still does.

(4.8)a. If a farmer owns a donkey then he beats it. [*Geach*]

b. If Wanda used to beat Pedro then she still beats him.

c. If Wanda used to beat Pedro then she still does.

(4.9)a. Either there is no bathroom in this house or it's in a funny place. [*Partee*]

b. Either Wanda never beat Pedro, or she still beats him.

c. Either Wanda never beat Pedro, or she still does.

(4.10)a. A wolf might come to the door. It might eat you.

b. Perhaps Wanda used to beat Pedro, and perhaps she still beats him.

c. Perhaps Wanda used to beat Pedro, and perhaps she still does.

The parallel is compelling, and furthermore similar examples are easily constructed involving all standard presupposition types. But evidence for the anaphoricity of presuppositions goes beyond cases, like those above, where the presupposition is satisfied because it is in some sense anaphoric on a textual antecedent. The reverse of the coin is that, for at least some types of presupposition trigger, if a textual antecedent is not present the presupposition *cannot* be satisfied. Kripke observes that a common analysis of 'too' would make the presupposition of sentence 4.11, below, the proposition that somebody other than Sam is having supper in New York tonight. However, this proposition seems uncontroversial, so the standard account provides no explanation of why the sentence, uttered in isolation, is infelicitous.

(4.11)Tonight <u>Sam</u> is having supper in New York, too. [Krip:MS]

Notably, 4.11 is felicitous when it follows a sentence saying of somebody other than Sam that he is having dinner in New York tonight, e.g. 'Saul is having dinner in New York tonight...'. It might be argued that 4.11 places a requirement on its local context that there is a salient having-supper-in-NY-tonight event. Although one could imagine introducing event discourse markers, and some ontology of events, into the framework we have sketched so far, less effort will be required if we restrict ourselves to an alternative suggestion in [Hei90]. This is the hypothesis that 4.11 is felicitous in contexts where there is a discourse entity of which it is locally satisfied that the entity is having supper in New York tonight.[33] Adapting from Heim somewhat, we might give the following sketch of an admittance condition for a sentence

[33] To back up the suggestion that the presence of a discourse marker is essential to the felicity of 'too', observe that of the following two discourses (adapted from a well known pronominalisation example due to Partee) A is odd, but B is felicitous.

A: I have ten marbles and you have one. Only nine of mine are transparent. Your marble is opaque too.

B: I have ten marbles and you have one. One of mine is not transparent. Your marble is opaque too.

of the form 'S too', where the word 'too' is assumed to be co-indexed with some focussed NP[34]:

Definition 4.15 (Heimian 'too').

> $\sigma \triangleright$ S too_i *iff* $\sigma \triangleright$ S, *and there is some index* j *such that* S$[i/j]$ *is satisfied in* σ *(where* S$[i/j]$ *represents the sentence* S *with all instances of NPs indexed* i *replaced by* x_j*)*

4.11 would be indexed 'Tonight Sam_i is having supper in New York, too_i', and would only be admitted in contexts where for some j, 'Tonight x_j is having supper in New York' was satisfied.[35] We would thus expect 4.11 only to be admitted in a restricted range of contexts, but 'If Saul is having supper in New York tonight, then <u>Sam</u> is having supper in New York, too.' to carry no presupposition at all.[36]

[34] Kripke does not limit his consideration to cases where an NP is in focus, and, of course, a fuller analysis than that given here would allow non-NPs to be focussed constituents as well.

[35] In order for definition 4.15 fully to meet Kripke's objections, an additional constraint on Heimian contexts would be required, roughly that they contain only information introduced in the immediately previous discourse. Otherwise an instance of 'too' might be predicted to be satisfied by material that was not introduced in the preceding text.

[36] Kripke makes the provocative claim that the presupposition of a discourse like 'If Herb comes to the party the boss will come too' is that Herb and the boss are distinct individuals. This is interesting, and perhaps it is right in the pragmatic sense of presupposition, in as much as it would be usual for the speaker to be assuming distinctness. But I do not think that this is a presupposition which is conventionally associated with 'too', and I am not sure it is helpful to call it a presupposition at all. Consider firstly the following dialogue segment:

A: If Clark is at the party then is Lois in Washington?

B: No. If Clark is at the party then Lois is in New York too.

In the B sentence, the antecedent of the conditional acts as an anaphoric antecedent for the presupposition in the consequent, and we arrive at a presupposition to the effect that if Clark is at the party then Clark is in New York. And indeed, there does seem to be an assumption associated with the sentence that Clark, and hence the party, is in New York. This presupposition can be removed by adding extra information to the antecedent, as in 'If the party is in New York and Clark is at the party, then Lois is in New York too.', but it cannot be canceled simply by adding contradictory information. The following dialogue segment is infelicitous if it occurs discourse initially (when there is no other possible antecedent for the 'too'):

A: If Clark is at the party then is Lois in Washington?

B: ? No. If Clark is at the party then Lois is in New York too, although the party is in Seattle.

However, the claimed distinctness presupposition behaves differently, and can be canceled simply by denying its truth later. The following discourse *is* felicitous:

A: I never see Clark Kent and Superman together, so if Clark Kent is at the party, then Superman isn't.

B: If Clark is at the party, then Superman is definitely there too, since Clark is Superman!

I would favour a Gricean explanation of the distinctness implication, whereby each clause of a sentence or discourse is normally required to be informative. A sentence 'X Ys too' will only be informative if in its local context X is not established to Y. But if the presupposition that some salient entity Ys is satisfied by X itself, then clearly 'X Ys too' does not add any new information to that context. Note that on this basis van der Sandt's DRT-based theory, which incorporates such an informativeness constraint as a condition on DRS well-formedness, could account for Kripke's distinctness effect without any need to specify distinctness in the lexical entry for 'too'.

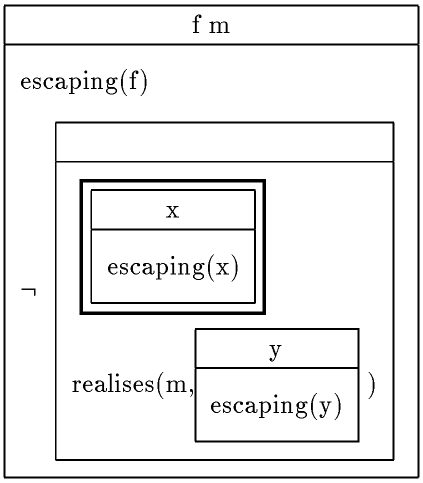
For which presupposition triggers is an anaphoric analysis appropriate? Van der Sandt gives a straightforward answer: all presupposition triggers are anaphors. Perhaps it can be imagined how analyses like that for '`too`' above could be given for other presupposition types. For instance, to make factives anaphoric, one might introduce discourse markers for propositions and facts, a development which would anyway be essential to treat propositional anaphora within texts (c.f. [As93]). One could then make acceptability of a factive verb with propositional complement ϕ conditional on the presence of a factual discourse marker (perhaps a discourse marker identifying a proposition satisfied in the local context) with interpretation related to ϕ in some yet to be specified manner. The addition of discourse markers for uttered propositions would yield a fine grained notion of information. An information state would record in much greater detail exactly what statements had been used to update it than is found in the dynamic systems discussed above. For instance, Stalnaker's notion of an information state as a set of worlds can only distinguish between asserted statements up to classical equivalence, and Heimian contexts go only a little further. Van der Sandt's approach to providing an anaphoric account of presupposition does not, however, involve refining Stalnaker's sets of worlds or Heim's contexts. Instead van der Sandt utilises a rather different sort of dynamic system, Kamp's DRT [Kam81, KRe93], with which I will assume the reader's familiarity.

Van der Sandt is not the only one to have provided an account of presupposition in DRT, but his is the most developed account, and others, such as Kamp and Rossdeutscher's [KRo94, Ros94] are closely related. Accordingly, when discussing the relevance of the dynamics of DRT interpretation to presupposition, I will concentrate on van der Sandt's account. Note that in this section I will only be discussing the part of van der Sandt's account which takes advantage of the inherent dynamism of standard DRT, and it is only in the next section that I will discuss the considerable further developments that van der Sandt has made in the form of a theory of accommodation.

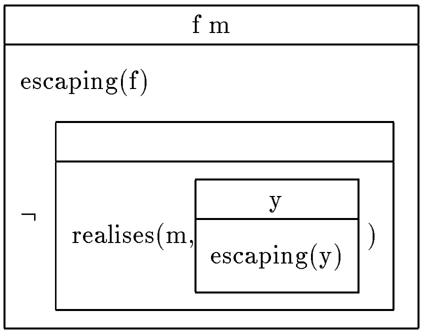
Discourse Representation Structures provide a very fine grained notion of information state, one which is ideal for an anaphoric account of presupposition, since so much of the original surface structure of utterances is recorded. But crucially, although van der Sandt's model operates under the motto *presupposition is anaphora*, it does not treat presuppositions as anaphors in the strict sense of requiring a *textual* antecedent. Rather, van der Sandt claims that a presupposition trigger is anaphoric at the level of discourse representation. The heart of the theory involves a structural relation between the position at which a presupposition trigger is represented in a DRS, and the point at which its *antecedent* is represented. The antecedent must be represented somewhere along the *anaphoric accessibility path* from the representation of the trigger, this condition being exactly the same requirement as is placed on anaphoric pronouns and their antecedents in standard DRT. The treatment of 4.12 should illustrate.

(4.12)Fred is escaping, but Mary doesn't realise that somebody is escaping.

Initially a DRS like the following, in which the presence of a presupposition is indicated using a double thickness box, is constructed:



The global DRS is accessible from within the negation. The marker x can be resolved with the marker f, and in this case both the universe of the presupposition (now f) is accessible in the global universe, and the condition in the presupposition is accessible as a global condition. Thus the presupposition has an antecedent. The double-lined presupposition box, which plays no further role in DRS construction, and does not enter into the model theoretic interpretation of the completed DRS structure, is simply removed, to yield the final logical form:



Note that it would make little difference to the treatment of 4.12 if the word '**somebody**' had been replaced by '**he**'. Van der Sandt thus provides an interesting twist to the DRT treatment of noun phrase semantics, since in his extended DRT an indefinite can (when embedded in a presuppositional environment) behave to some extent anaphorically.

This model of presupposition resolution, as will be seen shortly, is just one part of van der Sandt's theory of presupposition. Let us explore the relation between van der Sandt's resolution model and the other dynamic theories considered in this section, a job done much more thoroughly by Zeevat [Ze92]. The dynamics of van der Sandt's model is not stated in terms of update functions as in Heim's work. Although some effort has been devoted to providing a more declarative statement of the model (see [vdS92, SG91]), it remains explicitly procedural. For instance, it is important that the anaphors and presuppositions of a sentence are dealt with only after processing of previous discourse is complete. The dynamics can be said to reside in at least three aspects of the theory: the (extended) DRS construction algorithm, the standardly dynamic DRT semantics of implication and quantifiers, and the statement of anaphoric accessibility conditions.

The notion of accessibility is implicitly directional, in that it is invariably defined using an anti-symmetric relation, and reflects Karttunen's conditions on context incrementation. We might restate accessibility conditions in a way that brings this out. Say that a DRS α is a pair $\langle \alpha_0, \alpha_1 \rangle$, with α_0 a set of discourse markers and α_1 a set of conditions. Define $var(\alpha)$ as the set of markers mentioned in the conditions α_1, and take the context σ of any sub-DRS to be a set of discourse markers: this should be thought of as the set of markers external to a DRS which are accessible from within it. The markers of a DRS α in a context σ are completely accessible, written $\sigma \succ \alpha$, if $var(\alpha) \in \alpha_0 \cup \sigma$. Then the following two rules state whether the variables in the sub-DRSs of negations and implications are accessible:

$$\sigma \succ \ \alpha \rightarrow \beta \text{ iff } \sigma \succ \alpha \ \ \textit{and} \ \ \sigma \cup \alpha_0 \succ \beta$$
$$\sigma \succ \ \neg\alpha \text{ iff } \sigma \succ \alpha$$

These rules, which must be extended to allow for van der Sandt's notion of accessibility of DRS conditions as well as DRS markers, are obviously close to Karttunen's admissibility conditions, as given above (definition 4.1). Differences arise with conjunction and disjunction, however. Regarding disjunction, it is fair to say that Karttunen's, Heim's and van der Sandt's theories all have problems. The problems with Karttunen and Heim's account are analogous to those facing multivalent accounts of presupposition — see the discussion in Section 2. The difficulties with disjunction in van der Sandt's model will be discussed in the following section, after the main component of van der Sandt's theory, the accommodation mechanism, has been introduced. The absence of any conjunction operation between DRSs in standard DRT makes comparison on this count difficult, but at least in the case of sentence sequencing, the fact that sentences are processed in a definite order will have the effect that the context of one sentence includes information from previous sentences, which is just what is given in Karttunen's admittance rule for conjunction (again in 4.1). In other cases there will be a difference in predictions. Van der Sandt's model, unlike the Karttunen or Heim theories, does not seem to predict any difference in acceptability between the following two examples:

(4.13)If John has children and John's children are at home, he's elsewhere.

(4.14)?If John's children are at home and John has children, he's elsewhere.

To deal with this in van der Sandt's theory, one would presumably have to replace the set of conditions in a DRS with a sequence of conditions, and make one condition accessible from another within the same DRS only if the first preceded the second in the sequence. To make such an adjustment, of course, would increase even further the similarity between van der Sandt's model and the other dynamic accounts which have been discussed.

Anaphoricity is generally understood as a structural relation, whether the structures involved are texts, syntactic trees, or DRSs. But it must be pointed out that whilst such structures place some constraints on which items can stand in the relation, it would be wrong to suppose that this was the end of the story. The following examples all concern counterfactual conditionals, although I think the points I will make could be addressed to any intensional predicate which creates a local context that might be inconsistent with the global context:

(4.15)Mary owns a donkey. If she had been a farmer, she would have beaten it.

(4.16)?Mary owns a donkey. If she had not owned any animals, she would have beaten it.

(4.17)?Mary owns a donkey. If she had owned a mule instead, John would have owned a donkey too.

The first of these, 4.15, shows that in principle a pronoun in the consequent of a counterfactual conditional can stand in an anaphoric relation to an object introduced outside of the conditional. In DRT terms, one would have to say that the global DRS is accessible from the consequent DRS of a counterfactual conditional just as it is from the consequent box of a non-counterfactual conditional. But 4.16, which I take to be infelicitous, shows that one cannot arbitrarily resolve pronouns in the consequent of a counterfactual to relevant objects in the global box. There seems to be some extra non-structural condition: perhaps, given an appropriate theory of the semantics of counterfactual conditionals, one could say that not only must the antecedent to a pronoun be on the accessibility path, it must also correspond to an object which *exists* (in an intuitive sense which I will not attempt to clarify) in the local DRS. But in stating such a constraint, we would be complicating our notion of anaphoricity, placing semantic preconditions on when an anaphoric link could hold. In other words, we would be providing pronouns, the paragons of anaphoricity, with something like semantic presuppositions.[37] Similarly, in 4.17 it seems that regarding the structural relationship between 'Mary owns a donkey'

[37] Gender and number requirements can also be seen as semantic presuppositions, but there is at least the possibility of defining these requirements as grammatical constraints which are determined syntactically.

and 'owned a donkey too', anaphora should be licensed. Van der Sandt's model, as it now stands, would certainly predict simple resolution of the presupposition. But this is clearly wrong. 4.17 is infelicitous, and this shows us that conceiving of the anaphoricity of 'too' purely structurally, whilst a good approximation in many cases, does not work in general. It is at least arguable that the Heim-style 'too' given above, which involves semantic constraints on the local context, should fare better in such cases, but such a claim remains vacuous in the absence of a CCP semantics for counterfactual conditionals. Heim actually discusses such a semantics in [Hei92], but I will not attempt to combine it with the above analysis of 'too' here.

5. Accommodation

> "... ordinary conversation does not always proceed in the ideal orderly fashion described earlier. People do make leaps and short cuts by using sentences whose presuppositions are not satisfied in the conversational context.... But ... I think we can maintain that a sentence is always taken to be an increment to a context that satisfies its presuppositions. If the current conversational context does not suffice, the listener is entitled and expected to extend it as required. He must determine for himself what context he is supposed to be in on the basis of what is said and, if he is willing to go along with it, make the same tacit extension that his interlocutor appears to have made."[Kar74, p. 191]

The process Karttunen here describes, whereby a "tacit extension" is made to the discourse context to allow for update with otherwise unfulfilled presuppositions, is what Lewis later called *accommodation* [Le79].[38] Theories which utilise a mechanism of accommodation, are not classical *static* theories of meaning, but rather theories about the dynamics of the interpretation process. Yet theories of accommodation could reasonably be said to involve a *dynamic pragmatics*, in that accommodation is not usually thought of in compositional terms, but as an extra process operating in addition to the normal composition of meanings.

In this section I will describe the contributions of Heim and van der Sandt to the theory of accommodation, and will detail van der Sandt's recent theory of presupposition and accommodation in DRT, this being by far the most comprehensive and fully specified current theory of presuppositional accommodation.

[38] Stalnaker [St72, p. 398] expresses similar sentiments to those in the above Karttunen quotation, commenting that presuppositions "need not be true", and that in some cases a "Minor revision might bring our debate in line with new presuppositions." Interestingly, in the same paragraph Stalnaker talks of certain things being "accommodated" in the light of new presuppositions, although what he is describing here is not how we change our assumptions (the Lewisian notion of "accommodation"), but how *after* we have changed our assumptions we may reinterpret earlier observations.

5.1. Heim and van der Sandt

Two questions are central to understanding the characteristics an accommodation-based theory of presupposition might have:

(i) Given that the interpretation of a discourse involves not one linguistic context, but a series of contexts corresponding to different parts of the interpretation process and different parts of the discourse's meaning, in which context should accommodation occur?

(ii) Given some decision as to the context in which accommodation occurs, exactly how should a hearer determine what the new context is supposed to be?

Heim, in [Hei83a], was the first author to recognise the significance of the first question, noting that quite different effects could result according to which point in the interpretation of a sentence accommodation occurs. In the Heim/Karttunen account one can distinguish two types of context. There is the *global* context which represents the information agents have after complete interpretation of some sequence of sentences of text, but there are also *local* contexts, the contexts against which sub-parts of a sentence are evaluated.

Under definition **??** above, updating a context σ with a conditional '$\mathsf{If\ A\ then\ B}$' will involve local contexts $\sigma{+}\mathsf{A}$ and $\sigma{+}\mathsf{A}{+}\mathsf{B}$ (to be read left-associatively) which are involved during the calculation of the update. Suppose that B contains some presupposition which is unsatisfied in the context $\sigma{+}\mathsf{A}$, so that σ does not admit the conditional. In that case accommodation must occur, adjusting one of the contexts involved in the calculation so that A is admitted in its local context of evaluation. This might take the form of adding some sentence P directly to the local context in which B is to be evaluated, so that the final result of updating with the context would not be $\sigma\backslash(\sigma + \mathsf{A} \setminus (\sigma + \mathsf{A} + \mathsf{B}))$, but $\sigma\backslash(\sigma + \mathsf{A} \setminus (\sigma + \mathsf{A} + \mathsf{P} + \mathsf{B}))$: this would be called *local accommodation*. On the other hand, an agent might backtrack right back to the initial context, add a sentence Q to the global context, and then start the update again. This is termed *global accommodation*, and the result of updating would be $\sigma + \mathsf{Q} \setminus ((\sigma + \mathsf{Q} + \mathsf{A} \setminus (\sigma + \mathsf{Q} + \mathsf{A} + \mathsf{B}))$. There is at least one other possibility. The agent might just backtrack as far as the evaluation of the antecedent, and add some extra information, say a proposition R, into the context in which the antecedent is evaluated, producing a result like $\sigma\backslash(\sigma + \mathsf{R} + \mathsf{A} \backslash(\sigma + \mathsf{R} + \mathsf{A} + \mathsf{B}))$. Since this last option involves accommodation into a context intermediate between the global context and the context in which the problematic presuppositional construction is actually evaluated, it can be termed *intermediate accommodation*. Clearly the Heimian view on accommodation is highly procedural, and the exact options which are available for accommodation will be dependent on the details of how updating actually occurs, such processing details not being fully specified by the CCP alone.

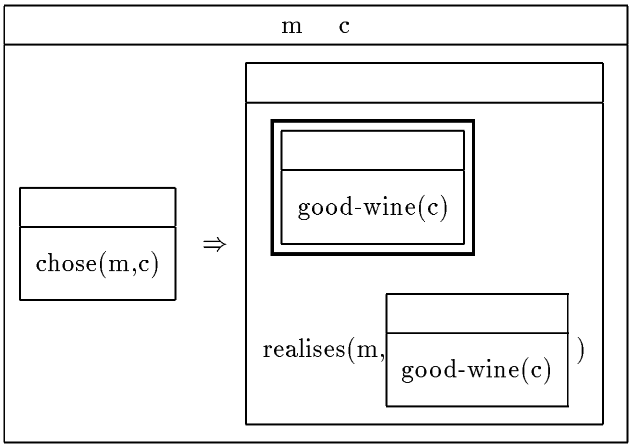
The Heimian answer to question (1), then, is that accommodation might take place at any time during the interpretation process such as to ensure later local satisfaction of presuppositions. Put another way, accommodation might potentially take place in any of the discourse contexts used in the calculation of a sentence's CCP. Unfortunately, Heim has given no indication of how question (2) should be answered.[39] The first theory of accommodation which provides a fully explicit answer to both questions is that of van der Sandt [vdS92], and having described one part of that theory in the previous section, I will now present the theory in full. As mentioned, in van der Sandt's theory Heimian contexts are replaced by explicit discourse representations. Consequently, whereas for Heim accommodation must consist in augmenting a set of world-sequence pairs, van der Sandtian accommodation is simply addition of discourse referents and conditions to a DRS. This difference could be minimised if the CCP model were presented in terms of Heimian *filecards* (c.f. [Hei82, Hei83b]), so that accommodation would consist of either creating new filecards, or adding conditions to existing ones. Regarding question (1), van der Sandt's theory shares the flexibility of Heim's. If a presupposition lacks an antecedent in a DRS, van der Sandt allows accommodation to take place in any discourse context that is accessible from the site of the trigger. Thus once again we can talk of *local accommodation*, meaning accommodation in the DRS where the trigger is represented, *global accommodation* meaning addition of material in the global DRS, and *intermediate accommodation* meaning addition of material in any DRS intermediate on the accessibility path between the global DRS and the site of the trigger.

Van der Sandt's answer to question (2), the question of what is accommodated, is as simple as it could be: if a trigger has an antecedentless presupposition, then accommodation essentially consists of transferring the discourse markers and conditions of the presupposition from the trigger site to the accommodation site. An example will demonstrate the power of the accommodation mechanism. At the same time, the example should illustrate an analogy that might be drawn between van der Sandt's theory and a transformational account of syntax, with van der Sandt's equivalent of *move*-α being an operation on DRSs.

(5.1)If Mary chose the Chateau Neuf, then she realises it's a good wine.

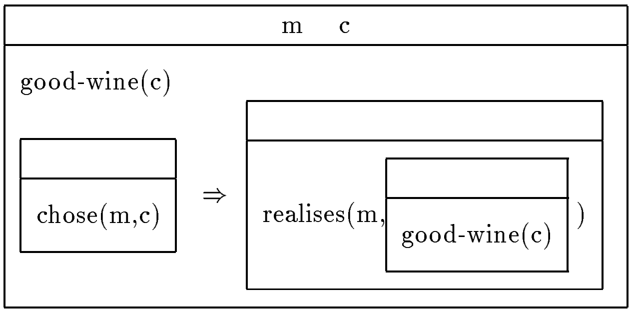
Assuming, just so that we can concentrate on the treatment of the factive 'realises', that 'Mary' and 'the Chateau Neuf' and 'it' are simply represented as discourse markers, we derive the following DRS:

[39] Witness the following quote from [Hei83a]: "Suppose [a sentence] S is uttered in a context σ which doesn't admit it.... simply amend the context σ to a richer context σ', one which admits S and is otherwise like σ, and then proceed to compute σ' [updated with] S instead of σ [updated with] S." Here she does not specify the relation between σ and σ', except to say that σ' is richer than σ, and strong enough to admit S. Her later comparison with Gazdar's theory, a comparison to which we will turn shortly, does seem to suggest that she considers accommodation to consist in adding exactly the proposition that Gazdar would have labeled the *potential presupposition*, but, as Heim (p.c.) has pointed out, she nowhere says this explicitly. It seems I was mistaken in assuming, in an earlier version of this work [Bea95], that Heim was committed to a *structural* account of accommodation, a term which will be explained shortly. Zeevat [Ze92] has also assumed that Heimian accommodation consists in adding the proposition signalled as presupposed by the trigger. On the other hand, Geurts [Geu95] supposes that the most natural explicitation of Heim's theory would involve accommodation of the logically weakest proposition needed to guarantee local satisfaction.



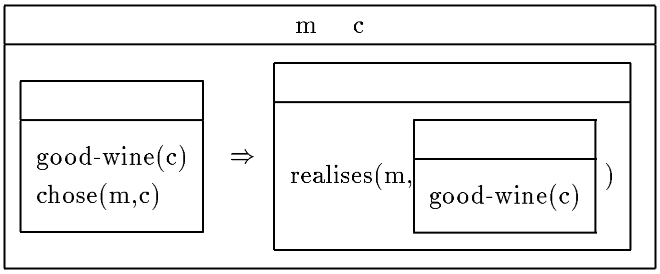
To produce a DRS in which there is no antecedentless presupposition, a transformation must take place whereby α, the presupposition [][good-wine(c)][40], is moved to one of the three sites accessible from the site of the trigger, producing the following three representations:

Global Accommodation (Gloss: 'CN is good, and if Mary orders it then she realises it's good.')

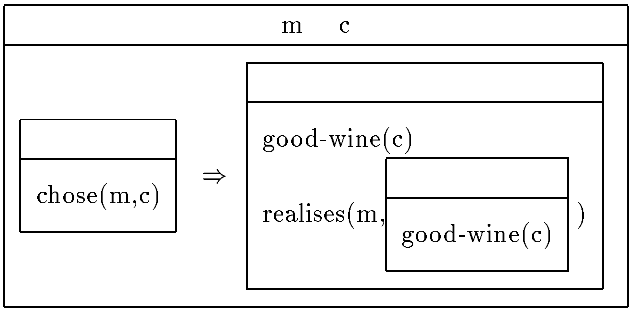


Intermediate Accommodation (Gloss: 'If CN is good and Mary orders it, then she realises it's good.')

[40] When giving DRSs in the running text, I use a linear notation, whereby [a,b][p(a,b),q(a)] represents a DRS which introduces markers a and b, and has conditions p(a,b) and q(a).



Local Accommodation (Gloss: 'If Mary orders CN then it's good and she realises it's good.')



Given all these forms of accommodation, and, in van der Sandt's theory, additional options when resolution is possible, how are we to decide which treatment is preferred? Heim offered only one heuristic: "I suggest that the global option is strongly preferred, but the local option is also available in certain circumstances that make it unavoidable."[Hei83a, p.120] Van der Sandt provides much more detail. He offers a number of constraints that any solution must obey, and also suggests a group of preferences between alternative solutions that satisfy those constraints, including a preference for global over local accommodation.[41] The following versions of the preferences and constraints are at some points revised, but I think capture van der Sandt's intentions[42]:

[41] In earlier versions of van der Sandt's theory the preferences between solutions were stated less explicitly, as side effects of a general algorithm for treating presuppositions. This algorithm, which he termed the "anaphoric loop" consisted of the following steps: on encountering a presupposition, firstly check each DRS along the accessibility path from the trigger, moving successively outwards, and attempting to resolve the presupposition, and if after reaching the top box no resolution site has been found, check each box in the reverse direction (i.e. from the top box to the trigger site) attempting to accommodate. Thus resolution is attempted first, and only if that fails is accommodation attempted.

[42] In particular, the presentation of constraints here differs considerably from, for instance, the presentation in [vdS92]. Firstly van der Sandt gives two consistency constraints, but these should

Definition 5.1 (Absolute Constraints on van der Sandtian Solutions).

(i) *Trapping. If a presupposition containing a discourse marker d is triggered in an environment where d is bound, the presupposition will be resolved or accommodated at a site from where the relevant binding occurrence of d is accessible.*

(ii) *Global Informativity. If some DRS K is incremented with information from a new sentence, such that after solution of all presuppositions the new DRS is K', then* $K \not\models K'$

(iii) *Local Informativity. No sub-DRS is redundant. Formally, if K is the complete DRS structure and K' is an arbitrarily deeply embedded sub-DRS, K' is redundant if and only if* $\forall M, f \ \ (M, f \models K \ \rightarrow \ M, f \models K[K'/\top])$. *Here* $K[K'/\top]$ *is a DRS like K except for having the instance of K' replaced by an instance of an empty DRS, and* $\models$ *denotes the DRT notion of* embedding.

(iv) *Consistency. No sub-DRS is inconsistent. Formally, if K is the complete DRS structure and K' is an arbitrarily deeply embedded sub-DRS, K' is locally inconsistent if and only if* $\forall M, f \ \ (M, f \models K \ \rightarrow \ M, f \models K[K'/\bot])$. *Here* $K[K'/\bot]$ *is a DRS like K except for having the instance of K' replaced by an instance of an inconsistent DRS.*

Definition 5.2 (Preferences Between van der Sandtian Solutions).

(i) *Resolution is preferred to accommodation.*

(ii) *One resolution is preferred to another if the first is more local (i.e. closer to the site of the trigger).*

(iii) *One accommodation is preferred to another if the first is more global (i.e. further from the site of the trigger).*

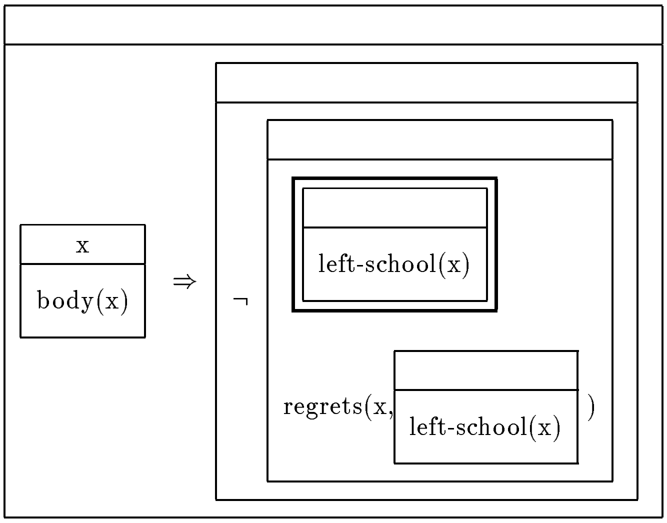
I will illustrate these constraints with some examples. Firstly, trapping:

(5.2)Nobody regrets leaving school.

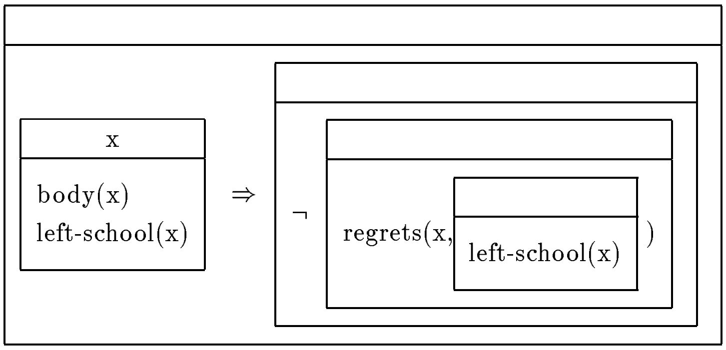
Initially the following DRS might be constructed:

---

both be subsumed under the one constraint given here. Secondly, van der Sandt's formulations of informativity and consistency constraints seem to involve a notion of local entailment of sub-DRSs, although I am not aware of such a notion ever having been formalised. Thus his equivalent of my *local informativity* (given as (iii)a on p.167) is "Resolving [a DRS] K_0 to [produce a new DRS] K_1' does not give rise to a structure in which ... some subordinate DRS is entailed by the DRSs which are superordinate to it". Whilst he does not formalise what it is for a DRS to be entailed by the DRSs which are superordinate to it, the formalisation of local informativity given here, in terms of the standard notion of DRS embedding and a simple syntactic operation on DRSs, hopefully ties up that loose end, and is in the spirit of the definitions used in van der Sandt's formalisation of the notion of *acceptability* in his earlier non-DRT work.



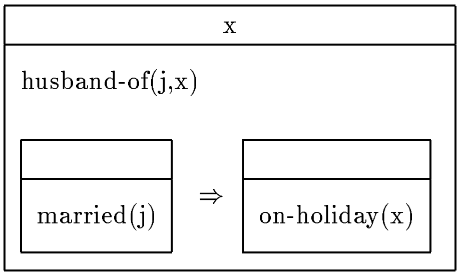
The presupposition cannot be accommodated globally because the discourse marker x would become unbound. The next most preferred accommodation site is in the antecedent box. This produces the final structure, the meaning of which can be glossed as 'Nobody who leaves school regrets having left school':



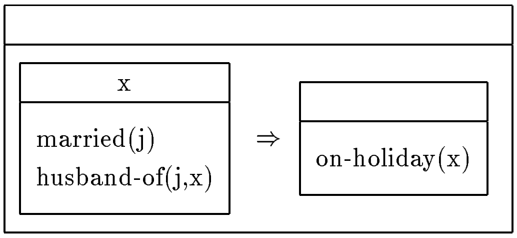
Next, application of the informativity constraint. This is exemplified by 5.3:

(5.3)If Jane is married then her husband is on holiday.

Global accommodation of the presupposition that Jane has a husband (triggered by 'her husband') would produce the following DRS:



But, on the assumption that models are constrained by meaning postulates in such a way that if somebody has a husband then they are married, this DRS breaks the informativity constraint: replacing the DRS in the antecedent of the conditional, [][married(j)], by the empty DRS [][] would not alter the range of models in which the global DRS could be embedded. Thus, once again, intermediate accommodation is preferred, producing a structure glossable as 'If Jane is married to x, then x is on holiday':



The next two examples, which I will not discuss in detail, illustrate the consistency and global informativity constraints, respectively:

(5.4)Either Jane is a spinster, or else her husband is on holiday.

(5.5)Jim is Fred's friend, and Fred is married. He is married too.

The reader should verify that for 5.4, the consistency constraint prevents global accommodation of the presupposition that Jane is married, forcing local accommodation, and that for 5.5 the global informativity constraint prevents resolution of the variable associated with 'he' to the discourse marker for Fred.[43]

Like the combined Gazdar-Karttunen theory described earlier, or Soames' similar synthesis of Gazdar's and Karttunen's work, van der Sandt's DRT-based model of presupposition gets right the cases which Gazdar's theory handles well (i.e. where

[43] Note that in van der Sandt's system pronouns are treated in the same way as standard presupposition triggers, except that the presupposed DRS associated with a pronoun (something like [x][]) is assumed to contain insufficient conditions to support accommodation.

presuppositions are either explicitly denied, or appear to be out-competed by implicatures) *and* the cases which Karttunen's theories handle well (typically where a presupposition is entailed in its local context). However, *none* of the cancellation accounts discussed, *none* of the various theories proposed singly or in joint work by Karttunen, and *neither* the above combined Gazdar-Karttunen theory *nor* Soames own combined model provides an adequate account *either* of presupposed open propositions and their interaction with quantifiers, *or* of Kripkean cases of anaphoric presupposition. Van der Sandt's model treats both of these phenomena. It is on this basis that I would claim that the most successful fully formalised[44] model of presupposition to date is van der Sandt's, whose theory, with a judicious mixture of resolution and accommodation, successfully handles a wide range of problems from the literature and more besides[45]

However, there remain considerable problems for van der Sandt's theory. Some of these difficulties seem to me to be of such a general nature as to be relevant to any theory of accommodation, but firstly I will discuss a few problems which seem particular to van der Sandt's formalisation.

5.2. Anaphora from Accommodated Material

One strength of van der Sandt's model concerns the predictions it makes concerning the anaphoric accessibility of discourse entities introduced within presuppositional constructions. The following two counter-examples to DRT constraints on accessibility of anaphoric antecedents date back to over a decade before DRT was introduced, from Karttunen's influential work on discourse reference [Kar76] (which was only published some years after its first presentation):

(5.6)Bill didn't realise that he had a dime. It was in his pocket.

(5.7)John knew that Mary had a car, but he had never seen it.

In the first example, not only is 'a dime' embedded within an intensional context, but that context is itself embedded under a negation. In standard DRT, either of

[44] What it is for a model to be *fully formalised* is a matter of judgement. None the less, it is clear that van der Sandt's model goes further than most of its competitors. For instance, perhaps Seuren's model will in principle yield comparable coverage, but at least one central component of the theory, i.e. *backward suppletion*, Seuren's equivalent of accommodation, remains unformalised to my knowledge (but see the developments in Chapter ?? of [Bea95]). Heim, though presenting an account with many superficial similarities to van der Sandt, has likewise not offered a detailed formal model of accommodation. One could transport a van der Sandtian view of accommodation into Heim's model (as indeed Zeevat has done [Ze92]) or into Seuren's, but then one produces, not surprisingly, a model with very similar descriptive coverage to van der Sandt's account. Or take the accounts of Burton-Roberts and Link. Both have offered promising starting points, but push much of the work over to an as yet unformalised pragmatic component. Another justification for calling van der Sandt's account "fully formalised" is that it has reached a stage where it can be implemented in an NLP system — see van der Sandt and Geurts' [SG91] and Bos' [Bo94].

[45] For the "more besides" see especially §5.2 below on anaphora from accommodated presuppositions. Also see Saebo's [Sa94] development of van der Sandt's model which involves applying the model to data not usually thought of as presuppositional.

these embeddings would normally be sufficient to guarantee anaphoric inaccessibility. Since 'a car' in the second example is embedded within an intensional context, standard DRT incorrectly predicts it to be inaccessible. However, van der Sandt predicts that in both these cases global accommodation occurs. For instance the final DRS for 5.6 would be something like the following:

$$
\begin{array}{|l|}
\hline
\qquad b \quad x \quad z \\
\hline
b = \mathrm{bill} \\
\mathrm{dime}(x) \\
\mathrm{had}(b,x) \\
\neg \begin{array}{|l|}
\hline
\\
\hline
\mathrm{realise}(b, \begin{array}{|l|}\hline \quad y \\ \hline \mathrm{dime}(y) \\ \mathrm{had}(b,y) \\ \hline \end{array}) \\
\hline
\end{array} \\
\mathrm{pocket\text{-}of}(b,z) \\
\mathrm{in}(x,z) \\
\hline
\end{array}
$$

Here global accommodation of a DRS of the form [x][dime(x),had(b,x)] creates an anaphorically accessible dime to which the pronoun in the second sentence can refer.

Such patterns of anaphoric reference can be demonstrated with a wide range of presuppositional constructions embedded in environments that would otherwise block anaphoric reference. Perhaps most significant of these presuppositional constructions are definite descriptions. For instance, in the following discourse, van der Sandt's theory predicts that the presupposition associated with 'the tallest mountain in the world' is globally accommodated, and hence correctly licenses subsequent anaphoric reference:

(5.8) John believes that he can see the tallest mountain in the world. But in fact it is completely obscured by mist.

What is most notable about this last case is that it shows that given a theory like van der Sandt's, a rather *ad hoc* stipulation in standard DRT, the promotion of proper names and definites, can be dispensed with. This stipulation, that referents introduced by proper names and definite descriptions are automatically promoted to a position in the global DRS regardless of how deeply embedded they arose, was originally motivated only by the need to account for the special anaphoric accessibility of names and definites. But in van der Sandt's account, the separately motivated theory of presupposition takes care of promotion (under the name of accommodation), and it is only necessary to make the relatively uncontroversial assumption that both definites and names are presuppositional.

5.3. Accommodation as a Journey through Mental Space

Fauconnier [Fa85] presents a representationalist theory in which meanings are rendered in a structured collection of interconnected *mental spaces.* Mental spaces are akin to Kamp's DRS boxes (or, perhaps even more aptly, Seuren's *discourse domains*).[46]

In order to see what Fauconnier's theory of presupposition [Fa85, pp.86–87] would look like in a van der Sandtian setting, let us assume that a space is just a DRT box (i.e. a set of discourse markers and a set of conditions), and assume a DRT-like notion of accessibility. Let us say that a proposition is *supported* in a space if it is a consequence of the conditions in that space, and that a proposition is *accessible* from a space if it is a consequence of propositions in accessible (i.e. superordinate) spaces, and let us assume a standard logical definition of *consistency* of a space, meaning consistency of the set of conditions in that space.[47] In certain cases (generally non-intensional contexts) Fauconnier also employs a notion of *compatibility*, meaning consistency of the set of conditions either in the space or accessible from it. Fauconnier's theory of presupposition can be described as a theory of presupposition flotation, whereby locally triggered presuppositions float

[46] A few remarks should clarify the similarity with DRT:

(i) Like DRS boxes, mental spaces can be seen as partial models in which a set of discourse entities bear certain properties and relations to each other, but in which the extensions of many other properties and relations are left undecided.

(ii) Like DRS boxes, mental spaces are arranged hierarchically, with some boxes being seen as subordinate to others. Properties of objects in subordinate *daughter* spaces may be inherited from their *parent* spaces. However, the links between entities in different spaces are not sustained by variable binding, but by a Lewisian counterpart relation. The inter-space links between entities are analogous to the connections between discourse markers in later versions of DRT [KRe93] where objects in intensional contexts are linked to objects outside by *anchoring* functions, these determining which objects are counterparts of which others.

(iii) Unlike Kamp, Fauconnier does not follow the Montagovian method of fragments. He does not provide a fully formalised method of constructing mental spaces for all the strings produced by a generative grammar.

(iv) Unlike in DRT, no semantic interpretation or Tarski truth definition is given for mental spaces, and no notion of logical consequence between mental spaces is defined.

[47] The relation *supports* corresponds approximately to Fauconnier's *satisfaction*, but I refrain from using this term here since I have tended to use it elsewhere with a slightly different meaning. I have also been rather cavalier with Fauconnier's notion of *accessibility* of a proposition. I have assumed that propositions in all superordinate spaces are accessible, but Fauconnier is interested in a wide variety of intensional contexts such that (consequences of) propositions holding in parent spaces cannot in general be expected to hold locally.

up through as many spaces as they can without creating inconsistency.[48] I would characterise the theory as follows:

(i) Presuppositions must be supported in the local space of the trigger.

(ii) If a presupposition is accessible, then nothing further need be done.

(iii) Otherwise, the presupposition is accommodated into successively more global spaces along the accessibility path, until reaching the highest space where accommodation does not create inconsistency at the accommodation site, or incompatibility of any (non-intensional) subordinate space.[49]

It is readily seen that, at least in the van der Sandtian form that I have presented it, Fauconnier's model will make predictions comparable to some of the other models that have been discussed in this section. The first clause means that in a sense Fauconnier always locally accommodates, whatever else he does. This produces the effect that in a cancellation account would be derived by assuming presuppositions to be part of the asserted content.[50] The second clause provides for something like van der Sandt's anaphoric resolution of presuppositions. In most cases this will presumably yield filtering of entailed presuppositions as in Karttunen's '73 model. The third clause meanwhile will prevent global accommodation in case that would produce inconsistency, thus giving the effect of a cancellation theory in cases of presupposition denial.

There is one important respect in which the version of Fauconnier's theory above makes different predictions from van der Sandt's. Under Fauconnier's accommodation strategy as a presupposition floats upwards, it leaves a shadow behind (i.e. a copy of the presupposition) in every space through which it passes. But van der Sandt's strategy depicts presuppositions as bubbling up without leaving any trace of their journey. In fact Zeevat has compared an accommodation strategy just like Fauconnier's to van der Sandt's, although Zeevat attributes what I call Fauconnier's strategy to Heim. Distinguishing the two strategies Zeevat says [Ze92, p.396]: "The one remaining difference [i.e. between his version of van der Sandt's theory and his version of Heim's theory] is the question whether we should add the presupposition everywhere between the position of the trigger and the highest position where it can be accommodated, or whether we can be satisfied with adding it just once at that position."

So which is the right strategy? Zeevat comes to an interesting conclusion: both are right, but for different classes of presupposition trigger. The two classes Zeevat delimits are what he calls *anaphoric* and *lexical* presuppositions. The anaphoric (or *resolution*) triggers are those "whose primary function is — like anaphora —

[48] The flotation metaphor is used by Fauconnier himself. Coincidentally, the same metaphor is chosen by Geurts [Geu95] when discussing van der Sandt's accommodation theory.

[49] I take the *incompatibility* requirement from Fauconnier's discussion of conflicting presuppositions in disjunctions [Fa85, p.92].

[50] In a section entitled "Presupposition Transfer" [Fa85, pp.105–108], Fauconnier also discusses cases where a presupposition need not be supported in the local space of its trigger. For example, he discusses the sentence 'Hey, In this painting Gudule is beautiful again.' He allows that that the sentence may be interpreted in a context where Gudule in reality was once beautiful, but is no longer, without committing the speaker to a proposition like 'In the painting Gudule was once beautiful.'

to collect entities from the environment in order to say new things about them."[Ze92, p.397] This class, which presumably at least includes definite noun phrases, and discourse particles like *too* and *again*, is the one for which Zeevat supposes the van der Sandtian strategy to be appropriate. The *lexical triggers* are those where the presupposition is a condition on the application of a concept, so that the presupposition must hold in any context where the trigger is applied if the application of the concept is to be meaningful. Factive verbs are presumably in this class. From the definition of lexical triggers, we can see that the presupposition should be expected to hold not only at the highest accommodation site, but also locally. Zeevat goes further in requiring lexical presuppositions to hold Fauconnier fashion in all the intermediary contexts.[51]

6. Syntheses and Comparisons

Theories of presupposition continue to proliferate. Since it is rarely clear what the relationship between different theories is, it is hard to trace any clear evolutionary path that theories have followed through time, and not easy to say whether progress is being made either technically or descriptively. My feeling is that progress is being made on both counts. In this section it will shown that there has been a great deal of technical convergence, so that various different intuitions about presupposition can now be studied in the same formal setting, and the resulting theories compared. In fact the degree of convergence runs deeper than can be detailed here. For instance, I give no direct comparison between multivalent and cancellationist accounts of presupposition. In fact there are now a number of theories which model the defeasibility of presuppositions using methods of multivalent logic, such as those of Schöter [Schö95, Schö:MS] and Marcu [Ma94]. Descriptive issues are relegated to the end of the section.

6.1. Cancellation and Filtering

The cancellation and filtering theories are largely complementary in terms of which data they get right. Having observed this complementarity, Soames [So82] proposed a synthesis of Gazdar's account with the later versions of Karttunen's account in [Kar74, KP79]. However, as mentioned earlier, the later versions of Karttunen's

[51] Goldberg *et al* [GKS:MS] motivate a division between what they term *external* and *internal* presuppositions, the idea being that external presuppositions hold in the model, but internal presuppositions need only be satisfied in the discourse context. At least at a schematic level, it seems natural to equate their term *external* with Zeevat's *lexical*, and their *internal* with Zeevat's *resolution*, although I will not pursue this line any further here. Other theories of presupposition that can be compared with van der Sandt's in much the way as Fauconnier's are those of Dinsmore [Di81b, Di92], and Schiebe [Schi79]. Like the theories of van der Sandt and Fauconnier, these accounts are explicitly procedural, and explicitly representational. Note that although Schiebe talks of worlds of evaluation, one of his uses of the term *world* is akin to Fauconnier's term *mental space*.

theory are not filtering theories in the sense defined above. The presuppositions that a complex sentence is predicted to have are not a subset of the potential presuppositions of its parts. This complicated Soames' attempt to unify the insights of the two account in a single theory. To give an idea of the difficulties faced, ask yourself this question: when looking for a synthesis between two accounts, where the first account makes all presuppositions members of the set of potential presuppositions, and the second account does not, should the resulting theory be expected to make all presuppositions members of the set of potential presuppositions? (Soames in fact answers in the negative.)

A much simpler integrated theory, but one which still preserves Soames' central insight, could be formed by combining the Karttunen 1973 theory, as discussed above, with Gazdar's. The most obvious way to join the two theories so as to address both defeat of presuppositions by inconsistency and filtering of presuppositions which are locally entailed, would simply be to take the intersection of the set of presuppositions predicted by each of the two models. One would need first to strip the epistemic operators from Gazdar's presuppositions, or add such operators to Karttunen's, but I take this to be a trivial task. It would be natural to identify Karttunen's set of assumed facts with the incoming context in Gazdar's model. Such a joint Gazdar-Karttunen model (I will refer to it as GK) provides a formidable account of presupposition, combining relative simplicity with a clear improvement over the original cancellation and filtration accounts (as will be seen in §6.5).

6.2. Trivalent and Dynamic Semantics

The thesis, descending from the work of Frege and Strawson, that presupposition projection should be explained as inheritance of semantic undefinedness, seems to find an antithesis in the suggestion that presupposition projection arises from (pragmatically justified) principles of context change. However, Peters, in [Pe77], provided a synthesis, observing that the presupposition inheritance properties derived in [Kar74] could be duplicated in a system with a trivalent semantics, and thus do not depend on the dynamicity of Karttunen's account. The connectives in Peter's trivalent system, which I will refer to as the *Peters' connectives* (but which Krahmer [Krah93] terms the *Middle Kleene* connectives), can be used to show the relationship between the dynamic logics developed in the current work and trivalent logics. Note that the correspondence breaks down once we move to a quantificational logic, since the dynamic systems discussed manifest quantifier-scope properties not found in any standard trivalent system.

The Peters' connectives may be likened to the strong Kleene connectives, except that if the left-hand formula under a binary Peters' connective is undefined, then the whole formula is undefined:

Definition 6.1 (The Peters' Connectives). *The 3 valued interpretation of a complex formula ϕ relative to a world w, written $[\![\phi]\!]^3_w$, is given by recursion over the following truth tables:*

$\phi \wedge \psi$	t	f	$\star$
t	t	f	$\star$
f	f	f	f
$\star$	$\star$	$\star$	$\star$

$\phi \rightarrow \psi$	t	f	$\star$
t	t	f	$\star$
f	t	t	t
$\star$	$\star$	$\star$	$\star$

$\phi \vee \psi$	t	f	$\star$
t	t	t	t
f	t	f	$\star$
$\star$	$\star$	$\star$	$\star$

ϕ	$\neg\phi$
t	f
f	t
$\star$	$\star$

Definition 6.2 (Entailment in the 3-valued system). *Let $[\![\phi]\!]^w_3$ be defined using the Peters' connectives and the trivalent interpretation of the presupposition operator given in definition 2.7. Then trivalent entailment is given by:*

$$\phi \models_3 \psi \;\; \textit{iff} \;\; \forall w \in W, [\![\phi]\!]^w_3 = t \;\Rightarrow\; [\![\psi]\!]^w_3 = t$$

Definition 6.3 (Entailment in the Update System). *Let $[\![.]\!]_u$ be as in $[\![.]\!]$ of definitions 4.4, 4.5 and 4.7. Then dynamic entailment is given by:*

$$\phi \models_w \psi \;\; \textit{iff} \;\; \forall \sigma \subseteq W \; \sigma[\![\phi]\!]_u\sigma \;\rightarrow\; \sigma[\![\psi]\!]_u\sigma$$

Fact 6.4.

$$\phi \models_3 \psi \;\; \textit{iff} \;\; \phi \models_w \psi$$

A proof is given in [Bea95].[52]

6.3. From Cancellation to Accommodation

Accommodation provides one of the great unifying themes of modern presupposition theory, since many theories of presupposition which were not originally proposed as accommodation theories can be thought of in terms of accommodation. In a sense cancellation is the inverse of global accommodation. Heim [Hei83a], after suggesting her enhancement of the CCP model with an account of accommodation, makes the following observation:

> 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.

[52] In fact the proof in [Bea95] concerns a system with a unary connective ∂ instead of the binary presupposition connective. However, the systems are interdefineable, with $\phi_\psi =_{\text{def}} \phi \wedge \partial\psi$, so the proof carries over directly.

I find this stunning. With one short remark buried in a terse paper Heim offers a simple synthesis between the two antitheses of 1970's presupposition theory, namely the Karttunen 1974 derived model which her paper uses as its base, and Gazdar's cancellation account. Perhaps implicit in Heim's remark is the idea that global accommodation of an elementary presupposition may be identified with what was termed *projection* in earlier models. In this case whenever accommodation is not global, we have the effect of cancellation. Looked at this way, a preference for global over local accommodation becomes a preference for projection over cancellation, and given an appropriate stipulation of the circumstances in which this preference can be overridden (e.g. in order to avoid inconsistency), the effects of a cancellation theory can be mimicked. In a stroke this shows a way to eliminate the bulk of existing counter-examples to the CCP model, in particular examples where a presupposition associated with an embedded trigger is eliminated by explicit denial. Further, and in common with van der Sandt's cancellation account, Heim's remark introduces a way of thinking about Gazdar's theory that preserves his insight that default reasoning is involved in the processing of presuppositions, whilst restoring the intuition that, in some sense, presuppositions are to do with *what come first*, with definedness conditions on the input rather than preferences on the output. Note that in [vdS88] van der Sandt is explicit in identifying his cancellation analysis as involving an accommodation-like mechanism, although this was not the case in his theory's first incarnation [vdS82]. Also note that for Heim's analogy between cancellation and accommodation theories to really drive home it is important that in the cancellation account it is assumed that presuppositions are also part of the asserted content. Entailment of presuppositions is what produces the effect of local accommodation in cases where the presupposition is globally canceled.

6.4. The Transformation from Russell to van der Sandt

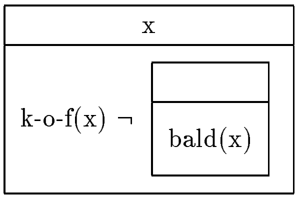
Now let us consider a very different type of theory, that of Russell, in which alternative presuppositional readings are obtained only as a result of variations in logical scope. Strangely, these scopal variations are mirrored by the alternative accommodation readings in van der Sandt's theory, save that Russell's logical forms happened to be expressed in FOPL, whereas van der Sandt's are expressed in the language of DRT. Russell gave few hints as to how his logical forms should be derived, and I see no obvious reason why a Russellian theory of scopal variation should not be developed where scope bearing operators are initially interpreted *in situ* to produce a first logical form, and are then moved about to produce the final logical form in a manner reminiscent of the semantic *move-α* operations of van der Sandt's theory.[53] Thus we see that the transformation from Russell to van der

[53] For formulations of Russellian theories of presupposition, see the work of Delacruz [Del76], Cresswell [Cr73, pp.168-169] and Grice [Gr81]. Also relevant is Neale's [Ne90], although this does not target presupposition *per se*. Kempson [Kem75, Kem79], Wilson [Wi75] and Atlas [At76, At77], whilst holding in common with Russell that there is no special presuppositional component to meaning, provide forceful arguments against the Russellian explanation of presuppositional

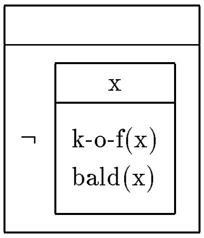
Sandt is surprisingly small.

For instance, a neo-Russellian and van der Sandt accounts allow essentially the same two readings for sentences like 'The King of France is not bald.' Taking 'ι' to be a Russellian definite description operator, the Russellian narrow scope negation reading can be represented as $\iota x[\text{k-o-f}(x)](\neg\text{bald}(x))$. Corresponding to this is the van der Sandtian global accommodation reading in (a), below. On the other hand the neo-Russellian wide-scope negation reading, $\neg(\iota x[\text{k-o-f}(x)](\text{bald}(x)))$, is analogous to van der Sandt's local accommodation reading, in (b).

(a)



(b)



But this is not to deny that van der Sandt's theory incorporates important innovations. Firstly, van der Sandt's account includes not only an accommodation component, but also an anaphoric resolution component completely alien to the Russellian picture of definites. Secondly, van der Sandt not only allows for presuppositional elements to take different *scopes*, he also provides an account of which scopes are to be preferred, and this is again something absent from the Russellian account. Thirdly, and specifically as a result of being situated in DRT, van der Sandt's model allows for extra possibilities which would not be available to Russell. For instance, a presupposition α triggered in the consequent of a conditional may, in van der Sandt's theory, eventually make its way to the antecedent of the conditional. Such a transformation would make no sense on the Russellian picture, since an element in the antecedent of a conditional could classically not bind material in the consequent.

inferences in terms of scope.

6.5. Empirical Discussion

Consider the following three five-way examples, some of which have already been discussed ((i–v) are understood according to the list beneath the examples):

(6.1)If David wrote the article then the knowledge that (i/ii/iii/iv/v) will confound the editors.

(6.2)If David wrote the article and the knowledge that (i/ii/iii/iv/v) disturbs the editors, they'll read the manuscript very carefully.

(6.3)If knowledge that (i/ii/iii/iv/v) disturbs the editors and David wrote the article, they'll read the manuscript very carefully.

(6.4)Either David didn't write the article, or the knowledge that (i/ii/iii/iv/v) will confound the editors.

i = 'the article is already finished'
ii = 'he (i.e. David) wrote the article'
iii = 'he (i.e. David) wrote the article whilst blindfolded and juggling torches on horseback'
iv = 'no decent logician was involved (in writing the article)'
v = 'the article was written in record time'

Example 6.1(i) may be translated as $A \rightarrow (\partial a \wedge B)$, where A is the proposition that David wrote the article, a is the proposition that the article is already finished and B is the proposition that the editors are confounded by the knowledge that a. Since 6.1(i) does not imply that the article is already finished, i.e. that the presupposition triggered by the factive 'the knowledge that' is cancelled. We derive the datum: $A \rightarrow (\partial a \wedge B) \not\models a$. The presupposition is also cancelled in 6.1(ii), i.e. $A \rightarrow (\partial A \wedge B) \not\models A$, and similarly for the (i) and (ii) cases, i.e. from 6.2(i,ii) we obtain $(A \wedge \partial a \wedge B) \rightarrow C \not\models a$ and $(A \wedge \partial A \wedge B) \rightarrow C \not\models a$, and from 6.4(i,ii) we obtain $(\neg A) \vee (\partial a \wedge B) \not\models a$ and $(\neg A) \vee (\partial A \wedge B) \not\models A$.***[54]

The (iii) variants of 6.1–6.4 are rather odd. In spite of this oddity, I think it is safe to say that they do not imply that David actually did write the article whilst blindfolded and juggling torches on horseback, since they do not imply that he wrote the article at all. So if a corresponds to 'David wrote the article', A to the sentiment in (iii), and B to the editors being confounded by the knowledge that A, we derive a first datum for 6.1(iii) to the effect that $a \rightarrow (\partial A \wedge B) \not\models A$, and correspondingly for 6.2 and 6.4. But the sentences do seem to suggest that it is a matter of course that if David wrote the article then he did so in the strange circumstances described. My feeling is that all three sentences improve markedly if they are preceded, for example, by 'David is the only academic I know to have a successful simultaneous career in the circus, and he always writes his articles whilst performing. But. . . '. Given this extra background, the likelehood that if David wrote the article then he did so whilst

[54] THIS SUBSECTION REQUIRES ADJUSTMENT DUE TO A CHANGE IN NOTATION

blindfolded and juggling on horseback surely improves. One possible explanation of the mild infelicity of the (iii) variants is then that they presuppose something that is rather unlikely, a conditional $a \rightarrow A$. Thus we derive the datum: $a \rightarrow (\partial A \wedge B) \models a \rightarrow A$. I will not claim that the data is so clear that a theory which does not make this prediction of what may be called a *conditionalised* presupposition is wrong, for many authors have argued against the occurence of conditionalised presuppositions.[55] But I do think that prediction of such a conditionalised presupposition provides one line of explanation for the oddity of the (iii) cases, so that a theory which fails to predict the conditionalised presupposition should explain the infelicity in some other way.

What distinguishes the (iv) and (v) variants from the previous three is that logic alone does not allow us to link the presupposition to other material in the examples. For instance, whereas the article being finished is a logical consequence of David having written the article, it is neither the case that there being no decent logician involved follows automatically from David having written the article, nor *vice versa*. Concentrating on 6.1 — I take it that the remaining examples are similar — both 6.1(iv) and 6.1(v) can be notated as $A \rightarrow (\partial B \wedge C)$. However, there appears to be a significant difference between the behaviour of the presuppositions in 6.1(iv) and 6.1(v). To wit, on hearing 6.1(iv), one would not normally conclude that no decent logician was involved in writing the article, but on hearing 6.1(v) I think it quite plausible that one would conclude that the article was completed in record time. So in the first case the presupposition is apparently cancelled, whereas in the second it (at least optionally) projects. But now let us consider 6.1(iv) in slightly more detail. Though the presupposition might not be implied *per se*, a hearer would perhaps be tempted to conclude something else which is subtly linked to the presupposition, something that seems rather mysterious in its generality, namely that David is not a decent logician, and that decent logicians are not involved when he writes an article. But where could an inference to such a generalisation arise from? One line of approach would be to say that the sentence has a conditionalised presupposition of the form $A \rightarrow B$, i.e. that if David wrote the article then no decent logician was involved, and that this is in some way pragmatically justified in terms of a generalisation about David's ablities *qua* logician. One line of approach would be to say that in both the version (iv) and version (v) examples, the presupposition is initially only projected in conditionalised form, but that additional pragmatic mechanisms then cause strengthening, but that in the version (v) case this extra strengthening actually leads the hearer to conclude that the presupposition was true. Then again, one could also argue that there is some ambiguity involved in interpreting sentences having the form of $A \rightarrow (\partial B \wedge C)$, and that on one reading a presupposition B is projected, but that on another reding either the presupposition is cancelled altogether (in which case some wholly non-presuppositional explanation is needed for the inferences that I have mentioned in connection with the version (iv) cases), or that a consitionalised $A \rightarrow B$ inference arise. As we will see, different theories of presupposition make quite different predictions with respect to sentences

[55] For arguments against conditionalised presuppositions see [vdS82, Geu95]. Elsewhere I have attempted a defence of conditionalised presuppositions, in [Bea95].

of this form.

Gazdar's theory correctly predicts that $\phi = (A \wedge \partial A \wedge B) \rightarrow C \not\models A$ (c.f. 6.2(ii)), this being a case where implicature plays an important role. Here the potential implicature $\neg K(A)$ is sufficient to cancel the potential presupposition $K(A)$. However, if the presupposition in ϕ is weakened, the implicature fails to have the same canceling effect, so that $(A \wedge \partial a \wedge B) \rightarrow C \models a$: unfortunately this contrasts with the data reported earlier w.r.t. 6.2(i)) (and similarly for 6.1(i)), 6.4(i)). The predictions of the theory are also questionable in cases where the presupposition in ϕ is replaced with one logically stronger than the implicature. We have that $(a \wedge \partial A \wedge B) \rightarrow C \not\models A$. Thus in this sort of example the presupposition disappears without trace, whereas in the relevant example, 6.2(iii), the failure of the presupposition to disappear completely leads to infelicity. It was claimed that a possible explanation would be the emergence of a conditionalised presupposition $a \rightarrow A$ in such cases. In the Gazdarian account there is no mechanism whereby such presuppositions could emerge.

Another problematic type of example for Gazdar's theory are those where (like the (iv) and (v) variants of 6.1-6.4) presupposition projection is determined by plausibility with respect to common sense knowledge about the world, and not by logical consistency with previous knowledge. Perhaps here an alternative theory of presupposition might improve on Gazdar's. It is conceivable that Mercer's model might be utilised in cases where plausibility rather than logical consistency plays a role in in predicting cancellation. Presumably plausibility criteria would themselves have to be captured using default rules, such that evaluation ofpresuppositions took place against a background of a database containing both absolute knowledege and default rules, both of which could determine whether projection occurred.

Finally, a summary of the the behaviour of various of the systems discussed is given in the following table. A convention is adopted wrt. the proposition letters p, P, π it being assumed that models are restricted such that $\P \models \pi \models p$: all other proposition letters are assumed logically independent. The theories compared are Weak Kleene/External Bochvar (WK), Strong Kleene (SK), supervaluation semantics (SUP), Peters' connectives (P), Karttunen and Peters' two dimensional system[56] (KP), Karttunen's 1974 model (K74), Heim's 1983 model minus accommodation (H), Karttunen's 1973 model, Gazdar's cancellation theory (G), the combined Karttunen/Gazdar model introduced earlier (KG), and van der Sandt's DRT-based theory[57] (vdS).

[56] KP was not presented in terms of PrL, but its relation to other systems discussed is well established.

[57] I use some latitude in interpreting how van der Sandt's model behaves, translating into natural DRT equivalents of the formulae given, and taking the maximal presupposition to be whatever is globally accommodated.

Formula	Maximal Presupposition								
	WK	SK/SUP	P/K&P/K74/H	K73	G	KG	vdS	Example	Data
ϕ_π	π	π	π	π	π	π	π	1.1	π
$\neg\phi_\pi$	π	π	π	π	π	π	π	1.3	π
$\phi \wedge \psi_\pi$	π	$\phi \rightarrow \pi$	$\phi \rightarrow \pi$	π	π	π	π		
$\phi_\pi \wedge \psi$	π	$\psi \rightarrow \pi$	π	π	π	π	π		
$\phi \vee \psi_\pi$	π	$\neg\phi \rightarrow \pi$	$\neg\phi \rightarrow \pi$	π	π	π	π		
$\phi_\pi \vee \psi$	π	$\neg\psi \rightarrow \pi$	π	π	π	π	π		
$\pi \rightarrow \phi_\pi$	π	$\top$	$\top$	$\top$	$\top$	$\top$	$\top$	$6.1(ii)$	$\top$
$(\pi \wedge \phi_\pi) \rightarrow \psi$	π	$\top$	$\top$	$\top$	$\top$	$\top$	$\top$	$6.2(ii)$	$\top$
$P \rightarrow \phi_\pi$	π	$\top$	$\top$	$\top$	π	$\top$	$\top$	$6.1(iii)$	$\top$
$(P \wedge \phi_\pi) \rightarrow \psi$	π	$\top$	$\top$	$\top$	π	$\top$	$\top$	$6.2(iii)$	$\top$
$p \rightarrow \phi_\pi$	π	$p \rightarrow \pi$	$p \rightarrow \pi$	π	$\top$	$\top$	$\top$	$6.1(i)$	$p \rightarrow \pi?$
$(p \wedge \phi_\pi) \rightarrow \psi$	π	$(\neg\psi \wedge p) \rightarrow \pi$	$p \rightarrow \pi$	π	$\top$	$\top$	$\top$	$6.2(i)$	$p \rightarrow \pi?$
$(\phi_\pi \wedge P) \rightarrow \psi$	π	$(\neg\psi \wedge p) \rightarrow \pi$	π	π	$\top$	$\top$	$\top(*)$	$6.3(iii)$	π
$\neg\phi_\pi \wedge \neg\pi$	$\bot$	$\bot$	$\bot$	π	$\top$	$\top$	$\top$	3.13	$\top$
$\sharp\phi_\pi \wedge \neg\pi$	$\top$	$\top$	$\top$	$\top$					
$\neg(K\phi)_\pi$				π	$\top$	$\top$	$\top$	3.15	$\top$
$\phi_\pi \vee \phi_{\neg\pi}$	$\bot$	$\bot$SK	$\bot$	$\bot$	$\top$	$\top$	π or $\neg\pi$	3.12	$\top$

References

[Ar50] Aristotle, 1950. "Categories" (translator: E.M. Edghill), in W.D. Ross (ed.), *The Works of Aristotle Translated into English*, Vol.1, Oxford University Press.

[As93] Asher, N., 1993. *Reference to Abstract Objects in Discourse*, Studies in Linguistics and Philosophy, vol. 50, Kluwer, Dordrecht.

[At76] Atlas, J., 1976. *On the Semantics of Presupposition and Negation: an Essay in Philosophical Logic and the Foundations of Linguistics*, PhD. Dissertation, University of Princeton.

[At77] Atlas J., 1977. "Negation, Ambiguity and Presupposition", *Linguistics and Philosophy* 1, pp.321–336.

[AL81] Atlas, J. and S. Levinson, 1981. "It-Clefts, Informativeness and Logical Form: Radical Pragmatics", in Cole, P. (ed.), *Radical Pragmatics*, Academic Press, pp.1–61.

[Ba87] Barwise, J., 1987. "Noun Phrases, Generalised Quantifiers and Anaphora", in P. Gardënfors (ed.) *Generalized Quantifiers*, Reidel, Dordrecht.

[BC81] Barwise, J. and R. Cooper, 1981. "Generalized Quantifiers and Natural Language", *Linguistics and Philosophy* 4, pp.159–219.

[Bea92] Beaver, D., 1992. "The Kinematics of Presupposition", in P. Dekker and M. Stockhof (eds.), *Proceedings of the Eighth Amsterdam Colloquium*, , University of Amsterdam.

[Bea93] Beaver, D., 1993. "Kinematic Montague Grammar" in H. Kamp (ed.), deliverable R2.2A *Presupposition*, University of Amsterdam.

[Bea94a] Beaver, D., 1994. "When Variables Don't Vary Enough", in Harvey, M. & L.Santelmann (eds.), *SALT 4*, Cornell.

[Bea94b] Beaver, D., 1994. "Accommodating Topics", in R. van der Sandt and P. Bosch (eds.), *The Proceedings of the IBM/Journal of Semantics Conference on Focus*, IBM Heidelberg.

[Bea95] Beaver, D., *Presupposition and Assertion in Dynamic Semantics*, PhD Dissertation, University of Edinburgh.

[Bea:MS] Beaver, D., ms. "An Infinite Number of Monkeys", to appear in *Acta Linguistica Hungarica (Special edition devoted to Proceedings of the 5th Hungarian Symposium on Logic and Language.)*.

[BK:MS] Beaver, D. and E. Krahmer, ms. *Back to the Future*, University of Tilburg.

[Bel69] Belnap, N., 1969. "Questions, Their Presuppositions, and How They Can Arise.", in K. Lambert (ed.) *The Logical Way of Doing Things*, Yale University Press, Connecticut.

[Ber81] Bergmann M., 1981. "Presupposition and Two-Dimensional Logic", *Journal of Philosophical Logic* 10, pp.27–53

[Blam89] Blamey, S., 1989. "Partiality", in D. Gabbay and F. Guenther (eds.) *The Handbook of Philosophical Logic* Vol. IV , Reidel, Dordrecht, pp. 553–616.

[Blau78] Blau, U. 1978. *Die Driewertige Logik der Sprache: Ihre Syntax, Semantik und Anwendung in der Sprachanalyse*, Walter de Gruyter, Berlin.

[Blo93] Blok, P., 1993. *The Interpretation of Focus: An Epistemic Approach to Pragmatics*, PhD Dissertation, Groningen Dissertations in Linguistics 6, University of Groningen.

[Bo94] Bos, J., 1994. *Presupposition as Anaphora in the Verbmobil Semantic Formalism*, Verbmobil Report 25, Universität des Saarlandes.

[BBM95] Bos, J., P. Buitelaar and A. Mineur, 1995. "Bridging as Coercive Accommodation", in E. Klein, S. Manandhar, W. Nutt and J. Siekmann (eds.), *Working Notes of the Edinburgh Conference on Computational Logic and Natural Language Processing*, Human Communications Research Centre, University of Edinburgh.

[Br91] Bridge, D., 1991. *Computing Presuppositions in an Incremental Natural Language Processing System*, PhD Dissertation, available as Technical Report No. 237, University of Cambridge Computer Laboratory.

[Bu89a] Burton-Roberts, N. 1989. *The Limits to Debate: A Revised Theory of Semantic Pre-*

supposition, Cambridge Studies in Linguistics Vol.51, Cambridge University Press.

[Bu89b] Burton-Roberts, N., 1989. "On Horn's Dilemma, Presupposition and Negation", *Journal of Linguistics* 25, pp.95–125.

[Bu89c] Burton-Roberts, N., 1989. "Theories of Presupposition", *Journal of Linguistics* 25, pp.437–454.

[Bu90] Burton-Roberts, N., 1990. "Trivalence, Gapped Bivalence, and Ambiguity of Negation: A Reply to Seuren", *Journal of Linguistics* 26, pp.455–470.

[Ch92] Chierchia, G., 1992. *Anaphora and Dynamic Binding, Linguistics and Philosophy* 15, pp.111–183.

[Ch:MS] Chierchia, G., ms., 1994. *Lecture Notes for the LSA Summer School*, Cornell University, Ithica.

[Co83] Cooper, R., 1983. *Quantification and Syntactic Theory*, Dordrecht, Reidel.

[Cr73] Cresswell, M., 1973. *Logics and Languages*, Methuen, London.

[Dek92] Dekker, P., 1992. "An Update Semantics for Dynamic Predicate Logic", in P. Dekker and M. Stockhof (eds.), *Proceedings of the Eighth Amsterdam Colloquium*, , University of Amsterdam.

[Dek93] Dekker, P., 1993. *Trans-sentential Meditations, Ups and Downs in Dynamic Semantics*, Phd Dissertation, University of Amsterdam.

[Del76] Delacruz, E., 1976. "Factives and Propositional Level Constructions in Montague Grammar", in B. Partee (ed.), *Montague Grammar*, Academic Press, New York, pp. 177–199.

[Di81a] Dinsmore, J., 1981. "Towards a Unified Theory of Presupposition" (Review of [O&D79]), *Journal of Pragmatics* 5, pp. 335–363.

[Di81b] Dinsmore, J., 1981. *The Inheritance of Presuppositions*, John Benjamins, Amsterdam.

[Di92] Dinsmore, J., 1992. *Partitioned Representations: A Study in Mental Representation, Language Understanding and Linguistic Structure*, Kluwer, Dordrecht.

[Ei93] Eijck, J. van, 1993. "The Dynamics of Description", *Journal of Semantics* 10, pp. 239–267.

[E194] Eijck, J. van, 1994. "Presupposition Failure a Comedy of Errors", *Formal Aspects of Computing* 3.

[Ei95] Eijck, J. van, 1995. "Presuppositions and Dynamic Logic", in M. Kanazawa, C. Piñon and H. de Swart (eds.), *Papers from the Second CSLI Workshop on Logic, Language and Computation*, CSLI, Stanford.

[EC92] Eijck, J. van and G. Cepparello, 1992. *Dynamic Modal Predicate Logic*, Report CS-R9237, CWI, Amsterdam, 1992. To appear in M. Kanazawa and C. Piñon (eds.), *Dynamics, Polarity, and Quantification*, CSLI, Stanford.

[Em90] Emms, M., 1990. "Polymorphic Quantifiers", in M. Stokhof and L. Torenvliet, eds., *Proceedings of the Seventh Amsterdam Colloquium*, University of Amsterdam.

[Ev77] Evans, G., 1977. "Pronouns, Quantifiers and Relative Clauses", *The Canadian Journal of Philosophy* 7.

[Fa85] Fauconnier, G., 1985. *Mental Spaces: Aspects of Meaning Construction in Natural Language*, MIT Press, Cambridge, Massachusetts.

[Fe95] Fernando, T., 1995. "Computational Foundations for Dynamic Accounts of Presuppositions", in E. Klein, S. Manandhar, W. Nutt and J. Siekmann (eds.), *Working Notes of the Edinburgh Conference on Computational Logic and Natural Language Processing*, Human Communications Research Centre, University of Edinburgh.

[Fi71] Fillmore, C., 1971. "Verbs of Judging: An Exercise in Semantic Description", in C. Fillmore & D. Langendoen (eds.), *Studies in Linguistic Semantics* Holt, Reinhardt & Winston, New York.

[vF94] Fintel, K. von, 1995. *Restrictions on Quantifier Domains*, PhD Dissertation, University of Massachussetts at Amherst.

[vF69] Fraassen, B. van, 1969. "Presuppositions, Supervaluations and Free Logic", in K. Lambert (ed.) *The Logical Way of Doing Things*, New Haven, Yale University Press, pp. 67–92.

[vF75] Fraassen, B. van, 1975. *Logic and Formal Semantics*, Macmillan New York.

[Fr84a] Frege, G., 1984. *On Sense and Meaning*, [Fr84b], pp. 157–177. (First appeared: 1892.)

[Fr84b] Frege, G., 1984. *Collected Works*, B. McGuinness (ed.), Basil Blackwell, Oxford.

[Gal75] Gallin, D., 1975. *Intensional and Higher-Order Modal Logic*, North-Holland, Amsterdam

[Gam91] L.T.F. GAMUT, 1991. *Logic, Language and Meaning*, Vol. I, University of Chicago Press.

[Gaz79a] Gazdar, G., 1979. *Pragmatics: Implicature, Presupposition and Logical Form*, Academic Press, New York

[Gaz79b] Gazdar, G., 1979. "A Solution to the Projection Problem", in [O&D79].

[Gea62] Geach, P., 1962. *Reference and Generality*, Cornell University Press, Ithaca, New York.

[Ger95] Gervas, P., 1995. "Compositionality and Presupposition", in E. Klein, S. Manandhar, W. Nutt and J. Siekmann (eds.), *Working Notes of the Edinburgh Conference on Computational Logic and Natural Language Processing*, Human Communications Research Centre, University of Edinburgh.

[Geu95] Geurts, B., 1994. *Presupposing*, PhD Dissertation, University of Osnabrück.

[GKS:MS] Goldberg J., L. Kalman and Z. Szabo, ms. *Internal and External Presuppositions*, Budapest. Draft version appears in R. van der Sandt (ed.), *Reader for the Nijmegen Workshop on Presupposition, Lexical Meaning, and Discourse Processes*, University of Nijmegen.

[Gr81] Grice, P., 1981. "Presupposition and Implicature", in P. Cole (ed.) *Radical Pragmatics*, Academic Press, New York, pp. 183–199. Also in P. Grice, 1989, *Studies in the Way of Words*, Harvard University Press, Cambridge, Massachusetts, pp. 269–282. (Page numbers in text refer to 1989 version.)

[GS84] Groenendijk J. and M. Stokhof, 1984. *Studies in the Semantics of Questions and the Pragmatics of Answers*, PhD Dissertation, University of Amsterdam.

[GS90] Groenendijk J. and M. Stokhof, 1990. "Two theories of dynamic semantics", in Eijck, J. van (ed.), *Logics in AI. European Workshop JELIA '90*, Springer, Berlin, pp. 55–64.

[GS91a] Groenendijk J. and M. Stokhof, 1991. "Dynamic Predicate Logic", *Linguistics and Philosophy* 14, pp. 39–100.

[GS91b] Groenendijk J. and M. Stokhof, *Dynamic Montague Grammar*, in J. Groenendijk, M. Stokhof and D. Beaver (eds.), deliverable R2.2a *Quantification and Anaphora I*, Center for Cognitive Science, University of Edinburgh.

[GSV95] Groenendijk J., M. Stokhof, and F. Veltman, 1995. "Coreference and Modality", in S. Lappin (ed.) *Handbook of Contemporary Semantic Theory*, Blackwell, Oxford.

[GSV:MS] Groenendijk J., M. Stokhof, and F. Veltman, ms., 1995. *Coreference and Modality in the Context of Multi-Speaker Discourse*, University of Amsterdam.

[Gu81] Gunji, T., 1981. *Towards a Computational Theory of Pragmatics — Discourse, Presupposition and Implicature*, PhD Dissertation, Ohio State University.

[Ha76] Hausser, R., 1976. "Presuppositions in Montague Grammar", *Theoretical Linguistics* 3, pp.245–280.

[Hei82] Heim, I., 1982. *On the semantics of Definite and Indefinite Noun Phrases*, PhD dissertation, University of Amherst.

[Hei83a] Heim, I., 1983. "On the Projection Problem for Presuppositions", *WCCFL 2*, pp. 114–126.

[Hei83b] Heim, I., 1983. "File Change Semantics and the Familiarity Theory of Definites". In R. Bäuerle, C.Schwarze and A. von Stechow (eds.), *Meaning, Use and Interpretation of Language*, De Gruyter, Berlin, pp. 164–189.

[Hei90] Heim, I., 1990. "Presupposition Projection", in R. van der Sandt (ed.), *Reader for the Nijmegen Workshop on Presupposition, Lexical Meaning, and Discourse Processes*, University of Nijmegen.

[Hei92] Heim, I., 1992. "Presupposition Projection and the Semantics of Attitude Verbs", *Journal of Semantics* 9, pp. 183–221.

[Hein72] Heinämäki, O., 1972. "Before", in *Papers from the 8^{th} Regional Meeting, Chicago Linguistic Society*, University of Chicago, pp.139–151.

[Her73] Herzberger H., 1973. "Dimensions of Truth", *Journal of Philosophical Logic* 2, pp. 535-556.

[Hen89] Hendriks, H., 1989. "Type Change in Semantics: the Scope of Quantification and Coordination", in E. Klein and J. van Benthem (eds.), *Categories, Polymorphism and Unification*, Universities of Edinburgh and Amsterdam.

[Hi62] Hintikka, J., 1962. *Knowledge and Belief*, Cornell University Press, Ithaca, N.Y.

[HSAM90] Hobbs, J., M. Stickel, D. Appelt, and P. Martin, 1990. *Interpretation as Abduction*, Technical Note 499, SRI International, Menlo Park, California.

[Ho69] Horn, L., 1969. "A Presuppositional Analysis of *Only* and *Even*", *Papers from the Fifth Regional Meeting of the Chicago Linguistics Society*, University of Chicago, pp. 98–107.

[Horn85] Horn, L., 1985. "Metalinguistic Negation and Pragmatic Ambiguity", Language 61, pp.121–174.

[Horn86] Horn, L., 1986. "Presupposition, Theme and Variations", *Papers from the Parasession on Pragmatics and Grammatical Theory (22^{nd} Regional Meeting of the Chicago Linguistics Society, Part 2)*, University of Chicago, pp. 168–192.

[Horn89] Horn, L., 1989. *A Natural History of Negation*, University of Chicago Press.

[Horn90] Horn, L., 1990. "Showdown at Truth-Value Gap: Burton-Roberts on Presupposition", *Journal of Linguistics* 26, pp. 483–503.

[Horn94] Horn, L., 1994. "Pragmatics, Implicature and Presupposition" in R. Asher and J. Simpson (eds.), *The Encyclopedia of Language and Linguistics*, Pergammon Press, Oxford.

[Hort87] Horton, D., 1987. *Incorporating Agents' Beliefs in a Model of Presupposition*, MSc Dissertation, University of Toronto. Available as *Technical Report CSRI-201*, Computer Systems Research Institute, University of Toronto.

[Ja84] Janssen, T., 1984. *Foundations and Applications of Montague Grammar*, PhD Dissertation, University of Amsterdam.

[Ja90] Janssen, T., 1990. "Models for Discourse Markers", in M. Stokhof and L. Torenvliet (eds.), *Proceedings of the Seventh Amsterdam Colloquium*, University of Amsterdam.

[Kad90] Kadmon, N., 1990. "Uniqueness", *Linguistics and Philosophy*, 13, pp. 273–324.

[Kal90] Kálmán, L., 1990. "Deferred Information: the Semantics of Commitment", in L. K'alm'an and L. P'olos (eds.) *Papers from the Second Symposium on Logic and Language*, Akadémiai Kiadó, Budapest.

[Kam81] Kamp, H., 1981. "A Theory of Truth and semantic Representation", in J. Groenendijk, T. Janssen and M. Stokhof (eds.), *Formal Methods in the Study of Language, Part 1*, Mathematical Centre Tracts 135, Amsterdam, pp. 277–322. Reprinted in J. Groenendijk, T. Janssen and M. Stokhof (eds.), 1984, *Truth, Interpretation, and Information; Selected Papers from the Third Amsterdam Colloquium*, Foris, Dordrecht, pp. 1–41.

[KRe93] Kamp, H. and U. Reyle, 1993. *From Discourse to Logic*, Dordrecht, Kluwer.

[KRo94] Kamp H. and A. Rossdeutscher, 1994. "DRS-Construction and Lexically Driven Inference", *Theoretical Linguistics* 20, pp. 165–235

[Kan93] Kanazawa, M., 1993. *Dynamic Generalized Quantifiers and Monotonicity*, report LP-93-02, University of Amsterdam

[Kar71] Karttunen, L., 1971. "Some Observations on Factivity", *Papers in Linguistics* 5, pp. 55–69

[Kar71] Karttunen, L., 1971. "Some Observations on Factivity", *Papers in Linguistics* 5, pp. 55–69.

[Kar73] Karttunen, L., 1973. "Presuppositions of Compound Sentences", *Linguistic Inquiry* 4, pp.167–193.

[Kar74] Karttunen, L., 1974. "Presuppositions and Linguistic Context", *Theoretical Linguistics* 1, pp. 181–194.

[Kar76] Karttunen, L., 1976. "Discourse Referents", in J. McCawley (ed.), *Syntax and Seman-*

tics 2: Notes from the Linguistic Underground, Academic Press, NY, pp. 363–385.

[KP77] Karttunen, L., and S. Peters, 1977. "Requiem for Presupposition", in *BLS3, Proceedings of the Third Annual Meeting of the Berkely Linguistic Society*, Berkely, California, pp. 266–278.

[KP79] Karttunen, L., and S. Peters, 1979. "Conventional Implicatures in Montague Grammar", in [O&D79], pp. 1–56.

[Kay92] Kay, P., 1992. "The Inheritance of Presuppositions", *Linguistics and Philosophy* 15 pp. 333–381.

[Kee71] Keenan, E., 1971. "Two Kinds of Presupposition in Natural Language", in C. Fillmore and D. Langendoen (eds.), *Studies in Linguistic Semantics*, Holt, Rinehart and Winston, New York, pp. 45–54.

[Kee92] Keenan, E., 1992. "Beyond the Frege Boundary", *Linguistics and Philosophy* 15, pp. 199–221.

[Kem75] Kempson, R., 1975. *Presupposition and the Delimitation of Semantics*, Cambridge, Cambridge University Press.

[Kem79] Kempson, R., 1979. "Presupposition, Opacity and Ambiguity", in [O&D79], pp. 283–297.

[KK70] Kiparsky, P. and C. Kiparsky, 1970. "Fact", in M. Bierwisch and K. Heidolph (eds.), em Progress in Linguistics, The Hague, Mouton, pp. 143-173. Also in [PF73], pp 315–354.

[Kl75] Klein, E., 1975. "Two Sorts of Factive Predicate", *Pragmatics Microfiche* 1.1, frames B5–C14.

[Krac90] Kracht, M., 1990. "Assertivity, Theme and Presupposition", in R. van der Sandt (ed.), *Reader for the Nijmegen Workshop on Presupposition, Lexical Meaning, and Discourse Processes*, University of Nijmegen.

[Krac94] Kracht, M., 1994. "Logic and Control: How They Determine the Behaviour of Presuppositions", in J. van Eijck and A. Visser (eds.), *Logic and Information Flow*, MIT Press, Cambridge, Massachusetts, pp. 89–111.

[Krah93] Krahmer, E., 1993. *Partial Dynamic Predicate Logic*, ITK Research Report No. 48, University of Tilburg.

[Krah94] Krahmer, E., 1994. "Partiality and Dynamics", in P. Dekker and M. Stokhof (eds.), *Proceedings of the Ninth Amsterdam Colloquium: Volume 2*, , University of Amsterdam, pp. 391–410.

[Krah:MS] Krahmer, E., ms. *Discourse and Presupposition: from the Man in the Street to the King of France*, Draft PhD Dissertation, University of Tilburg.

[Krau95] Krause, P., 1995. "Presupposition and Abduction in Type Theory", in E. Klein, S. Manandhar, W. Nutt and J. Siekmann (eds.), *Working Notes of the Edinburgh Conference on Computational Logic and Natural Language Processing*, Human Communications Research Centre, University of Edinburgh.

[Krif92] Krifka, M., 1992. "Presupposition and Focus in Dynamic Interpretation", *Journal of Semantics* 10.

[Krip72] Kripke, S., 1972. *Naming and Necessity*, Blackwell, Oxford.

[Krip:MS] Kripke, S., ms. *Presupposition and Anaphora: Remarks on the Formulation of the Projection Problem*, Princeton University.

[FvK75] Kutschera, F. von, 1975. "Partial Interpretations", in Keenan, E. (ed.), *Formal Semantics of Natural Language*, CUP, Cambridge.

[JvK91] Kuppelvelt, J. van, 1991. *Topic en Comment: Expliciete en Impliciete Vraagstelling in Discourse*, PhD Dissertation, University of Nijmegen.

[La81] Landman, F., 1981. "A Note on the Projection Problem", *Linguistic Inquiry* 12, pp. 467–471.

[La86] Landman, F., 1986. "Conflicting Presuppositions and Modal Subordination", *Papers from the 22^{nd} Regional Meeting, Chicago Linguistic Society*, University of Chicago, pp. 195–207.

[LS71] Langendoen, D. and Savin, H., 1971. "The Projection Problem for Presuppositions", in

C. Fillmore & D. Langendoen (eds.), *Studies in Linguistic Semantics* Holt, Reinhardt & Winston, New York. Also in [PF73], pp. 373–388.

[Le83] Levinson, S., 1983. *Pragmatics*, Cambridge University Press.

[Le79] Lewis, D., 1979. "Scorekeeping in a Language Game", *Journal of Philosophical Logic* 8, pp. 339–359. Also in R. Bäuerle, U. Egli, and A. von Stechow (eds.), 1979, *Semantics from Different Points of View*, Springer, Berlin.

[Li86] Link, G. 1986. "Prespie in Pragmatic Wonderland: or the Projection Problem for Presuppositions Revisited", in J. Groenendijk, D. de Jongh and M. Stokhof (eds.), *Foundations of Pragmatics and Lexical Semantics*, Foris, Dordrecht, pp. 101-126.

[Lo92] Lorenz, S., 1992. *On the Role of Reasoning About Change in the Projection of Presuppositions*, IWBS Report 234, IBM Germany.

[Ma94] Marcu, D., 1994. *A Formalisation and an Algorithm for Computing Pragmatic Inferences and Detecting Infelicities*, PhD Dissertation, University of Toronto. Available as *Technical Report CSRI-309*, Computer Systems Research Institute, University of Toronto.

[Ma77] Martin, J., 1977. "An Axiomatisation of Herzberger's Two-dimensional Presuppositional Semantics", *Notre Dame Journal of Formal Logic* 18, pp. 378–382.

[Ma79] Martin, J., 1979. "Some Misconceptions in the Critique of Semantic Presupposition", *Theoretical Linguistics* 6, pp. 235–282.

[Me87] Mercer, R., 1987. *A Default Logic Approach to the Derivation of Natural Language Presuppositions*, PhD Dissertation, University of British Columbia.

[Me92] Mercer, R., 1992. "Default Logic: Towards a Common Logical Semantics for Presupposition and Entailment", *Journal of Semantics* 9, pp. 223–250.

[MS88] Moens, M. and M. Steedman, 1988. "Temporal Ontology and Temporal Reference", *Computational Linguistics* 14/2, pp. 15–29.

[Mo74a] Montague, R., 1974. *Formal Philosophy: Selected Papers*, Thomason, R. (ed.), Yale University Press, Newhaven.

[Mo74b] Montague, R., "The Proper Treatment of Quantification", in [Mo74a].

[Morr95] Morreau, M., 1995. "How to Derive Conveyed Meanings", in E. Klein, S. Manandhar, W. Nutt and J. Siekmann (eds.), *Working Notes of the Edinburgh Conference on Computational Logic and Natural Language Processing*, Human Communications Research Centre, University of Edinburgh.

[Morg69] Morgan, J., 1969. "On the Treatment of Presupposition in Transformational Grammar", in *Papers from the Fifth Regional Meeting, Chicago Linguistic Society*, University of Chicago, pp 167–77. Also in [PF73], pp. 373–88.

[Mul45] Mullally, J., 1945. *The Summulae Logicales of Peter of Spain*, Notre Dame Publications in Mediaeval Studies, Notre Dame, Indiana.

[McC79] McCawley, J., 1979. "Presupposition and Discourse Structure", in [O&D79], pp. 371–388.

[Mus89] Muskens, R., 1989. *Meaning and Partiality*, PhD Dissertation, University of Amsterdam

[Mus90] Muskens, R., 1990. "Anaphora and the Logic of Change", in J. van Eicjk (ed.), *JELIA'90*.

[Ne90] Neale, S., 1990. *Descriptions*, MIT Press.

[O&D79] Oh, C. and Dineen, D. (eds.), 1979. *Syntax and Semantics 11: Presupposition*, Academic Press, NY.

[Pe77] Peters, S., 1977. "A Truth-Conditional Formulation of Karttunen's Account of Presupposition", *Texas Linguistic Forum* 6, University of Texas at Austin.

[PF73] Petöfi, J. and Franck, D. (eds.), *Präsuppositionen in Philosophie und Linguistik/ Presuppositions in Philosophy and Linguistics*, Athanäum Verlag, Frankfurt.

[Pri78] Prince, E. "The function of Existential Sentences in Discourse", in *Papers from the 14th Regional Meeting, Chicago Linguistic Society*, University of Chicago, pp. 362–376.

[Reic47] Reichenbach, H., 1947. *Elements of Symbolic Logic*, Dover Press.

[Rein82] Reinhart, T., 1982. "Pragmatics and Linguistics: An Analysis of Sentence Topics", *Philosophica* 27, pp. 53–94.

[Rob87] Roberts, C., 1987. *Modal Subordination, Anaphora and Distributivity*, PhD. Dissertation, University of Massachusetts at Amherst.

[Roo87] Rooth, M., 1987. "Noun Phrase Interpretation in Montague Grammar, File Change Semantics, and Situation Semantics", in P. Gardënfors (ed.) *Generalized Quantifiers*, Reidel, Dordrecht

[Ros94] Rossdeutscher, A., 1994. "Fat Child Meets DRT. A Semantic Representation for the Opening Lines of Kaschnitz' 'Das dicke Kind' ", *Theoretical Linguistics* 20, pp.237–305.

[Ru05] Russell, B., 1905. "On Denoting", *Mind* 14, pp. 479–493.

[Ru46] Russell, B., 1946. *The History of Western Philosophy*, Allen and Unwin, London. (Page numbers in text refer to Counterpoint edition, Unwin, 1985.)

[Ru57] Russell, B., 1957. "Mr. Strawson on Referring", *Mind* 66, pp. 385–389.

[Sa94] Sæbø, K., 1994. "Anaphoric Presuppositions, Accommodation, and Zero Anaphora" in H. Kamp (ed.), deliverable R2.2A *Presupposition*, University of Amsterdam.

[SWZ94] Sanchez Valencia, V., T. van der Wouden and F. Zwarts, 1994. "Polarity, Veridicality and Temporal Connectives", in P. Dekker and M. Stokhof (eds.), *Proceedings of the Ninth Amsterdam Colloquium: Volume 3*, , University of Amsterdam, pp. 587–606.

[vdS82] Sandt, R. van der, 1982. *Kontekst en Presuppositie: Een Studie van het Projektieprobleem en de Presuppositionele Eigenschappen van de Logisch Konnektieven*, PhD Dissertation, Nijmegen Institute of Semantics.

[vdS88] Sandt, R. van der, 1988. *Context and Presupposition*, Croom Helm, London

[vdS89] Sandt, R. van der, 1989. "Anaphora and Accommodation", in R. Bartsch, J. van Benthem and P. van Emde Boas (eds.), *Semantics and Contextual Expression*, Foris, Dordrecht.

[vdS91] Sandt, R. van der, 1991. "Denial", *Chicago Linguistic Society II: Papers from the Parasession on Negation*, University of Chicago.

[vdS92] Sandt, R. van der, 1992. "Presupposition Projection as Anaphora Resolution", *Journal of Semantics* 9, pp. 333–377.

[vdS:MS] Sandt, R. van der, ms. *Discourse Systems and Echo-Quotation*, to appear in Linguistics and Philosophy.

[SG91] Sandt, R. van der, and B. Geurts, 1991. "Presupposition, Anaphora and Lexical Content", in O. Herzog and C. Rollinger (eds.), *Text Understanding in LiLOG*, Springer, Berlin.

[Schi79] Schiebe, T., 1979. "On Presupposition in Complex Sentences", in [O&D79], pp. 127–154.

[Schö95] Schöter, A., 1994. *Evidential Bilattice Logic and Lexical Inference*, Technical Report EUCCS/RP-64, Centre for Cognitive Science, University of Edinburgh.

[Schö:MS] Schöter, A. ms. *The Computational Application of Bilattice Logic to Natural Reasoning*, Draft PhD Dissertation, University of Edinburgh.

[Sea:69] Searle, J., 1969. *Speech Acts: An Essay in the Philosophy of Language*, Cambridge University Press.

[Seu:MS] Seuren, P., ms., 1979. *The Logic of Presupposition*, University of Nijmegen.

[Seu85] Seuren, P., 1985. *Discourse Semantics*, Blackwell, Oxford.

[Seu88] Seuren, P., "Presupposition and Negation", *Journal of Semantics* 6, pp. 175–226

[Seu90a] Seuren, P., 1990. "Burton-Roberts on Presupposition and Negation", *Jornal of Linguistics* 26, pp. 425–453.

[Seu90b] Seuren, P., 1990. "Review Article: The Limits to Debate, Noel Burton Roberts", *Linguistics* 28, pp. 503–516.

[Seu91] Seuren, P., 1991. "Präsuppositionen", in D. Wunderlich and A. von Stechow (eds.), *Semantik: Ein Internationales Handbuch der zeitgenössichen Forschung/Semantics: An International Handbook of Contemporary Research.*, Walter de Gruyter, Berlin/NY, pp.287–318.

[Sg:MS] Sgall, P., ms, 1995. *Presupposition of Existence and of Uniqueness, and Allegation*,

Charles University, Prague.
[SHB73] Sgall, P., E. Hajičová and E. Benešová, 1973. *Topic, Focus and Generative Semantics*, Scriptor Verlag, Kronberg.
[So79] Soames, S., 1979. "A Projection Problem for Speaker Presuppositions", *Linguistic Inquiry* 10, pp. 623–666.
[So82] Soames, S., 1982. "How Presuppositions are Inherited: a Solution to the Projection Problem", *Linguistic Inquiry* 13, pp. 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 D. Wilson, 1984. *Relevance: Communication and Cognition*, Basil Blackwell, Oxford; Harvard University Press, Cambridge, Massachusetts.
[St72] Stalnaker, R., 1972. "Pragmatics", in D. Davidson and G. Harman (eds.) *Semantics of Natural Language*, Dordrecht, Reidel. Also in [PF73], pp. 389–408. Pagenumbers in text refer to [PF73] version.
[St73] Stalnaker, R., 1973. "Presuppositions", *The Journal of Philosophical Logic* 2, pp. 447–457.
[St74] Stalnaker, R., 1974. "Pragmatic Presuppositions", in M. Munitz and P. Unger, (eds.) *Semantics and Philosophy*, New York University Press, pp. 197–214.
[St79] Stalnaker, R., 1979. "Assertion", in P. Cole (ed.) *Syntax and Semantics 9*, Academic Press, London.
[St50] Strawson, P., 1950. "Referring", *Mind* 59, pp. 320–44.
[St64] Strawson, P., 1964. "Identifying Reference and Truth Values", *Theoria* XXX.
[Th72] Thomason, R., 1972. "A Semantic Theory of Sortal Incorrectness", *Journal of Philosophical Logic* 1, pp. 209–258.
[Th79] Thomason, R., 1979. "Truth-Value Gaps, Many Truth Values, and Possible Worlds", in [O&D79], pp. 357–369.
[Tu92] Turner, K., 1992. "Defending Semantic Presupposition", *Journal of Pragmatics* 18, pp. 345–371.
[Ve86] Veltman, F., 1986. "Data Semantics and the Pragmatics of Indicative Conditionals", in E. Traugott, A. ter Meulen, Reilly and Ferguson (eds.), *On Conditionals*, Cambridge University Press.
[Ve91] Veltman, F., 1991. *Defaults in Update Semantics*, in deliverable R2.5.C. To appear in: Journal of Philosophical Logic.
[Ver93] Vermeulen C., 1992. "Sequence Semantics for Dynamic Predicate Logic", *Journal of Logic, Language and Information* 2, pp. 217–254.
[Wi75] Wilson, D., 1975. *Presupposition and Non-truth-conditional Semantics*, Academic Press, London.
[WS79] Wilson, D. and D. Sperber, 1979. "Ordered Entailments: An Alternative to Presuppositional Theories", in [O&D79], pp. 299–323.
[Ze91] Zeevat, H., 1991. *Aspects of Discourse Semantics and Unification Grammar*, Ph.D. Dissertation, University of Amsterdam
[Ze92] Zeevat, H., 1992. "Presupposition and Accommodation in Update Semantics", *Journal of Semantics* 9, pp. 379–412.