

Incorporating Agents' Beliefs
in a Model of Presupposition

by

Diane Lynn Horton

Department of Computer Science
University of Toronto
Toronto, Ontario, Canada
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Abstract

The full communicative content of an utterance consists of its direct meaning, as well as a variety of indirect information which can be inferred from the utterance. Presupposition is one category of such information.

Many theories of presupposition have been postulated. Most implicitly assume that presuppositions are facts, and that all agents involved in a discourse share knowledge of the presuppositions that it generates. We argue that these assumptions are unrealistic and propose a new view which eliminates them by considering presuppositions to be beliefs associated with particular agents. We then develop a definition of presupposition which embodies this view. We conclude that a model of presupposition which incorporates agents' beliefs, in addition to being more correct, is able to account for presuppositional phenomena which could not be accounted for otherwise.

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Chapter 1

Introduction

Any natural language understanding system that is intended to be capable of discerning the full meaning of utterances must be able to handle not only the information directly conveyed by an utterance, but also a variety of indirect information. Presupposition is one category of such information.

Many theories have been postulated which attempt to characterize presupposition. One common problem among existing theories is that they take presuppositions to be facts, and implicitly assume that all involved agents share knowledge of them. That is, for any given presupposition, they do not consider who it is that holds the presupposition to be true. We will propose an alternative approach which considers all presuppositions to be beliefs explicitly associated with particular agents, rather than facts. We will argue that this approach provides a more realistic, detailed, and robust account of this important phenomenon.

This chapter is intended to give a purely descriptive account of what presupposition is — an account which will provide enough intuition to motivate this work. As our approach is presented, we will attempt to formalize the somewhat vague notions used in this chapter.

1.1 The Communicative Content of Utterances

The communicative content of an utterance consists of the proposition directly expressed, as well as a host of other information which may be inferred from the utterance, including entailments, conversational implicatures, conventional implicatures, and presuppositions. While the inference of interest to us here is presupposition, understanding something of the others will make it possible to distinguish presupposition from them. We now give a brief description and example for each.

In the context of computational linguistics, an **entailment**, written “ \models ”, is a logical inference which can be drawn from the propositional content of a sentence or utterance. For example,

- (1) John got a higher mark than Fred, and Fred got a higher mark than Rick.
 \models John got a higher mark than Rick.

Conversational implicatures, which will be denoted by the symbol “ \rightarrow ”, are

related to general principles of cooperative interaction which were described by Grice. He defined a general **co-operative principle** which operates in normal conversation and broke this principle down into several specific maxims. These have come to be known as the **Gricean Maxims of Conversation**. The following is a summary of the maxims, abbreviated from that in [Levinson 1983, 101]:

- Maxim of Quality: Try to say only that which is true, or for which you have adequate evidence.
- Maxim of Quantity: Be as informative as is required, but not more.
- Maxim of Relevance: Say only things that are relevant.
- Maxim of Manner: Be perspicuous.

Conversational Implicatures are inferences which can be made with the help of these principles.

In the event of ... an apparent violation of the co-operative principle and maxims, hearers are expected to make any additional assumptions needed to dispose of the violation ... Grice calls additional assumptions and conclusions ... supplied to preserve the application of the co-operative principle and maxims, *implicatures* [Sperber and Wilson 1986, 35].

For example,

- (2) We had seven articles of mail today.
- (3) →We had only seven articles of mail today.

Although Sentence 2 would not be incorrect in a situation where eight articles of mail arrived, it would certainly be misleading. Grice's Maxim of Quantity captures the principle which would be violated and it can be the basis of an argument that leads one to conclude 3.

Conversational Implicatures can be divided into two subcategories. **Generalized conversational implicatures** are those which do not require any particular context in order to be valid. The example above falls into this group. **Particularized conversational implicatures** are only valid in a particular context. For example, Sentence 5 is not a generalized conversational implicature of 4 since it is not generally valid.

- (4) The dog looks happy.
- (5) Perhaps the dog ate the roast beef.

However, the utterance of 4 in response to Sentence 6 would only be reasonable if 5 were true.

- (6) Where on earth is the roast beef?

Hence, 5 is a particularized conversational implicature of Sentence 4 if Sentence 6 is the context. This is supported by the Maxim of Relevance.

There is another type of implicature called **conventional implicature**, which will be denoted by “>”. This is an inference which does not require an appeal to any conversational principles in order to be justified. It is simply conventionally associated with lexical items. For example, such an implicature is associated with the word “*even*”:

- (7) Even Ben can read that book.
 >Ben is not likely to be able to read that book.

We now come to presupposition, which we mark using “>>”. Roughly, presuppositions are

propositions which the sentences are not primarily about but which have to be established prior to utterances of the sentences in order for communication to go smoothly [Karttunen and Peters 1979, 1].

For example,

- (8) Diane is happy that she didn’t waste time today.
 >>Diane didn’t waste time today.

Actually, the requirement that they be “*established prior to utterances*” is too strong, for presuppositions can be used to introduce new information as in the following example:

- (9) Sorry I’m late Mike, but I got carried away with waxing my new Porsche.
 >>I have a new Porsche.

For now, we will just say that a presupposition must be consistent with established information.

There are two important features of presuppositional phenomena. First, if a presupposition is *not* consistent with established information, an infelicity results. Consider the following:

- (10) Have some wine.
 (11) >>There is some wine.

The utterance of Sentence 10 would be infelicitous if 11 were not consistent with established information, as in the following exchange¹:

“Have some wine,” the March Hare said in an encouraging tone.

Alice looked all round the table but there was nothing on it but tea. “I don’t see any wine,” she remarked.

“There isn’t any,” said the March Hare.

“Then it wasn’t very civil of you to offer it,” said Alice angrily.

¹Lewis Carroll, *Alice’s Adventures in Wonderland*, Purnell Books, 1975, p. 59.

Source	Example
Factive Verb	<i>Diane is thrilled that she was accepted.</i> \gg <i>She was accepted.</i>
It-cleft	<i>It was John who married Margaret.</i> \gg <i>Someone married Margaret.</i>
Change-of-State Verb	<i>Tom finished making dinner.</i> \gg <i>Tom had been making dinner.</i>
Non-Restrictive Relative Clause	<i>Kerry, who is Jay's son, was married last month.</i> \gg <i>Kerry is Jay's son.</i>
Implicative Verb	<i>Mom forgot to call.</i> \gg <i>Mom intended to call.</i>
Definite Description	<i>The Soviet high-wire defectors are on t.v.</i> \gg <i>There are Soviet high-wire defectors.</i>
Verb of Judging	<i>I congratulated Lois when she finished her thesis.</i> \gg <i>For Lois to finish her thesis was a good thing.</i>

Table 1.1: Some common sources of presupposition, with examples

Hence, 11 satisfies the first aspect of being a presupposition for 10. The second attribute of presuppositions is that they are background assumptions, as opposed to being the main point of an utterance. Since Sentence 13 does not satisfy this criterion with respect to Sentence 12 it is not a presupposition of 14 even though it must be true for smooth communication. Sentence 14 however, is a presupposition of 12.

(12) On Wednesday, Tom stopped going to ballroom dancing classes.

(13) $\not\gg$ Tom is no longer going to ballroom dancing classes.

(14) \gg Tom had been going to ballroom dancing classes.

Table 1.1 gives a list of some prototypical sources of presupposition and their traditional analyses. These will be drawn upon in the example sentences to follow. Chapter 4 will provide a more complete enumeration as well as our analysis, which differs from that presented in the table.

1.2 Properties of the Inferences

We now have some idea of the inferences which make up the total communicative content of an utterance; however, the distinctions between them are not clear. This section attempts to justify the classification of the inferences into the classes of entailment, conventional implicature, generalized and particularized conversational implicature, and presupposition by showing that the inferences can be distinguished from each other by a few properties. It also attempts to provide the reader with a better understanding of the inferences.

1.2.1 Behaviour Under Negation

The behaviour of presupposition under negation is its most notable property. In fact, we will show that this behaviour alone is sufficient to distinguish presuppositions from the other classes of inference.

When a sentence is negated, its presuppositions are *usually* not affected. In the following example, the presupposition holds regardless of whether or not the first sentence is negated.

(15) I [do not] regret that I joined the team. \gg I joined the team.

This property is commonly called **constancy under negation**. However, presuppositions of a positive sentence do not always hold in a corresponding negated sentence. For example, the sentence *John stopped beating his wife* presupposes that *John had been beating his wife*, but in Example 16 the presupposition does not hold.

(16) John didn't stop beating his wife — he never beat her! $\not\gg$ John had been beating his wife.

The usual analysis of such examples is that the presupposition *John had been beating his wife* remains constant under the negation in *John didn't stop beating his wife*, but is later cancelled or defeated by the clause *he never beat her*. Presuppositions are thus said to be **defeasible**.

Our analysis of such examples is slightly different. Notice that the examples of presupposition cancellation always involve a sentence which is negated. We claim that this is not a coincidence; rather, in a positive sentence, an attempt to defeat a presupposition always results in an infelicity like the one below:

(17) * It was Tom who made dinner, but no one did.

Since the existence of negation is the only necessary condition for cancellation of a presupposition, we conclude that it is the negation, not the contradictory contextual information, which actually does the cancelling. By our view then, presuppositions are not constant under negation. Of course, we must still explain the phenomena, demonstrated by Examples 15 and 16 above, whereby presuppositions sometimes do and sometimes do not survive negation. To this we now turn.

Terminology

We must first introduce some terminology regarding the syntactic and semantic complexities of negation. Unfortunately, the same terms have been used in different ways by different authors. We will present the nomenclature we choose, as well as its relation to that used by some others.

Quirk and Greenbaum define one syntactic feature of a negative form, its **scope**, as the part of a sentence which is governed by the negative element [Quirk and Greenbaum 1973, 187]. The **focus** of a negative form, however, is a semantic feature. It indicates where the contrast of meaning is located, and must fall within the scope of the negative form [Quirk and Greenbaum 1973, 188]. Huddleston uses the term **syntactic domain**

for Quirk’s scope, and **scope** for Quirk’s focus [Huddleston 1984, 428]. We adopt the Quirk terminology. The scope and the focus of a negative element can be difficult to pinpoint. However, contrastive stress can be used to locate the focus and, since the scope must include the focus, stress can place bounds on the scope.

The above terminology can be used to draw a distinction between two ways in which negation is used. Recall that the information conveyed by an utterance consists of the proposition expressed directly and, possibly, some other indirect information, such as a presupposition. We use the term **internal negation** to denote negation whose focus is a particular element of this set of information, usually the main proposition, and **external negation** for negation whose focus may be any element of the set². For example, Sentence 18 contains internal negation (acting upon the main proposition), while the negation in 19 is external:

(18) Julie, who lived with me at Western, isn’t in London now.

(19) It’s not true that the boogiemán blew the door shut.

The truth condition for a negative is that “the set of conditions for the truth of the positive . . . is not satisfied . . . A negative does not indicate where the failure lies” [Huddleston 1984, 432]. So for sentences which express more than just a single direct proposition, external negation is ambiguous between several possible interpretations. Sentence 19, for example, has at least three interpretations:

- (20) It’s not true that the boogiemán blew the door shut, . . .
- (a) it’s still open. (*negating the main proposition*)
 - (b) there is no boogiemán! (*negating a presupposition*)
 - (c) the door was already shut. (*negating a felicity condition*)

We call this sort of semantic ambiguity **vagueness**.

With the appropriate distinctions and terminology established, we now present our view of the behaviour of presupposition under negation.

Our View

It is generally agreed that presuppositions “tend to” or “usually” survive negation. In order to be more precise, internal and external negation must be considered separately.

In the case of semantically internal negation, the focus of negation is unambiguous, by definition. If that focus is on a presupposition, the presupposition clearly does not survive the negation, as in the following³:

(21) Meryl Streep, who played Sophie, is a good actress. \gg Meryl Streep played Sophie.

²This use of the terms internal and external negation is roughly equivalent to Russell’s narrow and wide scope negation. Russell’s logical form “allows (at least) two slots for negation to capture this ambiguity: negation either occurs with wide scope . . . or with narrow scope” [Levinson 1983, 171].

³Examples such as this one are rare. In fact, this sentence structure — with a non-restrictive relative clause containing negation — is the only one we have found that has internal negation acting upon a presupposition.

- (22) Meryl Streep, who didn't play Sophie, is a good actress. $\not\Rightarrow$ Meryl Streep played Sophie.

Internal negation that focuses on anything other than a presupposition does not affect that presupposition. This is simply because presuppositions do not depend on the truth of the main proposition or of any other thing expressed by a sentence. Usually, the focus of internal negation is the main proposition expressed by the sentence. In such cases, as many examples have shown, they survive the negation. If a sentence has internal negation which does not act on the main proposition or on a presupposition, then the presuppositions of that sentence survive the negation as well. For example, the presupposition of Sentence 23 still holds in 24, where a conversational implicature is negated.

- (23) Some of my cousins went to the family reunion last September. \Rightarrow There was a family reunion last September.
- (24) It's not true that SOME of my cousins went to the family reunion last September — all of them did. \Rightarrow There was a family reunion last September.

When semantically external negation occurs, with its inherent vagueness, one cannot be sure whether the proposition, a presupposition, or some other indirect information, is being negated. The boogieman Sentence, 19, displays such vagueness. We claim that semantically external negation is dealt with as follows. One first notes whether or not there is any evidence favoring one or another of the interpretations. If a presupposition of the sentence contradicts any established information, then there would be a contradiction in believing both the established information and the presupposition. This is the case in the following example:

- (25) *Joe* : Did John manage to pass the exam?

Fred : John didn't have to struggle with the material. So no, he didn't **MANAGE** to pass.

$\not\Rightarrow$ For John to pass was difficult.

The potential contradiction provides evidence favouring the reading that negates the presuppositions, and one assumes that this was the intended reading; hence the presupposition is never asserted. We will call this **blocking** of presuppositions. In the absence of any evidence to guide one in choosing an interpretation, we argue that one does not maintain all the possible readings in one's mind. Rather, one assumes, by default, that negation of the main proposition was intended, and hence that the presupposition stands. This assumption might be either supported or proven incorrect by information to follow. If it is proven wrong, then the incorrect presupposition must be **retracted**. For example, the reader of

- (26) I don't wish I had a Porsche.

would assume the intended reading was that *I don't have a Porsche, and I don't want one*. If it were followed by

(27) I already have one.

the presupposition that *I don't have a Porsche* would have to be retracted.

In summary, a presupposition cannot be defeated (by blocking or retraction) in a positive sentence. In negative sentences, presuppositions behave as follows. A presupposition always survives semantically internal negation that does not focus on the presupposition. It is assumed to survive semantically external negation unless there is evidence to the contrary, in which case it is blocked. If a presupposition of a sentence with external negation is *not* blocked, it may be retracted later if the assumption is shown to be incorrect by evidence that follows.

The Other Inference Classes

We now consider how the other inference classes behave under negation. Here lies the most important distinction between presupposition and the other inferences. Presuppositions are background assumptions, not directly related to the main proposition. Hence, when any element of the sentence's full meaning is negated or assumed to be negated, all presuppositions of the sentence are unaffected. The other inferences, however, *are* directly related to the main proposition, and rely on its truth for their justification. With internal negation that acts upon the main proposition, then, in contrast to presupposition, these inferences do not survive. With external negation, the assumption that the main verb was the intended target of negation also implies that these inferences do not survive. The examples below support this argument.

We have been unable to find sentences which carry entailments, conversational implicatures, or conventional implicatures, for which the semantic classification of negation as external or internal is clear. However, the following examples, each of which uses several syntactic forms of negation, provide evidence of the defeasibility of these inferences under both semantic forms of negation.

(28) Susan has two children.

\models Susan has one child.

(29) Susan doesn't have two children OR It is not true that Susan has two children.

$\not\models$ Susan has one child.

(30) The flag is red and white.

\rightarrow The flag is only red and white.

(31) The flag is not red and white OR It is not true that the flag is red and white.

$\not\rightarrow$ The flag is only red and white.

(32) Even John likes Mary.

\succ John isn't likely to like Mary.

(33) Even John doesn't like Mary OR It is not true that even John likes Mary OR Not even John likes Mary.

$\not\succeq$ John isn't likely to like Mary.

The presuppositions of a sentence are not dependent upon the truth of the main proposition expressed by that sentence. This is their hallmark property. It distinguishes them from all other inference classes. The behaviour of presuppositions under negation is a manifestation of this property, and can be used practically to make the distinction between presuppositions and the other inference classes. The definition of presuppositions which is developed in Chapter 4 relies crucially on this fact.

One final observation is relevant to this section. It was noted earlier that presuppositions cannot be defeated in positive sentences. Conversational implicatures, in fact, can. For example, the first clause of Sentence 34 conversationally implicates 35, but when the second is included the implicature is cancelled.

(34) Some of the boys went, in fact all of them did.

(35) \nrightarrow Not all of the boys went.

This property distinguishes conversational implicature from all the other inference classes, including presupposition, since conversational implicatures are the only inferences that allow cancellation in positive sentences. If the usual conventional implicature of a sentence such as 36 is denied, an infelicitous sentence results.

(36) I flicked the switch; therefore the light came on.

(37) \rightarrow Flicking the switch was the cause of the light coming on.

(38) * I flicked the switch, therefore the light came on, but flicking the switch was not the cause of the light coming on.

The denial of an entailment also results in an infelicity, as illustrated below:

(39) Susan has two children.
|= Susan has at least one child.

(40) * Susan has two children, but she doesn't have at least one.

1.2.2 Triggering

Every presuppositional inference is caused by a certain lexical item (such as “*regrets*”) or syntactic construct (such as a cleft structure). Levinson [1983, p. 171] calls these words and structures **triggers** for the presuppositions associated with them.

Recall that those implicatures which have become conventionally associated with particular lexical items are called conventional implicatures; the rest are called conversational. So by definition, conventional implicatures are triggered, but conversational implicatures are not.

Entailments are sometimes indicated by a lexical item or syntactic structure. For example, the number “*thirty*” indicates an entailment involving “*some*”, as follows:

(41) Thirty people visited the museum today.
|= Some people visited the museum today.

However, for many entailments, including the following, a simple trigger does not exist.

- (42) Ron is taller than Peter, and Peter towers over me.
 \models Ron is taller than me.

We conclude that entailments are not always triggered.

1.2.3 Effect of Embedding

Langendoen and Savin suggested that the presuppositions of a compound sentence are simply the sum of the presuppositions of its parts [Levinson 1983, 191]. If this idea were applied to Sentence 43, the presupposition 44 of the first clause would automatically become a presupposition of the whole sentence. Yet, this cannot be true, since it is overtly denied later by the second clause.

- (43) Gerhard didn't remember that Margot's birthday is today, because he knows that it was yesterday.
 (44) $\not\models$ Margot's birthday is today.

Hence, the summation idea for presuppositions is inadequate.

It is still hoped that a method for determining the presuppositions of a sentence from the presuppositions of its parts can be found. This task has been termed **the projection problem**. Schiebe expressed it well by asking "how are the presuppositions of a complex sentence determined by relevant characteristics of the presuppositional constructions that it contains?" [Schiebe 1979, 129]. We shall use the term **first-order presupposition** to denote presuppositions of simple sentences for which projection is not an issue, and **higher-order presupposition** for presuppositions which arise from the constituents of complex sentences. For example, 47 is a first-order presupposition of 45, but it is a higher-order presupposition of 46 because, in this sentence, it must project over the *if-then* environment.

- (45) I'll be sorry that I left.
 (46) If he shows up, then I'll be sorry that I left.
 (47) \gg I left

To illustrate the complexity of the projection problem, consider conditional sentences. In Sentence 48, the presupposition, 49, of the *then*-clause is also a presupposition of the whole sentence.

- (48) If Ehrlich says something insensitive, then Dr. Craig will be angry again.
 (49) \gg Dr. Craig was angry before.

However, the presupposition, 51, of the *then*-clause in Sentence 50 does *not* become a presupposition of the entire sentence.

(50) If Susan has three children, then her three children can get in for half price.

(51) $\not\gg$ Susan has three children.

Clearly, some other factor is involved, at least for conditional sentences.

Inferences from all of the other classes appear to be affected by embedding as well. The following examples illustrate this fact for entailment and conversational implicature.

(52) He has two sons.
 \models He has one son.

(53) If he has two sons, he can get a discount.
 $\not\models$ He has one son.

(54) Some of them went.
 \rightarrow Not all of them went.

(55) Either some of them went, or all of them went.
 $\not\rightarrow$ Not all of them went.

It is difficult to illustrate the effect of embedding on conventional implicature because the interpretation of embedded forms of sentences with conventional implicatures is not always clear. But since it has already been shown that they are not constant under negation, we can conclude that conventional implicatures are affected by at least one embedding context.

1.2.4 Detachability from Semantics

An inference class is **non-detachable** from semantics if no matter how the surface structure of a sentence is changed, as long as its semantics remain the same so will its inferences of this class. This is true of conversational implicatures and entailments. It may appear also to be the case for presuppositions, but we will argue that this view is incorrect. Consider sentences 56, 58, and 60 which all convey the same direct information – that two of George’s three sons attended Western. Because of this, they share conversational implicature 62 and entailment 63. However, the presuppositions of these sentences vary.

(56) Western is the university that two of George’s three sons attended.

(57) \gg Two of George’s three sons attended some university.

(58) It is two of George’s three sons that attended Western.

(59) \gg Some number of George’s three sons went to Western.

(60) Two of George’s three sons attended Western.

(61) \gg (no similar presupposition)

(62) \rightarrow George’s third son didn’t attend Western.

(63) \models One of George’s sons attended Western.

So if Sentences 56, 58 and 60 are assumed to have the same semantics, we have an example of detachability from semantics for presupposition. However, this assumption is far from clear. The issue of detachability from semantics depends critically upon what is included in the semantics. Atlas and Levinson [1981] attempt to provide an enhanced semantic representation which includes all information necessary to generate presuppositions (see section 2.2.6). If successful, this would render presuppositions *non*-detachable from their semantic representation. In fact, it is very difficult to find rephrasings of sentences which maintain the semantics but change presuppositions. It appears that the only way to do so is to introduce a cleft structure. We believe, as do Atlas and Levinson, that a cleft structure sufficiently changes the meaning of a sentence that the resulting sentence cannot be considered semantically equivalent to the original one. So although one can rephrase a sentence by using a cleft structure and change its presuppositions, this does not provide evidence for detachability from semantics. Hence, we conclude that presuppositions are non-detachable from semantics.

Conventional implicature is the only class which may have the detachability property. For example, Sentence 64 conventionally implicates 65, but Sentence 66 does not, although it *might* be considered to have the same semantics.

(64) Even John likes Mary.

(65) \succ John isn’t likely to like Mary.

(66) John likes Mary.

Of course, labelling conventional implicature as detachable from semantics also depends upon whether or not sentences like 64 and 66 are actually considered semantically equivalent. That is, the question of detachability for conventional implicatures cannot be resolved until it is decided whether or not their triggers belong in a semantic representation. This is an open question.

1.2.5 Summary of the Properties

The behavior of each type of inference is summarized in Table 1.2. This shows that conversational and conventional implicature, entailment, and presupposition can be distinguished from each other by their behaviour with respect to these properties. In order to single out presupposition, only the properties related to behaviour under negation are required.

1.3 “Real World” Examples

Table 1.2 has given some indication of the prevalence of presuppositions in everyday language. As further motivation for this work, we now give actual examples of some interesting uses of presupposition from two very different domains — television advertising and courtroom cross-examination.

Property	Presupposition	Entailment	Conversational Implicature	Conventional Implicature
Constant under semantically internal negation, acting on main proposition	yes	no	no	no
Constant under semantically external negation	assumed yes	assumed no	assumed no	assumed no
Defeasible in positive sentences	no	no	yes	no
Triggered	yes	no	no	yes
Affected by embedding	yes	yes	yes	yes
Detachable from semantics	? no	no	no	? no

Table 1.2: Important properties of the inferences

Geis argues that

the primary virtues of conveying information indirectly are, first, that indirectly conveyed propositions are rarely defended in ordinary conversation and thus advertisers are under no pressure to defend them in their advertising and, second, that indirectly conveyed propositions are perceptually less salient than asserted propositions and will less likely stimulate consumer cognitive defenses [Geis 1982, 19].

Advertisers make frequent use of this technique to present information as if it were uncontroversial, and to take the onus off themselves to defend it. The following commercials, documented in [Geis 1982, 43], illustrate this fact:

- (67) We’re about to find out orange juice from Florida isn’t just for breakfast anymore.
 »Orange juice from Florida isn’t just for breakfast anymore.
- (68) No matter how much you relax, this [J.C. Penney’s] shirt will stay looking neat and crisp because the outside is all polyester.
 »This J.C. Penney’s shirt looks neat and crisp.
- (69) This Atra face-hugging action keeps twin blades at the perfect angle.
 »Atra twin blades are at the perfect angle.

Indirect presentation of information is also commonly used to de-emphasize information which the advertiser must present, but does not want the consumer to take great notice of. The following example is from a commercial for a children’s toy [Geis 1982, 178]:

- (70) Two 9-volt and two D batteries not included provide the power.
 »Two 9-volt and two D batteries are not included.

These same features of presenting information indirectly can be used, sometimes dishonorably, in cross-examination. By putting information in the background, it is possible to get a witness to agree to, or imply, the truth of something which he would not have otherwise.

It is easy to produce evidence that varies very widely from the exact truth. This is often done by overzealous practitioners by putting leading questions or by incorporating two questions into one, the second a simple one, misleading the witness into a “yes” for both, and thus creating an entirely false impression [Wellman 1903, 176].

The classic example of this is the question:

(71) Have you stopped beating your wife?

Either a positive or negative direct answer would presuppose that the witness had been beating his wife.

The fact that indirectly expressed information appears uncontroversial also presents interesting opportunities to the cross-examiner, as illustrated by the following anecdote [Wellman 1903, 126–7]. In this case, a physician was called to give expert testimony for the plaintiff. By using sentences which presuppose the existence of fictitious books and articles (rather than explicitly claiming or questioning this), counsel managed to trick the witness into believing that they do exist, thereby putting his entire “expert” testimony under question.

The plaintiff’s doctor was a loquacious gentleman of considerable personal presence. He testified to a serious head injury, and proceeded to “lecture” the jury on the subject in a sensational and oracular manner which evidently made a great impression upon them . . .

Counsel. “. . . perhaps you are acquainted with Andrew’s celebrated work ‘On the Recent and Remote Effects of Head Injury’?”

Doctor (smiling superciliously). “Well, I should say I was. I had occasion to consult it only last week.”

Counsel. “Have you ever come across ‘Charvais on Cerebral Trauma’?”

Doctor. “Yes, I have read Dr. Charvais’s book from cover to cover many times.”

Counsel continued in much the same strain, putting to the witness similar questions relating to many other fictitious medical works, all of which the doctor had either “studied carefully” or “had in his library about to read,” until finally, suspecting that the doctor was becoming conscious of the trap into which he was being led, counsel suddenly changed his tactics and demanded in a loud sneering tone if the doctor had ever read Page on “Injuries of the Spine and Spinal Cord” (a genuine and most learned treatise on the subject). To this inquiry the doctor laughingly replied, “I never heard of any such book and I guess you never did either!”

Wellman gives one other interesting reason why indirect information is used. “The juror sees the point for himself, as if it were his own discovery, and clings to it all the more tenaciously” [Wellman 1903, 46]. “The juror holds on to his own discovery with the greatest tenacity and often, possibly, to the exclusion of every other fact in the case” [Wellman 1903, 184].

These examples demonstrate that an understanding of the subtleties of presupposition can greatly enhance our understanding of language as a whole.

1.4 Thesis Overview

Now that we have examined the behavior of presuppositions, we shall consider how they should be characterized. Chapter 2 discusses existing theories and their shortcomings. Chapter 3 gives a formal apparatus on which we can build our approach. In Chapter 4 we attempt to provide improved definitions of presupposition which has, so far, been only vaguely described. The presuppositions which these definitions predict are considered in Chapter 5. Chapter 6 examines what happens to the presuppositions of a sentence when it is embedded in a complex sentence (the projection problem). Finally, Chapter 7 summarizes and discusses directions for future work.

Chapter 2

Approaches to Modelling Presupposition

This chapter presents several existing analyses of presupposition, pointing out two shortcomings which are common among them. It then introduces our approach, which attempts to overcome these problems.

First we describe a categorization for theories of presupposition.

2.1 Categorizing Theories of Presupposition

A theory is termed **semantic** if it assumes that presupposition can and should be properly accounted for using only semantic information; it is **pragmatic** otherwise. An orthogonal distinction can be made between **reductionist** and non-reductionist theories. Reductionist theories try to diminish, or eliminate entirely, presupposition as a separate inference class by arguing that phenomena which have been called presuppositional are really instances of the other inferences. We now give more detail to these distinctions and argue for a non-reductionist and pragmatic view of presupposition.

2.1.1 Semantic Theories

So-called **semantic theories** of presupposition assume that, in order to determine the presuppositions of a sentence, only semantic information about the sentence under consideration. We will show that this view is incorrect.

First, let us look at some definitions of semantic presupposition. They are generally based on a notion of semantic entailment or implication. Levinson [1983, 175] gives the following pair of definitions:

DEFINITION 1: Sentence S_1 **semantically entails** Sentence S_2 (written $S_1 \models S_2$) iff in all situations where S_1 is true, S_2 is true.

DEFINITION 2: Sentence S_1 **semantically presupposes** Sentence S_2 iff $S_1 \models S_2$ and $\neg S_1 \models S_2$.

If these definitions are adopted, a peculiar situation arises when a presupposition P of Sentence S is not true. The sentence cannot be true, because that would imply

that the presupposition is true; nor can it be false, since that too would imply that the presupposition is true. In other words, the Sentence S can have no truth-value. This problem has usually been solved by adopting a trivalent logic, or by introducing truth-value gaps.

In [Van Der Auwera 1979], this problem is avoided by using a definition of semantic presupposition which allows a presupposition of a Sentence S to be false if that Sentence S is false.

DEFINITION 3: Proposition S **semantically implies** proposition P iff P must be true for S to be true.

DEFINITION 4: Proposition S **semantically presupposes** proposition P iff S semantically implies P and P can, but does not have to be true when S is false.

Unfortunately, this definition does not capture presupposition alone. For example, the following entailment satisfies the definition:

- (1) Cathie has three children.
 \models Cathie is a parent.

In fact, all semantics definitions of presupposition are, in principle, inadequate. We argued in the last chapter that failure of a presupposition of a sentence depends on information both inside and outside the sentence. Specifically, a presupposition of a negative sentence can be blocked by information in the sentence or presented earlier, and information which is yet to come can require that such a presupposition be retracted. By definition, a semantic theory does not have access to information beyond the sentence under consideration. More importantly, we will show that this blocking and retraction depends upon the beliefs of agents involved, which is certainly not semantic information. We thus conclude that a semantic theory cannot account for the full range of presuppositional behavior, and is thus misdirected.

2.1.2 Pragmatic Theories

Pragmatic theories of presupposition take a different approach, with the concepts of **appropriateness** and **mutual knowledge** as central. The incorporation of these concepts results in two major differences from semantic approaches. The first difference is that if a pragmatic presupposition P of Sentence S “fails”, we have an inappropriate utterance rather than a sentence without a truth-value, as some semantic theories would predict. This avoids the need for trivalent logic or truth-value gaps. The second difference is that the “failure” of a presupposition is not the condition used to test appropriateness of an utterance. The actual truth of a presupposition is irrelevant to the appropriateness of the utterance. It is the knowledge of the agents involved about the presupposition which is relevant. One common pragmatic approach is to require that a presupposition be known by all participants in order for the utterance to be appropriate. This condition is, however, too strong. It is sufficient that a presupposition be *consistent* with the mutual knowledge of the participants. For example, one could appropriately utter Sentence 2 even if the hearer is not aware that 3 is true, as long as it is consistent with the shared knowledge.

- (2) Lois will be starting to swim daily.
- (3) \gg Lois hasn't been swimming daily.

The following definition incorporates these ideas:

DEFINITION 5: Utterance U **pragmatically presupposes** proposition P iff U is appropriate only if P is consistent with the mutual knowledge of the participants¹.

We believe that a pragmatic rather than semantic theory of presupposition is appropriate. However, in Chapter 4 we will see that definition 5 is still too strict, and will develop our own definitions.

2.1.3 Reductionist Theories

A **reductionist theory** of presupposition is one which tries to reduce presupposition, in whole or in part, to instances of the other phenomena. Levinson [1983, 216–217] calls such an approach a *re-allocation programme*, and describes it as follows:

The first step is to assume that part of the difficulty of formulating adequate theories of presupposition arises from the fact that what is normally called *presupposition* is actually a heterogeneous collection of quite distinct and different phenomena, some perhaps semantic, others different varieties of pragmatic implication. The task then is to try to reduce presupposition to other kinds of inference, in particular to semantic entailment and matters of logical form on the one hand, and to conversational implicatures, conventional implicatures, felicity conditions, and the like on the other. If this reductionist programme leaves no residue, then the notion *presupposition* would be successfully reduced to other, more useful concepts. If, on the other hand, some clear cases of presuppositional phenomena remain unreducible, then we can formulate a theory of presupposition to handle just these cases.

In Chapter 1 it was shown that none of the other inference classes behaves in the same way as presupposition does with respect to the properties discussed. Hence, we can assume that presupposition as a whole cannot be reduced to any of these types of inference. However, it may still be shown that some particular phenomena which have been called instances of presupposition are reducible to the other inference classes.

2.2 Two Difficulties

Two problems are shared by most theories of presupposition.

¹Here we have switched from talking about presuppositions of sentences to presuppositions of utterances of sentences. This distinction will be made clear when our approach is presented.

2.2.1 Inappropriate Status of Presuppositions

With some minor exceptions, which we will discuss later, theories of presupposition implicitly share two incorrect assumptions²:

- Truth Assumption: If Sentence S (or its utterance) presupposes proposition P , then P is true.
- Shared Belief Assumption: If Sentence S (or its utterance) presupposes proposition P , then all agents involved share the prior belief that P is true.

When these assumptions are made, presuppositions are granted an inappropriate status as facts, in whose truth the agents share belief. We will now show why the Truth Assumption and the Shared Belief Assumption are unfounded.

Consider the usual analysis given to 4:

- (4) Don criticized Carol for grounding Jimmy.
 (5) \gg For Carol to ground Jimmy was a bad thing.

Even if it is assumed that Sentence 4 is true, we cannot conclude that 5 is necessarily true. In the case of an utterance of this sentence, where we can assume that the speaker believes it to be true, we cannot even conclude that the speaker believes 5 to be true. This is illustrated by the following example:

- (6) Don criticized Carol for grounding Jimmy, but she did the right thing.

One could argue that in Sentence 6 the presupposition is simply cancelled by the second clause. However, there is a presupposition of 6 which is *not* cancelled; we are just looking at the wrong one. The correct presupposition of both 4 and 6 is:

- (7) Don believes that for Carol to ground Jimmy was a bad thing.

(In the case of an utterance of either 4 or 6, we would take the sentence and its presupposition to be according to the speaker.) So we have shown that the Truth Assumption is incorrect and that it can be avoided by modifying presuppositions to specify who believes them to be true.

The Shared Belief Assumption can also be disproven by the above example. We have no grounds for assuming that all agents involved in a sentence (or utterance) share the belief that the presupposition is true. In our example Don must believe it (or for an utterance, the speaker must believe Don's belief of the presupposition), or else use of the word "*criticize*" was inappropriate. However, we can create situations in which the presupposition is either believed or not by both Carol and Jimmy. For example, in 8 Carol believes it, but in 9 she doesn't.

- (8) Don criticized Carol for grounding Jimmy, and Carol knows she shouldn't have.

²In what follows we mention both sentences and utterances. The offending assumptions are generally made both when presuppositions of sentences and utterances are analyzed. We will be clear about the distinction between sentences and utterances when our approach is presented.

(9) Don criticized Carol for grounding Jimmy, but she thinks she did the right thing. Similarly, in Sentence 10 Jimmy believes it, while in 11 he doesn't.

(10) Don criticized Carol for grounding Jimmy, and Jimmy's glad because he thinks it was unfair.

(11) Don criticized Carol for grounding Jimmy, but even Jimmy knows he deserved it. By simply specifying exactly who holds the presupposition to be true, as in 7, this problem can be avoided.

So both the Truth Assumption and the Shared Belief Assumption are unreasonable, and can be avoided if we specify to whom a presupposition should be attributed.

2.2.2 Inadequate Definitions of Presupposition

The second problem has been finding a precise and accurate definition of presupposition. We argued in Section 2.1.1 that a semantic definition is, in principle, doomed to failure. Unfortunately, deriving an adequate pragmatic definition has not been easy.

Many existing definitions state that the presuppositions of a sentence must be known prior to the utterance of that sentence or else an infelicity results. Some have the stronger constraint that the presuppositions must be mutually known by all participants. For example, the following definition [Levinson 1983, 205] has these properties:

DEFINITION 6: An utterance *A* **pragmatically presupposes** a proposition *B* iff *A* is *appropriate* only if *B* is *mutually known* by participants.

These requirements, which reflect the Shared Belief Assumption, are too strict — presuppositions can be used to introduce *new* information. In fact, one reason why presuppositions are so common is that by introducing new information indirectly, various effects can be achieved. (See Section 1.3 for examples, and 4.6 for a definition of such “marked” uses of presupposition.) Any definition that incorporates the constraint that participants must have prior knowledge of presuppositions will reject presuppositions of this sort.

Conversely, other definitions have the opposite problem of accepting as presuppositions inferences from the other classes. For example, in as much as Definition 6 captures presupposition, it also captures entailment.

Our definition of presupposition, presented in Chapter 4, weakens the overly strict prior knowledge condition so that the definition does not reject valid presuppositions, and avoids accepting inferences from other classes by checking that a candidate inference exhibits the distinctive behavior under negation that signifies a presupposition. Hence, the new definition captures presupposition more precisely.

2.3 Recent Theories of Presupposition

Several important theories of presupposition will now be presented. For each, we will discuss its key ideas and general shortcomings. We will then examine whether it treats presuppositions as facts or beliefs; and if the latter, which agents' beliefs are brought to bear.

2.3.1 Karttunen and Peters

The theory of presupposition presented in [Karttunen 1973] and in [Karttunen and Peters 1979] addresses the projection problem. It is pragmatic because it assumes that presupposition involves more than truth-conditional semantics. It is also a reductionist approach, attempting to reduce presupposition to conventional implicature. Karttunen and Peters claim that this reduction is possible because presuppositions share the three fundamental characteristics of conventional implicature. First, they can be considered conventional in nature because they are associated with lexical items and syntactic structures by convention. Second, the inferences are not part of the truth-conditional semantics of a sentence. Finally, they are not cancellable. On this basis, they include the inferences which had previously been called presuppositional in the category of conventional implicature³.

We now briefly describe the projection mechanism which has become well known as the “holes, plugs, and filters approach”. The set of linguistic environments in which a sentence can be embedded is divided into three categories. The first category contains those environments in which presuppositions always survive embedding. These are termed **holes**. They include all ordinary complementizable predicates. The second category consists of environments in which presuppositions do not survive embedding. These **plugs** include verbs of propositional attitude such as “hopes”, and verbs of saying, such as “announces”.

The final class is the most complicated. It contains environments in which the presuppositions neither always survive nor always fail. These environments, which include conjunctions, disjunctions and conditionals, are called **filters**. The survival of the presuppositions of a sentence embedded within a filter is dependent upon **filtering conditions**. Karttunen and Peters define the filtering conditions for each of the filter environments, using semantic information (*i.e.* the entailments of the clauses) from the sentence in question and from other “assumed facts”⁴. For example, the projection rule for conditional sentences is given as follows:

- Let S be any sentence of the form “If A then B ”.
 - If A presupposes P , then S presupposes P .
 - If B presupposes P , then S presupposes P unless there is some (possibly null) set X of assumed facts such that $X \cup \{A\}$ semantically entails P .
Constraints on X : X must not semantically entail $\neg A$ (otherwise everything would follow from $X \cup \{A\}$), and it must not semantically entail P itself.

By this rule, all presuppositions of an *if*-clause project. For example, the presupposition, 13, of Sentence 12’s *if*-clause is a presupposition of the whole sentence.

(12) If they play that song again, then I will leave.

³In discussions of this theory, these inferences will still be referred to as presuppositions, in order to distinguish them from the usual sorts of conventional implicature.

⁴The filtering rules as originally presented make use only of the sentence in question. They are later modified to take into account other assumed information. For more information about the effect of context on projection, see Chapter 6.

(13) They have played that song before.

In contrast, this rule states that presuppositions of *then*-clauses must pass a test in order to project. The *then*-clause of 14 presupposes 15, but since this presupposition is entailed by the *if*-clause, it fails to project.

(14) If Mary dyed her hair green, then she'll regret that she did.

(15) She did, *i.e.* Mary dyed her hair green.

There are several arguments against this theory. The holes, plugs, and filters apparatus has been called an “engineering solution” [Levinson 1983, 209] which must increase in complexity to handle the complex details of projection. One would hope to find a more principled approach. Also, Levinson [1983, 209–210] shows that the filtering conditions make some incorrect predictions. Although these errors may be rectified, another objection still stands. This objection is against the reduction of presupposition to conventional implicature. Ordinary conventional implicatures cannot be cancelled, so if presuppositions are to be considered conventional implicatures, they must also be indefeasible. Yet presuppositions *can* be defeated. To get around this problem, the projection mechanism must prevent instantiation of all presuppositions which would, if instantiated, eventually be cancelled. This is what the holes, plugs and filters are intended to do. However, while presuppositions can be cancelled due to information which *follows* the sentence, the projection mechanism has available only the sentence and any earlier information. So cancellation of presuppositions cannot be entirely prevented by the projection mechanism. Hence, the reduction of presupposition to conventional implicatures, which are not cancellable, is not possible.

Status of Presuppositions

Karttunen has made some steps towards treating presuppositions as beliefs. In [Karttunen 1973] he uses “assumed facts” of the speaker in his projection rules. So use is only made of the beliefs of the speaker; and these beliefs are used only during projection. In [Karttunen 1974], he moves away from the idea of actually finding the presuppositions of a sentence or utterance, to simply determining whether or not they are satisfied. In this paper, for verbs of propositional attitude, he uses the beliefs of the referent of the verb's subject in determining whether the presuppositions of a sentence are satisfied. So beliefs of agents other than the speaker are used, but their use is very limited.

2.3.2 Weischedel

Weischedel's theory [1975, 1979] addresses the generation of first-order presuppositions as well as the projection of these to higher-order presuppositions. The most significant aspect of the theory is its claim that presuppositions are purely structural in nature, and can thus be generated during parsing. Weischedel supports this claim by providing a parser, based on augmented transition networks [Winograd 1983], that generates presuppositions.

First-order presuppositions are grouped into two categories — lexical and structural. **Lexical presuppositions** are those triggered by particular lexical items. This category includes such triggers as the factive and change-of-state verbs. For each lexical trigger, the associated presupposition is stored under its entry in the lexicon, in the form of a tree transformation. During the parsing of a sentence, each time the parser finds a lexical trigger it records the associated tree transformation. At the end of the sentence, each of these transformations is applied to the parse tree to produce the presuppositions of the sentence. **Structural presuppositions** are triggered by syntactic structures, such as clefts, and definite noun phrases. In order to recognize each of these structures, a separate path or subgraph in the network, only accessed during the parsing of that construct, is singled out. A tree transformation representing the presupposition of the structure is associated with an arc or arcs on this path. It is applied to the parse tree whenever that arc is taken, resulting in a presupposition for the sentence.

Projection is implemented in a manner somewhat similar to Karttunen and Peters’s scheme. Embedding contexts are divided into three groups. Holes are defined as by Karttunen and Peters. Weischedel’s treatment of plugs, however, differs from theirs. Rather than completely preventing projection, his plugs modify the lower-order presuppositions as follows. Verbs of saying allow each lower-order presupposition P to project, but modified by a claim predicate to become $claim(speaker, P)$. Verbs of propositional attitude, are similarly treated, but with a belief modifier yielding $believe(speaker, P)$. The final category of embedding context, which Karttunen and Peters dubbed filters, is instead called **connectives**. Weischedel’s treatment of connectives is problematic. The presupposition P of an embedded Sentence S is allowed to project, but into a form modified by the connective⁵. For example, if B presupposes C , the conditional sentence “*If A then B*” has the conditional presupposition “*If A then C*”. By this analysis, Sentence 16 presupposes 17.

(16) If Graeme is in his office, then he forgot his meeting.

(17) \gg If Graeme is in his office, then he intended to go to his meeting.

It seems much more likely that Graeme’s intention to attend his meeting is meant to be independent of whether or not he is in his office. Similarly inappropriate analyses are given for conjunction and disjunction. More detail on Weischedel’s projection mechanism is given in Chapter 6, where our approach to projection is discussed.

While the basic mechanism proposed is appropriate for calculating presuppositions out of context, we have two immediate objections to Weischedel’s theory. The first, already mentioned, is that the projection rule for connectives is problematic. The main objection is to the primary claim of the paper, that presuppositions are lexical and structural only — independent of non-structural context. It has been shown above that presuppositions *are* sensitive to context beyond the sentence level. Specifically, they can be defeated by inter-sentential context, and by inconsistency with background assumptions. This theory has no access to such information and hence cannot handle these types of defeat.

⁵The idea of modifying presuppositions of connectives rather than filtering them out, was introduced in [Karttunen 1974].

Status of Presuppositions

Weischedel treats some presuppositions as beliefs, but this only occurs during projection. Specifically, if Sentence S has presupposition P , when S is embedded in the context of a verb of saying (such as “announce” or “tell”) the presupposition becomes $claim(speaker, P)$, where *speaker* is the speaker, and when embedded in a predicate of propositional attitude (such as “hopes”, or “thinks”) the presupposition becomes $believes(speaker, P)$. Again, this is a very limited application of the idea that presuppositions are beliefs. It is used only in two isolated instances, and only considers the beliefs of the speaker.

2.3.3 Gazdar

Gazdar [1979] attempts to provide an elegant solution to the projection problem for presuppositions and conversational implicatures — one which is based on general pragmatic principles rather than on complicated, ad hoc rules.

Since his main concern is with projection, he spends little time discussing the computation of first-order presuppositions. He simply presents a few functions to compute some of the presuppositions, and claims that the rest can be determined in a “completely mechanical way”. To calculate the presuppositions of a sentence with embedding, first the *potential* presuppositions, termed **pre-suppositions**, are computed. These are simply the sum of the presuppositions of the embedded parts. The **actual** presuppositions are a subset of the pre-suppositions, and are computed by a simple rule. This rule allows only those pre-presuppositions which are consistent with the context to project and become members of the set of actual presuppositions (and of the cumulative context). The projection rule requires that conversational implicatures and presuppositions be added to the context in a specific order: first clausal implicatures, then scalar implicatures, and finally presuppositions. Unfortunately, “this ordering plays a part in the explanation of the data . . . , but it is not itself explained” [Gazdar 1979b, 68].

Gazdar’s solution to the projection problem seems to be very effective; there are few known counter examples. It is also much simpler, and far more general than Karttunen and Peters’s. Gazdar claims, in fact, that *their* solution only works as well as it does because it partly simulates the cancellation effect of clausal and scalar implicatures of his theory. Another very nice feature of Gazdar’s system is that, by virtue of the way it treats context, any kind of contextual information such as previous linguistic context, or background assumptions could be added to the model. Combining a cumulative context with the projection scheme, the model could handle defeat of presuppositions due to any kind of previous contextual information. However, the theory does not account for cancellation due to inconsistency with information which follows.

Status of Presuppositions

Because Gazdar is primarily concerned with the projection problem, he gives little attention to the actual computation of potential presuppositions. However, for each of those that he does mention, the presupposition has the form $K_s(P)$, where s is the speaker, and K is the “knows” predicate. Gazdar considers attributing presuppositions to the

speaker only.

2.3.4 Mercer

Mercer and Reiter [1982] presents a new representation for presuppositions which is intended to use the same consistency theme for projection as Gazdar, while avoiding the unexplained ordering. (See also Mercer and Rosenberg [1984].)

The representation is based on default logic [Reiter 1980]. The general form of a default logic rule is as follows:

$$\frac{\alpha(X) : M \beta(X)}{\gamma(X)}$$

where $\alpha(X)$, $\beta(X)$, and $\gamma(X)$ are formulae with free variables among $X = X_1, X_2, \dots, X_n$. The interpretation of this inference rule is roughly “if $\alpha(X)$ is believed and $\beta(X)$ is consistent with current beliefs, then $\gamma(X)$ may be believed”.

Having a consistency check incorporated in the logic makes the logic particularly well suited to the representation of presuppositions. A presupposition Q of P could be denoted thus:

$$\frac{P : M Q}{Q}$$

To avoid having to explicitly specify presuppositions for each individual trigger, default rule schemata are used to represent the presuppositions for groups of triggers. These schemata are then instantiated for each trigger, as necessary. For example, the fact that a negated factive normally presupposes that its complement is true could be represented by the following default rule schema:

$$\frac{Factive(F) \wedge \neg F(Subj, P) : M P}{P}$$

An instance of this might have “regrets” as the factive F , “John” as the subject, and “left(Margaret)” as the presupposition P , that is

$$\frac{Factive(regret) \wedge \neg regret(John, left(Margaret)) : M left(Margaret)}{left(Margaret)}$$

Mercer’s theory shares most of the positive features of Gazdar’s, while avoiding the seemingly ad hoc ordering for projection. It is a very simple theory, which uses a general pragmatic rule for projection. It could also accommodate, and handle defeat due to, any kind of previous contextual information. It does not handle cancellation due to inconsistency with information which follows.

Status of Presuppositions

Mercer’s approach does not address the issue of treating presuppositions as beliefs.

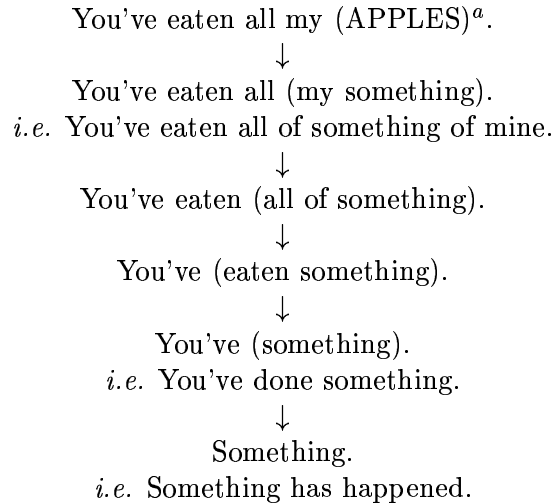


Figure 2.1: Focal scale for stressed item “*apples*” in the sentence “*You’ve eaten all my apples*”.

^aWords will be capitalized to indicate phonetic stress.

2.3.5 Wilson and Sperber

The theory presented in [Wilson and Sperber 1979] attempts to reduce presupposition to semantic entailment, so it is not only a reductionist theory, but a semantic one as well.

Wilson and Sperber believe that while criticisms of semantic approaches to presupposition have been justified, if the relationships among truth conditions are examined more closely an adequate semantic explanation *can* be found. The problem, they posit, is that truth conditions have traditionally been divided into categories (entailment and presupposition), but no attention has been paid to the structure within these groups. They propose an ordering on entailments. On the basis of this ordering they are able, for a given utterance, to distinguish **focalized** from **peripheral** entailments, and among the focalized entailments, between those in the foreground of attention and those in the background. The background entailments then can be considered roughly equivalent to our notion of presupposition.

The ordering of entailments is based on phonetic stress. Wilson and Sperber feel that this is justified because any ordering based on syntactic structure is either predicted by, or superceded by, their stress principle. First, the stressed item is determined. If contrastive stress is not indicated, normal stress is assumed. From this, an ordered list of entailments is generated by substituting a variable for each successively larger syntactic constituent containing the stressed item. This is called the **focal scale** for the stressed item. For example, the focal scale for the sentence “*You’ve eaten all my apples*”, where “*apples*” is stressed, is shown in Figure 2.1. All entailments on the focal scale are **focalized**. Any entailment not on the scale, such as 18, is called **peripheral**.

(18) Someone has eaten all my apples.

The **focus** of a sentence can be any syntactic constituent containing the stressed item. (The problem of determining the focus from the set of possible foci is not addressed.) The entailment resulting from a substitution for the focus is called the **first background entailment**. It marks the end of the foreground entailments. For example, if the focus in the above example was “all my apples”, then the first background entailment would be “you’ve eaten something”. The first background entailment can be considered a presupposition of the sentence, as opposed to the **point** of the utterance. The point of the utterance is that information which can supplement the first background entailment to equal the utterance itself.

The idea of using general principles such as these to compute presuppositions is a very good one. However, the theory presented cannot account for all presuppositional phenomena. For example, consider the following, very ordinary, presupposition:

(19) I’m amazed that Dave will be back on Thursday.

(20) \gg Dave will be back on Thursday.

There is no syntactic component of Sentence 19 which can be replaced by a variable to yield 20. So 20 is not on the focal scale for 19. Since all presuppositions of a sentence come from its focal scale in this theory, the theory cannot predict that 20 is a presupposition of 19. This is the case for many other sorts of presupposition. Wilson and Sperber’s theory also says nothing about projection or the impact of contextual information on presuppositions.

We are again concerned with the reductionist viewpoint. Reduction to entailment carries with it all the problems of the semantic theories, because entailment and presupposition do not behave in the same way with respect to the important properties. Most importantly, entailments cannot be defeated, while presuppositions certainly can. Hence, any theory which reduces presupposition to entailment cannot handle defeat of presuppositions. It might be possible to remedy this problem by removing the reductionist aspect of the theory, and promoting background entailments to presuppositions, which can be defeated.

Status of Presuppositions

Wilson and Sperber’s approach treats presuppositions as facts rather than beliefs.

2.3.6 Atlas and Levinson

Atlas and Levinson [1981, 56] were not satisfied with earlier theories which

treat presupposition as irreducible, a special species of conventional, non-truth-conditional inference that requires specific lexical items and syntactic structures to be associated with the inferences. This is accomplished not by rule but item by item.

In response, they attempt to provide a theory which makes improvements in two areas. First, like Wilson and Sperber, their theory generates first-order presuppositions through

the use of a few general principles which attempt to explain a wide range of data. Second, they attempt a reduction of presupposition. Rather than reduce to conventional implicature as by Karttunen and Peters, or to semantic entailment as by Wilson and Sperber, they choose a combination of generalized conversational implicature and entailment.

Recall that Wilson and Sperber base their contribution on the realization that previous work had not made use of the structural relationships among entailments of a sentence. Atlas and Levinson's contribution is based on a similar realization. They note that full advantage has not been taken of the fact that sentences with the same truth-conditions can have different logical forms. By restructuring the logical form of a sentence so that what the sentence is "about" becomes the subject of the logical form, and using the simple rule that one may assume the existence of the logical subject unless there is a specific assumption to the contrary, presuppositions can be accounted for in a very appealing manner. For example, the sentence "It was Tom who babysat Ben" has as logical subject the group of people who babysat Ben. Hence, its logical form would be⁶

$$\lambda x (x = Tom)(\gamma x \text{ babysat}(x, Ben))$$

with the group who babysat Ben being represented by

$$\gamma x \text{ babysat}(x, Ben)$$

By assuming the existence of this subject, the usual presupposition that "Someone babysat Ben" is attained.

With this revised logical form and some general principles of conversational inference, the reduction of presupposition to entailment and generalized conversational implicature is made possible. For sentences in the affirmative, the presupposition is considered to be an entailment from the logical form. For negative sentences, it is a generalized conversational implicature, with justification as illustrated by the following example. The negative sentence "It wasn't Tom who babysat Ben" is initially assumed to have external negation, and thus its logical form is

$$\neg \lambda x (x = Tom)(\gamma x \text{ babysat}(x, Ben)).$$

This is not very informative. By Grice's Maxim of Quantity, it may be assumed that the speaker must have intended internal negation.

$$\lambda x (x \neq Tom)(\gamma x \text{ babysat}(x, Ben))$$

As for the affirmative form above, this entails that the subject exists, since the subject is outside the scope of negation. Hence, the entailment that "Someone babysat Ben" is attained. Since it is an entailment of a conversational implicature, it can be considered a conversational implicature itself.

While the usual problems associated with reduction of presupposition to entailment are avoided because of the additional use of conversational implicature, *its* appropriate-

⁶ γ is the group- or gamma-operator, used to group collective terms. So $\gamma x P(x)$ represents the group of entities which satisfy proposition P .

ness as a representation for the phenomenon must be considered. Presupposition and entailment do differ with respect to constancy under negation, causing us to reject this reduction. The more sophisticated use of logical forms to generate presuppositions from general principles, however, is still very appealing and merits further attention.

Status of Presuppositions

Presuppositions are treated as facts in Atlas and Levinson’s theory.

2.4 Our Approach: Presuppositions as Beliefs

Our approach is to treat every presupposition as a belief of a particular agent, thereby avoiding the Truth and Shared Belief assumptions. We have observed that various forms of this approach have been taken by others. However, they have not noted the importance of this view, or thoroughly investigated how it should be applied. Furthermore, they have not thoroughly considered the beliefs of agents other than the speaker. This thesis is devoted to the thorough investigation of a model of presupposition that views presuppositions as beliefs, but also keeps in mind that beliefs of *any* agent involved in discourse may be relevant. One part of this model is a new definition of presupposition that embodies this view, and as mentioned above, captures presupposition more accurately than previous definitions. This definition is developed in the next chapter.

Before proceeding, we now pause to discuss the assumptions that we make. In order to simplify the problem, we will follow Grice in assuming that conversation is cooperative. Specifically, we will assume the following⁷:

1. Sincerity Assumption

The speaker will only say what he believes to be true. This is independent of what actually is true. In other words, the speaker will not deliberately try to deceive the listener.

2. Straightforwardness Assumption

The speaker will not use sarcasm (a flouting of the Maxim of Quality).

Sarcasm can, in fact, affect the status of presuppositions. For example, Sentence 21 normally presupposes 22.

(21) John started to annoy Brenda.

(22) \gg John hadn’t been annoying Brenda before.

However, if 21 is said with sarcasm centring on the word “started”, the presupposition does not hold. The use of sarcasm implies that a meaning opposite to that of the stressed word is intended, in this case that John didn’t *start* to annoy Brenda. Our use of the straightforwardness assumption is necessitated by the fact that while sarcasm might be detected in sentences that are blatantly false, it is often indicated only by tone of voice,

⁷See Chapter 7 for suggestions regarding eliminating these assumptions.

facial expression or gesture — elements of dialogue which are not readily accessible to a computer natural language processing system.

Of course, a lack of speaker sincerity can also affect presuppositions. A speaker can deliberately deceive a listener not only by uttering a sentence which expresses a false proposition, but also by uttering a true sentence which carries a presupposition that is false. However, since there is no existing model of speakers' intentions which can detect deliberate deceit, we require the sincerity assumption in order to simplify the problem.

Given the above, we shall say that for any Sentence S , the utterance of that sentence allows one to assume that the speaker believes S to be true. No assumption regarding the actual truth-value of S is warranted since it would be unrealistic to assume that what is said is true, even in cooperative conversation. Therefore, from the utterance of S by the speaker, we can only infer propositions about the beliefs of the speaker since such propositions are based on the assumption that, while S may be true or false, the speaker believes it to be true.

Chapter 3

A Logic of Belief for Presupposition

Our approach is to treat every presupposition as the belief of some agent or agents. In light of this, we now present a logic of belief that provides a language in which propositions involving agents' beliefs can be expressed, and that gives this language precise semantics. We will also discuss operations which would allow a model of agents' beliefs to be updated as new information about them is acquired.

Research in logics of belief is ongoing and there are many problems which are not yet solved. We do not attempt to break new ground in this area. Rather, we have drawn on existing work. The result is a logic of belief which is far from perfect, but does at least give a precise meaning to the belief operators which appear in great abundance in the chapters which follow.

Before presenting the logic of belief which we will use to represent presuppositions, we describe **belief structures**, a variant of **knowledge structures** [Fagin, Halpern and Vardi 1984], on which this logic is based.

3.1 Belief Structures

Belief structures are defined exactly as knowledge structures, except that one of the constraints, which we describe below, is modified¹. Before we present the formal definition of belief structures, an intuitive description will be given.

A **belief structure** is a list consisting of one possible assignment of truth values to the primitive propositions, and one possible assignment of beliefs about the primitive propositions to the agents, and one possible assignment of beliefs about the beliefs of agents about the primitive propositions to the agents and so on, to an infinite depth of beliefs. Intuitively, this describes one possible arrangement of what is actually true, and

¹This technique for modifying knowledge structures to obtain belief structures is suggested in [Fagin, Halpern and Vardi 1984]. Specifically, their C1 is changed. If the language is defined with semantics in terms of belief structures having this different constraint (see section 1), its properties are different from those it would have if defined in terms of knowledge structures. These properties are described in section 3.3.

what is believed by the agents.

Each element of the list which constitutes a belief structure is called a belief assignment. The first is of order 0, and each subsequent belief assignment has an order which is one greater than the previous one. A belief assignment of order n describes beliefs with a degree of nesting up to n . For example, a belief assignment of order 2 describes beliefs either of the form $B_i\alpha$ or $B_iB_j\alpha$, where α has no B operator.

A world is a finite prefix of a belief structure. A world has order k if it contains k belief assignments (of order 0 through $k - 1$). Such a world describes a truth value assignment and the beliefs of agents up to a depth of $k - 1$.

We now give the formal definitions of these concepts. A **0-th order belief assignment** f_0 is a truth value assignment to the primitive propositions, that is, a function from \mathbf{P} to either *true* or *false*. The list $\langle f_0 \rangle$ is a **1-ary world**; 1-ary because the length of the list is one. W_1 is the set of all such 1-ary worlds.

Generally, $\langle f_0, f_1, \dots, f_{k-1} \rangle$ is a k -ary world, and W_k is the set of all such k -ary worlds. If we assume that f_0, f_1, \dots, f_{k-1} and W_k have been defined, we can define the k -th order belief assignment f_k as a function from the set of agents, \mathbf{A} , to subsets of W_k . Intuitively, this gives the worlds of level $k - 1$ which each agent considers possible at level k . Later we will define a support relation for these belief assignments so that if, at level k , all the worlds of level $k - 1$ that agent i considers possible (*i.e.* all elements of $f_{k-1}(i)$) support α , then we have $B_i\alpha$.

Any infinite series $f = \langle f_0, f_1, \dots \rangle$ of belief assignments is a **belief structure**. We will use \mathbf{B} to denote the set of all belief structures.

Constraints on Worlds

Three constraints are placed on all $(k + 1)$ -ary worlds. For any $(k + 1)$ -ary world $\langle f_0, f_1, \dots, f_k \rangle$ and agent i :

C1 if $k \geq 1$, $f_k(i) \neq \{\}$.

If a world $\langle f_0, f_1, \dots, f_k \rangle$ had $f_k(i) = \{\}$, because of the way the semantics is defined (see the next section), it would follow that $\langle f_0, f_1, \dots, f_k \rangle \models B_i\alpha$ for *any* α . C1 prevents this.

C2 if $k \geq 2$ and $\langle g_0, g_1, \dots, g_{k-1} \rangle \in f_k(i)$, then $g_{k-1}(i) = f_{k-1}(i)$.

This says that at level k , every agent i has perfect knowledge of his level $k - 1$ beliefs, thus ensuring positive and negative introspection.

C3 if $k \geq 2$, $\langle g_0, g_1, \dots, g_{k-2} \rangle \in f_{k-1}(i)$ iff $\exists g_{k-1}$ such that $\langle g_0, g_1, \dots, g_{k-2}, g_{k-1} \rangle \in f_k(i)$.

This constraint ensures that for any world, each agent's level j beliefs do not differ from his beliefs at levels 0 through $j - 1$, *i.e.* his beliefs expressed by propositions of depth up to $j - 1$. Level j beliefs just extend these lower-order beliefs to include propositions of depth j . (C2 ensures that these level j and level $j - 1$ beliefs agree. The semantics of the logic, given below, depend on this constraint.)

3.2 The Logic

Syntax

We begin with sets $\mathbf{P} = \{P_1, P_2, \dots, P_m\}$ of atomic propositions and $\mathbf{A} = \{a_1, a_2, \dots, a_n\}$ of agents. The language \mathcal{L} contains the atomic propositions \mathbf{P} , the monadic operator \neg for negation, the dyadic operators \wedge and \vee for conjunction and disjunction respectively, the class of monadic operators B_i for i in \mathcal{A} , and brackets (and). The well-formed formulas of \mathcal{L} are defined as follows:

- All P in \mathbf{P} are well-formed formulas
- If P and Q are well-formed formulas, then so are:

$$\neg P \quad (P \wedge Q) \quad (P \vee Q) \quad B_i(P)$$

Omission of brackets will be allowed in the usual way. We define the depth of a formula as follows:

DEFINITION 1: The **depth** of a formula in \mathcal{L} is as follows:

1. $\text{depth}(\alpha) = 0$ if $\alpha \in \mathbf{P}$.
2. $\text{depth}(\neg\alpha) = \text{depth}(\alpha)$.
3. $\text{depth}(\alpha \wedge \beta) = \max(\text{depth}(\alpha), \text{depth}(\beta))$.
4. $\text{depth}(\alpha \vee \beta) = \max(\text{depth}(\alpha), \text{depth}(\beta))$.
5. $\text{depth}(B_i\alpha) = 1 + \text{depth}(\alpha)$.

Semantics

The semantics of \mathcal{L} is given by the support relation \models between belief structures and sentences of \mathcal{L} . This is based on the relation \models between k -ary worlds and sentences of \mathcal{L} , which we now define.

For α in \mathcal{L} , $k \geq \text{depth}(\alpha)$,

1. $\langle f_0, \dots, f_k \rangle \models \alpha \in \mathbf{P}$ if $f_0(\alpha) = \text{true}$.
2. $\langle f_0, \dots, f_k \rangle \models \neg\alpha$ if $\langle f_0, \dots, f_k \rangle \not\models \alpha$.
3. $\langle f_0, \dots, f_k \rangle \models \alpha \wedge \beta$ if $\langle f_0, \dots, f_k \rangle \models \alpha$ and $\langle f_0, \dots, f_k \rangle \models \beta$.
4. $\langle f_0, \dots, f_k \rangle \models \alpha \vee \beta$ if $\langle f_0, \dots, f_k \rangle \models \alpha$ or $\langle f_0, \dots, f_k \rangle \models \beta$.
5. $\langle f_0, \dots, f_k \rangle \models B_i\alpha$ if $\forall \langle g_0, \dots, g_{k-1} \rangle \in f_k(i), \langle g_0, \dots, g_{k-1} \rangle \models \alpha$.

Lemma 2.4 of [Fagin, Halpern and Vardi 1984] says that for a sentence α in \mathcal{L} of depth k , a $(k+1)$ -ary world w supports α exactly if all worlds of higher arity and of which w is a prefix, also support α . We repeat that lemma here:

LEMMA 1: For α in \mathcal{L} , $\text{depth}(\alpha) = k$, and $r \geq k$, $\langle f_0, \dots, f_k \rangle \models \alpha$ iff $\langle f_0, \dots, f_r \rangle \models \alpha$.

This lemma is made possible by constraint C3, which ensures that higher-order beliefs in a belief structure only extend lower-order beliefs. A proof, based on induction on formulas, is given in [Fagin, Halpern and Vardi 1984]. This lemma makes clear how the relation \models between belief structures and sentences in \mathcal{L} should be defined. For α in \mathcal{L} , $k = \text{depth}(\alpha)$,

$$6. \langle f_0, f_1, \dots \rangle \models \alpha \text{ iff } \langle f_0, f_1, \dots, f_k \rangle \models \alpha.$$

3.3 Properties of the Logic

Positive Introspection

THEOREM 2: For any belief structure $\langle f_0, f_1, \dots \rangle$, a_i in \mathbf{A} , and α in \mathcal{L} , if $\langle f_0, f_1, \dots \rangle \models B_i\alpha$ then $\langle f_0, f_1, \dots \rangle \models B_iB_i\alpha$.

PROOF:

Assume that the belief structure $\langle f_0, f_1, \dots \rangle \models B_i\alpha$ and that $\text{depth}(B_i\alpha) = d$. By statement 6 of the definition of the support relation \models , we can conclude that $\langle f_0, f_1, \dots, f_d \rangle \models B_i\alpha$. Hence,

$$\forall \langle g_0, g_1, \dots, g_{d-1} \rangle \in f_d(i), \langle g_0, g_1, \dots, g_{d-1} \rangle \models \alpha \quad (3.1)$$

Now consider any world $\langle x_0, x_1, \dots, x_d \rangle \in f_{d+1}(i)$. By constraint C2 and the fact that $d \geq 1$ (by definition of depth), we know that $x_d(i) = f_d(i)$. Substituting this into 3.1, we have $\forall \langle g_0, g_1, \dots, g_{d-1} \rangle \in x_d(i), \langle g_0, g_1, \dots, g_{d-1} \rangle \models \alpha$. Hence, $\langle x_0, x_1, \dots, x_d \rangle \models B_i\alpha$. So, $\langle g_0, g_1, \dots, g_d \rangle \in f_{d+1}(i)$ implies $\langle g_0, g_1, \dots, g_d \rangle \models B_i\alpha$. By statement 5 of the definition of the support relation \models , $\langle f_0, f_1, \dots, f_{d+1} \rangle \models B_iB_i\alpha$, and by statement 6, $\langle f_0, f_1, \dots \rangle \models B_iB_i\alpha$. So, $\langle f_0, f_1, \dots \rangle \models B_i\alpha$ implies $\langle f_0, f_1, \dots \rangle \models B_iB_i\alpha$

□

Negative Introspection

THEOREM 3: For any belief structure $\langle f_0, f_1, \dots \rangle$, a_i in \mathbf{A} , and α in \mathcal{L} , if $\langle f_0, f_1, \dots \rangle \models \neg B_i\alpha$ then $\langle f_0, f_1, \dots \rangle \models B_i\neg B_i\alpha$.

PROOF:

Assume that belief structure $\langle f_0, f_1, \dots \rangle \models \neg B_i\alpha$ and that $\text{depth}(B_i\alpha) = d$. By statement 6 of the definition of the support relation \models , $\langle f_0, f_1, \dots, f_d \rangle \models \neg B_i\alpha$, and by statement 2, $\langle f_0, f_1, \dots, f_d \rangle \not\models B_i\alpha$. By statement 5 we have

$$\exists \langle g_0, g_1, \dots, g_{d-1} \rangle \in f_d(i) \text{ such that } \langle g_0, g_1, \dots, g_{d-1} \rangle \not\models \alpha \quad (3.2)$$

Now consider any $\langle x_0, x_1, \dots, x_d \rangle \in f_{d+1}(i)$. By constraint C2 and the fact that $d \geq 1$ (by the definition of depth), we know $x_d(i) = f_d(i)$. Substituting this into 3.2, we get $\exists \langle g_0, g_1, \dots, g_{d-1} \rangle \in x_d(i)$ such that $\langle g_0, g_1, \dots, g_{d-1} \rangle \not\models \alpha$. By statement 5 of the support relation definition, we have $\langle x_0, x_1, \dots, x_d \rangle \not\models B_i\alpha$, and by statement 2, $\langle f_0, f_1, \dots, f_{d+1} \rangle \models B_iB_i\alpha$. Hence, $\langle g_0, g_1, \dots, g_d \rangle \in f_{d+1}(i)$ implies $\langle g_0, g_1, \dots, g_d \rangle \models \neg B_i\alpha$. By statement 5 of the \models definition, this means that $\langle f_0, f_1, \dots, f_{d+1} \rangle \models B_i\neg B_i\alpha$,

and by 6 we get this result in terms of the original belief structure, *i.e.*, $\langle f_0, f_1, \dots \rangle \models B_i \neg B_i \alpha$. So, $\langle f_0, f_1, \dots \rangle \models \neg B_i \alpha$ implies $\langle f_0, f_1, \dots \rangle \models B_i \neg B_i \alpha$.

□

True Sentences Need Not Be Believed

Agents need not believe all sentences that are actually true. This can be proven by example. Let $W = \langle f_0, f_1, \dots \rangle$ be any structure where $f_0 = p$ and $f_1(a) = \{p, \neg p\}$ ². (These restrictions on W do not violate any of the constraints, so it is possible for W to be a valid belief structure.) W supports p , $\neg B_a p$, and $\neg B_a \neg p$, so although p is true, agent a does not believe it.

Beliefs are Closed Under Logical Implication and All Valid Sentences are Believed

Because the truth value assignments in our 0-th order belief assignments are complete and consistent, belief has the strong property that $B_i \alpha \wedge B_i (\alpha \supset \beta)$ implies $B_i \beta$, that is, beliefs are closed under logical implication. Proof of this is left to the reader, however, an example may provide some insight into why it is true. Consider a belief structure W that supports $B_a p$ and $B_a (p \supset q)$, *i.e.* $B_a (\neg p \vee q)$. Because it supports $B_a p$, every $\langle g_0 \rangle$ in $f_1(a)$ must have p as true. Because it supports $B_a (\neg p \vee q)$, every $\langle g_0 \rangle$ in $f_1(a)$ must support either $\neg p$ or q . Since each supports p , none can support $\neg p$, and hence all must support q . So $W \models B_a q$.

In addition, all valid sentences are believed by each agent. This also stems from the fact that the truth value assignments to which the belief assignments map are complete and consistent.

The notion of belief could be weakened to eliminate these properties by allowing the 0-th order belief assignments to be incomplete and inconsistent, *i.e.* by defining them to be functions from \mathbf{P} to subsets of $\{true, false\}$ (possibly both; possibly neither). This would also require a move to two support relations, one for true support and one for false. In this way, a world could support both the truth and falsity of a single proposition, or neither. These changes correspond to Levesque's use of *situations* rather than possible worlds [Levesque 1984a].

3.4 Operations for Revising Beliefs

Our theory of presupposition requires not only a model of agents' beliefs, but also a method for revising models as presuppositional information is added to and retracted from agents' beliefs. In this section two operations for altering the current configuration of beliefs are discussed. The use of these operations to model the acquisition of new information about presuppositions is described in Chapter 4.

²In examples throughout, we use only one proposition, p , and abbreviate a truth-value assignment $\langle p \rightarrow true \rangle$ as p , and $\langle p \rightarrow false \rangle$ as $\neg p$.

For adding a new presupposition to an agent's beliefs, we need an operation which takes a model, an agent, and the proposition in which the agent is to believe, and returns a new model in which the belief assignments have been appropriately modified to reflect the new belief. Stated more formally, we require an **Add Presupposition** operation, $AP : \mathbf{B} \times \mathcal{L} \times \mathbf{A} \rightarrow \mathbf{B}$. Similarly, we need an operation which removes a belief which has already been attributed to an agent. We will call this the **Retract Presupposition** operation, where $RP : \mathbf{B} \times \mathcal{L} \times \mathbf{A} \rightarrow \mathbf{B}$. The formal definitions of these operations are left for future work, but we will discuss Add Presupposition in more depth in order to give an intuitive idea of the operation, and to demonstrate the difficulty of finding a satisfactory definition.

3.4.1 A Simplistic Definition of AP

The following definition has serious flaws, but provides a point of departure for our discussion.

DEFINITION 2: Let $W = \langle f_0, f_1, \dots, f_{d-1}, f_d, f_{d+1}, \dots \rangle$, and $W' = \langle f_0, f_1, \dots, f_{d-1}, f'_d, f_{d+1}, \dots \rangle$. Let $\alpha \in \mathcal{L}$, and $a \in \mathbf{A}$ such that $\{B_a \delta \in \mathcal{L} \mid W \models B_a \delta\} \cup \{B_a \alpha\}$ is consistent, and $d = \text{depth}(B_a \alpha)$. $AP(W, a, \alpha) = W'$ where:

$$f'_d(a) = \{x \in f_d(a) \mid x \models \alpha\}.$$

Of course, application of this definition will usually result in structures W' that violate the three constraints on belief structures, since it allows changes to $f_d(a)$ without corresponding changes to maintain the correct relationships between f_d and its neighbours f_{d-1} and f_{d+1} , between f_{d-1} and f_{d+1} and their neighbours, and so on. The following section makes some observations regarding exactly what rippling effects need occur, and one method by which they can *not* be described.

3.4.2 Facts About the Constraints

Unless it can be proven otherwise, it must be assumed that when a change is made to $f_d(a)$, in order to maintain C2 and C3 a rippling of its effect will be required both up through $f_{d+1}(a)$, $f_{d+2}(a)$, and so on, and down through $f_{d-1}(a)$ to $f_1(a)$. f_0 need not change since it is not about anyone's beliefs. (Accordingly, the constraints do not tie it to any of the belief assignments.) Also, each f_i need only change at a , because the original change only affects $f_d(a)$.

We do not discuss maintenance of C1 here, because it is not explicitly written into a definition. Given an existing definition, it must simply be proven that C1 can never be violated by its application.

How can rippling effects can be described in a definition of AP ? The simplest approach would be to define each $f'_i(a)$ for $i < d$ as the subset of those elements of $f_i(a)$ that satisfy C2 and C3 with respect to f'_{i+1} , and for $i > d$ as those elements of $f_i(a)$ that satisfy C2 and C3 with respect to f'_{i-1} . Unfortunately this approach, and in fact any that describes each $f'_i(a)$ as a subset of $f_i(a)$, will not work. In many situations, there is no element of $f_i(a)$ that satisfies C3 with respect to $f'_{i-1}(a)$, and none that satisfies

C2 with respect to $f'_{i-1}(a)$. That is, rippling up of C2 and C3 cannot be done by set restriction. Rippling down of these constraints may be possible by set restriction.

First consider C2. It requires that for all $\langle g_0, \dots, g_{i-1} \rangle$ in $f_i(a)$, $g_{i-1}(a) = f_{i-1}(a)$. Letting i be $d+1$, we have that for all $\langle g_0, \dots, g_d \rangle$ in $f_{d+1}(a)$, $g_d(a) = f_d(a)$. If $f_d(a)$ is changed as a result of adding a new proposition of depth d , the correspondence between it and these $g_d(a)$ is lost. It cannot be restored by eliminating elements of $f_{d+1}(a)$ that do not stand in this correspondence to the new $f'_d(a)$, because there aren't any. That is, there are no $\langle g_0, \dots, g_d \rangle$ in $f_{d+1}(a)$ such that $f_d(a) = f'_d(a)$. Hence, C2 cannot be rippled up from $f'_d(a)$ by set restriction.

Now consider C3, using as an example the performance of $AP(W, a, p)$ on a W that supports $\neg B_a p$ and $\neg B_a \neg p$. Because W says that a neither believes p nor $\neg p$, $f_1(a)$ must be $\{p, \neg p\}$. $f'_1(a)$ must be simply $\{p\}$, if W' is to support $B_a p$. By C2, we know that each $\langle g_0, g_1 \rangle$ in $f_2(a)$ was such that $g_1(a) = f_1(a) = \{p, \neg p\}$. To maintain C2 between f'_1 and f'_2 , each $\langle g_0, g_1 \rangle$ in $f'_2(a)$ must be such that $g_1(a) = f'_1(a) = \{p\}$. Now C3 requires that every $\langle g_0, g_1, g_2 \rangle$ in $f'_3(a)$ must extend one of these elements of $f'_2(a)$. If $f'_3(a)$ were to be chosen as a subset of $f_3(a)$, it would have to be guaranteed that there is some element of $f_3(a)$ that does this. Unfortunately, in this case it can be shown that there is no such element. Consider any $\langle g_0, g_1, g_2 \rangle$ in $f_3(a)$. By C3, we know that $\langle g_0, g_1 \rangle$ is in $f_2(a)$, and C2 stipulates that every $\langle g_0, g_1 \rangle$ in $f_2(a)$ has $g_1(a) = f_1(a)$, which is $\{p, \neg p\}$. Therefore, every $\langle g_0, g_1, g_2 \rangle$ in $f_3(a)$ must have $g_1(a) = \{p, \neg p\}$. Yet we showed above that every $\langle g_0, g_1 \rangle$ in $f'_2(a)$ has $g_1(a) = \{p\}$. So no element of $f_3(a)$ extends an element of $f'_2(a)$. So C3 cannot be rippled up from $f'_d(a)$ by set restriction.

3.4.3 Definition by Linear Constraint Rippling

One way to define Add Presupposition would be to change $f'_d(a)$ as in definition 2, and then ripple the effects of C2 and C3 out from the new $f'_d(a)$ in order to define $f'_i(a)$ for $i \neq d$; that is, to define $f'_i(a)$ based on $f'_{i+1}(a)$ for $i < d$, and based on $f'_{i-1}(a)$ for $i > d$. A first attempt at such a definition follows:

DEFINITION 3: Let $W = \langle f_0, f_1, \dots, f_d, f_{d+1}, \dots \rangle$, and $W' = \langle f_0, f'_1, \dots, f'_d, f'_{d+1}, \dots \rangle$.

Let $\alpha \in \mathcal{L}$, and $a \in \mathbf{A}$ such that $\{B_a \delta \in \mathcal{L} \mid W \models B_a \delta\} \cup \{B_a \alpha\}$ is consistent, and $d = \text{depth}(B_a \alpha)$. $AP(W, a, \alpha) = W'$ where $f'_i(x) = f_i(x)$ for all $i \geq 1$ and all $x \neq a$, and for all $i \geq 1$:

$$f'_i(a) = \begin{cases} \left. \begin{array}{l} 1. \{g \in f_i(a) \mid g \models \alpha\} \\ 2. \{\langle h_0, \dots, h_{i-1} \rangle \mid \\ \quad \langle h_0, \dots, h_{i-1} \rangle \in f_i(a), \text{ and} \\ \quad \langle h_0, \dots, h_{i-1}, h_i \rangle \in f'_{i+1}(a) \text{ for some } h_i\} \\ 3. \{\langle h_0, \dots, h_{d-1}, h'_d, h_{d+1}, \dots, h_{i-2}, h'_{i-1} \rangle \mid \\ \quad \langle h_0, \dots, h_{d-1}, h_d, h_{d+1}, \dots, h_{i-2}, h_{i-1} \rangle \in f_i(a) \text{ for some } h_d \text{ and } h_{i-1} \\ \quad h'_d(j) = \begin{cases} f'_d(a) & \text{if } j = a \\ h_d(j) & \text{otherwise} \end{cases} \\ \quad h'_{i-1}(j) = \begin{cases} f'_{i-1}(a) & \text{if } j = a \\ h_{i-1}(j) & \text{otherwise} \end{cases} \end{array} \right\} & \text{if } i = d \\ \\ \\ \\ \\ \\ \\ \\ \\ \left. \right\} & \text{if } i > d \end{cases}$$

Clause 1 defines $f'_d(a)$ as the set of those elements of $f_d(a)$ that support a 's new belief. Clause 2 defines $f'_i(a)$ for $i < d$ as the set of those elements of $f_i(a)$ that are extended in the new $f'_{i+1}(a)$. In effect, it ripples C3 down from $f'_d(a)$. It can be proven that C2 does not require a similar ripple down. Recall that C2 stipulates that for each belief assignment $f_i(a)$, for every $\langle g_0, \dots, g_{i-1} \rangle$ in it, $g_{i-1}(a)$ must equal $f_{i-1}(a)$. Since the original W already obeyed this constraint between f_d and f_{d-1} (and all other adjacent pairs of belief assignments), and since $f'_d(a)$ is only changed from $f_d(a)$ by set restriction, the elements that remain in $f'_d(a)$ are guaranteed to obey C2. The definition takes advantage of this by doing nothing to ensure that C2 holds between pairs of belief assignments below f'_d .

Clause 3 of the definition ripples C2 and C3 up from $f'_d(a)$, but not simply by set restriction since we have shown that such a technique will not work. Each element of $f_i(a)$ appears in $f'_i(a)$, but slightly modified. For the sake of C3, each $\langle g_0, \dots, g_{d-1}, g_d, g_{d+1}, \dots, g_{i-1} \rangle$ in $f_i(a)$ is changed at g_d so that $g'_d(a) = f'_d(a)$. This ensures that every element of $f'_d(a)$ is extended by some element of $f'_{d+1}(a)$ and every element of $f'_{d+1}(a)$ extends an element of $f'_d(a)$, and that the same facts hold between $f'_{d+1}(a)$ and $f'_{d+2}(a)$, and so on. For the sake of C2, each $\langle g_0, \dots, g_{i-1} \rangle$ in $f_i(a)$ is also changed at g_{i-1} to match $f'_{i-1}(a)$.

Unfortunately, this definition does not produce the desired results. In certain situations, it can create a W' that does not satisfy the constraints, and is therefore not a valid belief structure. For example, consider a W where

$$\begin{aligned} f_1(a) &= \{p, \neg p\} \\ f_2(a) &= \{ \langle p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ &\quad \quad \quad b \rightarrow \{p\} \quad) \rangle \\ &\quad \langle p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ &\quad \quad \quad b \rightarrow \{\neg p\} \quad) \rangle \\ &\quad \langle p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ &\quad \quad \quad b \rightarrow \{p, \neg p\} \quad) \rangle \\ &\quad \langle \neg p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ &\quad \quad \quad b \rightarrow \{\neg p\} \quad) \rangle \\ &\quad \langle \neg p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ &\quad \quad \quad b \rightarrow \{p, \neg p\} \quad) \rangle \end{aligned}$$

Notice that $W \models B_a(\neg B_b P \vee B_a p)$, that is $B_a(B_b P \supset B_a P)$. So if we were to add that $B_a B_b p$, we would expect $B_a B_a p$ to result and hence $B_a p$. Yet if $AP(W, a, B_b p)$ were performed according to Definition 3, the following would happen. $f'_2(a)$ would retain only the first world of $f_2(a)$, since only it supports $B_b p$ (see clause 1 of the definition). That is,

$$f'_2(a) = \{ \langle p, \quad (\quad a \rightarrow \{p, \neg p\}, \\ \quad \quad \quad b \rightarrow \{p\} \quad) \rangle \}$$

By clause 2, $f'_1(a)$ would retain only those elements of $f_1(a)$ that have an extension in the new $f'_2(a)$. Hence it would be reduced so that

$$f'_1(a) = \{p\}.$$

We have the expected result that by adding $B_a B_b p$ to this particular W , $B_a p$ results. However, the one element $\langle g_0, g_1 \rangle$ in $f'_2(a)$ does not agree with $f'_1(a) — g_1(a) \neq f'_1(a)$. In effect, we have cyclic changes occurring, which are not captured by our definition. Changes to $f_2(a)$ require a change in $f_1(a)$, and this in turn requires that $f_2(a)$ be altered. Clearly, a definition that relies on a simple linear rippling of the constraints will not suffice.

3.4.4 Definition by Stating What Must be Supported

Another approach is to define the set of propositions that W' must support, group them according to their depth, and define each f'_d so that it supports exactly those propositions in the set whose depth is d .

Some preliminary definitions will be useful. First, $S(W, a)$ describes the beliefs of agent a according to belief structure W .

DEFINITION 4: For any belief structure W and agent a , $S(W, a) = \{\beta \mid W \models B_a \beta\}$.

Next, $S^i(W, a, \alpha)$ describes the set of all propositions of depth i that are entailed by the set consisting of a 's beliefs according to W , plus a 's new belief in α .

DEFINITION 5: For all i , any belief structure W , agent a , and proposition $\alpha \in \mathcal{L}$,

$$S^i(W, a, \alpha) = \{\gamma \in \mathcal{L} \mid \text{depth}(\gamma) = i \text{ and } S(W, a) \cup \{\alpha\} \models \gamma\}$$

The simplest *AP* definition based on this is:

DEFINITION 6: Let $W = \langle f_0, f_1, \dots, f_d, f_{d+1}, \dots \rangle$, and $W' = \langle f_0, f'_1, \dots, f'_d, f'_{d+1}, \dots \rangle$. Let $\alpha \in \mathcal{L}$, and $a \in \mathbf{A}$ such that $\{B_a \delta \in \mathcal{L} \mid W \models B_a \delta\} \cup \{B_a \alpha\}$ is consistent, and $d = \text{depth}(B_a \alpha)$. $AP(W, a, \alpha) = W'$ where $f'_i(x) = f_i(x)$ for all $i \geq 1$ and all $x \neq a$, and for all $i \geq 1$:

$$f'_i(a) = \{g \in f_i(a) \mid g \models S^{i-1}(W, a, \alpha)\}.$$

Of course, this definition will not work. As we have shown above, each $f'_i(a)$ cannot be defined simply as a subset of $f_i(a)$. However, by modifying the elements of each $f_i(a)$ before performing the set restriction, we get a definition that is closer to being correct.

DEFINITION 7: Let $W = \langle f_0, f_1, \dots, f_d, f_{d+1}, \dots \rangle$, and $W' = \langle f_0, f'_1, \dots, f'_d, f'_{d+1}, \dots \rangle$. Let $\alpha \in \mathcal{L}$, and $a \in \mathbf{A}$ such that $\{B_a \delta \in \mathcal{L} \mid W \models B_a \delta\} \cup \{B_a \alpha\}$ is consistent, and $d = \text{depth}(B_a \alpha)$. $AP(W, a, \alpha) = W'$ where $f'_i(x) = f_i(x)$ for all $i \geq 1$ and $x \neq a$, and for all $i \geq 1$:

$$f'_i(a) = \{ \langle g_0, g'_1, \dots, g'_{i-1} \rangle \mid \begin{array}{l} 1. \langle g_0, g_1, \dots, g_{i-1} \rangle \in f_i(a) \\ 2. \text{ for } 1 \leq j \leq i-1, \\ \quad g'_j(x) = \begin{cases} g_j(x) & \text{if } x \neq a \\ f'_j(a) & \text{otherwise} \end{cases} \\ 3. \langle g_0, g'_1, \dots, g'_{i-1} \rangle \models S^{i-1}(W, a, \alpha) \end{array} \}$$

Again, however, the definition is inadequate. This time, the problem stems for the definition and use of S^i . Consider performing $AP(W, a, \alpha)$ on a W that supports $\neg B_a \alpha$, $\neg B_a \neg \alpha$, and hence $B_a \neg B_a \alpha$, $B_a \neg B_a \neg \alpha$. Now a 's belief set $S(W, a) \supseteq \{\neg B_a \alpha, \neg B_a \neg \alpha\}$. So

$$S(W, a) \cup \{\alpha\} \supseteq \{\neg B_a \alpha, \neg B_a \neg \alpha, \alpha\}.$$

By definition then,

$$\begin{aligned} S^1(W, a, \alpha) &\supseteq \{\alpha\}, \text{ and} \\ S^2(W, a, \alpha) &\supseteq \{\neg B_a \alpha, \neg B_a \neg \alpha\}. \end{aligned}$$

By our Definition 7 of AP , these S^i contain the propositions that a is supposed to believe in after belief in α is added. However, they are untenable as a belief set. If a believes in α , then by our semantics, he must believe $B_a \alpha$. Yet $\neg B_a \alpha$ is in the proposed belief set. As a result, it is impossible to create a belief structure W' that satisfies Definition 7.

3.5 Summary

We now have a language for expressing propositions involving beliefs, and a method for modelling the beliefs of agents. The AP and RP operations for updating our current notion of the beliefs of agents have only been described. In the remainder of this thesis, we assume that these operations exist, and leave their formal definitions for future work.

Chapter 4

The Definition of Presupposition

We now present our definition of presupposition, one that embodies the idea of attributing presuppositions to specific agents, and makes use of the language for expressing presuppositions, developed in the last chapter.

4.1 Notation

Sp will be used to refer to a speaker and L to refer to a listener, where $Sp, L \in \mathbf{A}$. The term **state**, and the letter s , will be used to refer to a particular state of affairs, *i.e.*, configuration of the primitive propositions and of the agents' beliefs, as encoded by a belief structure. The letters S and U will be used to refer to sentences and utterances respectively. Finally, \hat{S} will be used to denote the proposition expressed by the Sentence S . For convenience, we will often use a sentence to denote the proposition which that sentence expresses. For example, we might use $B_{Sp}(\textit{John likes to sing})$ to mean something of the sort $B_{Sp}(\textit{likes}(\textit{John}, \textit{sing}))$. This will allow us to ignore issues of semantic representation which are orthogonal to those issues which are addressed here.

4.2 Developing our Definition of Presupposition

We stated earlier that presuppositions of an utterance can only say something about the beliefs of the speaker, not about the actual truth-value of any proposition. Hence, presupposition must be relative to the speaker. Furthermore, presuppositions depend upon the listener and his current beliefs, as such beliefs affect the cancellation of presuppositions. So an actual presupposition must be relative to a speaker, listener, and state. We will refer to this as “contextual information”.

We sometimes wish to speak of presuppositions when not all of the contextual information is known. In particular, it is useful to be able to discuss presuppositions of a sentence entirely out of context, as we have done throughout this thesis. Even though it might be argued that there can never exist a sentence entirely without context, treating a sentence as extracted from its context allows one to capture general properties that hold regardless of the context in which the sentence may occur. Whenever some of the contextual information is unknown, one cannot perform the usual consistency check to

determine whether or not a proposition will actually turn out to be a presupposition; but one *can* say that if the necessary contextual information was available and the proposition was consistent with established information, it would be a presupposition. We will define **potential presupposition** to capture this notion of a presupposition which may turn out to hold, and **actual presupposition** to denote a potential presupposition which does turn out to hold¹

The minimal requirement for determining potential presuppositions is that we have a sentence. In addition, some contextual information may be known. Thus potential presupposition can be defined for a sentence alone, and for each combination of a sentence and some contextual information. The result is eight very similar definitions of potential presupposition. They are simply different instantiations of the same idea.

4.2.1 The Definitions

Before presenting the definitions, we introduce a notational convenience. For any Sentence S , we will use S^+ to represent the positive form of the sentence, and S^- to represent the negated form of the sentence. If S is a negated sentence, then $S^- = S$; if it is not, then $S^+ = S$. In either case, the opposite form of the sentence is attained by negating S with a phrase like “*it is not true that*”. This unambiguously produces external negation. In some cases, the result is equivalent in meaning to the sentence obtained by negating the main verb of S , but we will not assume so. The examples below illustrate this distinction.

1. If $S =$ “*John, who played Romeo, is a bachelor*”, then $S^+ = S$ and $S^- =$ “*It is not true that John, who played Romeo, is a bachelor*”. S^- is not semantically equivalent to “*John, who played Romeo, is not a bachelor*”, or to “*John, who did not play Romeo, is a bachelor*”. In fact, it is ambiguous between these two readings.
2. If $S =$ “*David didn't wrap the gift*”, then $S^- = S$ and $S^+ =$ “*It is not true that David didn't wrap the gift*”. There is only one element of the communicative content of S and thus only one thing which the “*it is not true that*” can negate, so S^+ is semantically equivalent to “*David did wrap the gift*”,

We now give the definitions for potential and actual presupposition. They will be followed by detailed explanations and examples.

Potential Presupposition

A potential presupposition is a proposition which could turn out to be a presupposition if all contextual information was available and the proposition was not contradicted by current beliefs. As stated above, there are several possible definitions of potential presupposition. First, we give a definition of potential presupposition for when only the sentence is known:

¹Gazdar's concepts of **pre-supposition** and **actual presupposition** correspond only roughly to our potential presupposition and actual presupposition (respectively). See Section 7.1.

DEFINITION 1: Sentence S **potentially presupposes** proposition P iff for any speaker Sp , listener L , and state s ,

- (a) The utterance of S^+ by Sp to L in state s would allow L to infer $B_{Sp}P$.
- (b) The utterance of S^- by Sp to L in state s would allow L to infer $B_{Sp}P$ unless L already believed $B_{Sp}\neg P$, *i.e.* unless $s \models B_L B_{Sp}\neg P$.

By this definition, a potential presupposition of the sentence “*John forgot to call*” would be “*John meant to call*”. In determining this, the proposition $Bel_{Sp}(\textit{John meant to call})$ is tested against clauses (a) and (b).

Clause (a) of the definition says that if the positive form of the sentence were spoken, any listener could infer that the speaker believed P . Clause (b) says that even if the negative form of the sentence were spoken, any listener could still infer that the speaker believed P , unless the listener already believed that this is false.

We will now explain some of the finer details of this definition. First, why does B_{Sp} appear in the definition? The presupposition of a sentence alone cannot itself refer to a speaker of the sentence since no speaker has been specified. However, within the definition, the variable Sp has been quantified, so we are dealing with an inference drawn from an *utterance* of the sentence. Recall that while it may be assumed that a sentence is true when making inferences from it, when inferences are made from an utterance it may only be assumed that the speaker believes the sentence to be true. So the inference drawn from the utterance must begin with B_{Sp} . Yet, as was said, B_{Sp} cannot be part of the potential presupposition of a sentence. This is why the B_{Sp} must be extracted and mentioned explicitly in the definition. Second, why is clause (b), involving the utterance of S^- , necessary? Nothing like this has appeared in any of the earlier definitions. This clause is necessary to distinguish potential presupposition from other inferences which can be drawn from a sentence, such as entailment, conversational implicature, and conventional implicature. Without its inclusion, our definition would also capture these inferences. Since only presupposition exhibits this behaviour under negation, the S^- clause suffices to exclude the other inferences. The examples below will illustrate this point.

It is usually sufficient to be able to speak of potential presuppositions of a sentence out of context, and actual presuppositions of the sentence placed in a particular context. However, we can also define potential presupposition where any of the contextual parameters Sp , L , and s are known by simply making the known parameters fixed. These definitions may sometimes be convenient. For completeness, we now describe them.

All definitions of potential presupposition for unknown speaker are identical to this previous one, except for the variable bindings. For example, potential presupposition could be defined for a sentence with a given listener, as follows:

DEFINITION 2: Sentence S **potentially presupposes** proposition P for listener L iff for any speaker Sp and state s ,

- (a) The utterance of S^+ by Sp to L in state s would allow L to infer $B_{Sp}P$.
- (b) The utterance of S^- by Sp to L in state s would allow L to infer $B_{Sp}P$ unless L already believed $B_{Sp}\neg P$, *i.e.* unless $s \models B_L B_{Sp}\neg P$.

In the definition		Example (For $S = \text{“John forgot to call”}$)	
Parameters known	Parameters universally quantified	Potential Presupposition	Proposition which is tested against clauses (a) and (b)
S	Sp, L, s	John meant to call	$B_{Sp}(\text{John meant to call})$
S, L	Sp, s	John meant to call	$B_{Sp}(\text{John meant to call})$
S, s	Sp, L	John meant to call	$B_{Sp}(\text{John meant to call})$
S, L, s	Sp	John meant to call	$B_{Sp}(\text{John meant to call})$
S, Sp	L, s	$B_{Sp}(\text{John meant to call})$	$B_{Sp}(\text{John meant to call})$
S, Sp, L	s	$B_{Sp}(\text{John meant to call})$	$B_{Sp}(\text{John meant to call})$
S, Sp, s	L	$B_{Sp}(\text{John meant to call})$	$B_{Sp}(\text{John meant to call})$
S, Sp, L, s		$B_{Sp}(\text{John meant to call})$	$B_{Sp}(\text{John meant to call})$

Table 4.1: Summary of the potential presupposition definitions

Now when Sp is among the known contextual variables, we are dealing with a potential presupposition of an utterance rather than a sentence. In such cases, the assumption is not that S is true, but that Sp believes it to be true. Hence, any presupposition (potential or actual) of an *utterance* should begin with B_{Sp} . That is, the B_{Sp} should appear in the presupposition itself, and the definition is adjusted to ensure this. For known sentence and speaker, we have:

DEFINITION 3: The utterance of Sentence S by speaker Sp **potentially presupposes** proposition $B_{Sp}P$ iff for any listener L and state s ,

- (a) The utterance of S^+ by Sp to L in state s would allow L to infer $B_{Sp}P$.
- (b) The utterance of S^- by Sp to L in state s would allow L to infer $B_{Sp}P$ unless L already believed $B_{Sp}\neg P$, i.e. unless $s \models B_L B_{Sp}\neg P$.

For example, a potential presupposition of the utterance by Tom of “*John forgot to call*” would be $B_{Tom}(\text{John meant to call})$. In order to determine this, the proposition $B_{Tom}(\text{John meant to call})$ is checked against clauses (a) and (b).

All definitions of potential presupposition where the speaker is known are the same as the one above, excluding variable bindings. In total there are four definitions of this form (speaker known), and four with the form of definition 1 (speaker unknown). Table 4.1 summarizes the ways that potential presupposition can be defined.

When determining potential presuppositions, there is a simple way to check if clause (a) of the definitions is true for a given candidate proposition². Consider following an utterance of Sentence S by the utterance of another sentence that contradicts the candidate proposition. If the candidate proposition is a potential presupposition of S , then any listener would find these utterances infelicitous, because of the contradiction. So, a

²Our use of the words “candidate” and “potential” may require clarification. “Candidate” is used exclusively in its usual English sense, while “potential” is used solely in the phrase “potential presupposition”, which is a technical term defined in this chapter.

candidate proposition P satisfies clause (a) of the potential presupposition definition for Sentence S if the utterance of S followed by some other sentence which contradicts P would be infelicitous for any listener. For example, consider testing the proposition expressed by 2 as a potential presupposition of 1.

- (1) I regret leaving.
- (2) I left.

Since the utterance of 3 would be infelicitous, 2 passes clause (a) of the potential presupposition definition.

- (3) * I regret leaving, but I didn't leave.

Actual Presupposition

If *all* of the contextual parameters are known, one can determine whether or not the proposition is actually a valid inference. An actual presupposition is a potential presupposition for which all the contextual information is known and which does turn out to be consistent with this information. A definition of actual presupposition that is based on the definition of potential presupposition for when only the sentence is known, definition 1, is as follows:

DEFINITION 4: The utterance of Sentence S by speaker Sp in state s **actually presupposes** proposition $B_{Sp}P$ for listener L iff

- (a) P is a potential presupposition of S .
- (b) If $S = S^-$, $s \not\models B_L B_{Sp} \neg P$.

It is the (b) clause of this definition which determines whether the potential presupposition P actually turns out to hold, based upon the speaker's and listener's beliefs.

If the definition of actual presupposition is based on a definition of potential presupposition for utterances rather than sentences, a definition of the following sort results:

DEFINITION 5: The utterance of Sentence S by speaker Sp in state s **actually presupposes** proposition $B_{Sp}P$ for listener L iff

- (a) $B_{Sp}P$ is a potential presupposition of the utterance of S by Sp .
- (b) If $S = S^-$, $s \not\models B_L B_{Sp} \neg P$.

4.3 Modelling Actual Presuppositions

We now describe how to use the formal apparatus which was developed in the last chapter to update the current state as new information about actual presuppositions is gathered.

Actual presuppositions are to be represented by sentences in \mathcal{L} . When a new actual presupposition P is found, the current state must be updated. This done by the Add Presupposition operation $AP(s, L, P)$, where L is the listener. A new state s' is returned,

where $s' \models B_L P$. If at some later time a contradiction to a presupposition from a negative sentence is discovered, the assumption regarding the meaning of the negation must have been incorrect, and the presupposition must be retracted. $RP(s, L, P)$ is intended to perform this task. It returns a new state s' such that $s' \not\models B_L P$. Remember that a presupposition of a positive sentence cannot be retracted in this manner since a contradiction to the presupposition would result in an infelicity, as in the following sentence:

- (4) * It's too bad that Jane cancelled her trip, but she didn't cancel it.

4.4 Perspective

So far we have treated the model as all-knowing — it records accurately the beliefs of agents involved in discourse. This can be described as taking a God's-eye view or perspective. Such a perspective is appropriate for a system which is to read text or simply view discourse.

For a system which is to actually participate in discourse (*i.e.* where L or Sp might be “the system”), we must be able to model a participant with its own beliefs as well as fallible opinions about the beliefs of others. This approach could be described as taking one agent's perspective. It can be achieved by simply selecting an agent as special — the one whose view we are representing. We will use v to represent this agent. All propositions $B_v P$ (where P itself may or may not contain B 's) supported by the model in a state are the beliefs of the special agent. Agent v can have incorrect beliefs about the beliefs of others. For example, a state can support both $B_i P$ and $B_v B_i \neg P$ or both $\neg B_i P$ and $B_v B_i P$. Agent v can also have beliefs about his own beliefs, such as $B_v \neg B_v P$.

Agent v can take any one of three roles in discourse — that of a speaker, a listener, or simply a viewer who is not directly involved. In order to determine actual presuppositions “according to v 's perspective”, we need to check not whether the listener's beliefs contradict the potential presuppositions, but whether v *thinks that* this is so. Thus, we have an additional definition of actual presupposition which takes an agent's perspective, rather than an all-knowing one, as the existing definitions do:

DEFINITION 6: The utterance of Sentence S by speaker Sp in state s **actually presupposes** proposition $B_{Sp} P$ for listener L according to agent i iff

- (a) $B_{Sp} P$ is a potential presupposition of the utterance of S by Sp .
- (b) If $S = S^-$, $s \not\models B_i B_L B_{Sp} \neg P$.

4.4.1 Modelling Presupposition From a Perspective

Consider adding a presupposition P of a positive sentence, from v 's perspective. The operation to use is $AP(s, v, B_L P)$, rather than $AP(s, L, P)$ which is used when we are taking a God's-eye view. If v is an uninvolved viewer, the operation returns s' , where $s' \models B_v B_L P$. If v is himself the listener, $s' \models B_L B_L P$; if v is the speaker, $s' \models B_{Sp} B_L P$.

Perspective	Operation	Result is s' where
God's-eye view	$operation(s, L, P)$	$s' \models B_L P$
v 's view		
(a) $L \neq v, Sp \neq v$	$operation(s, v, B_L P)$	$s' \models B_v B_L P$
(b) $L = v$	$operation(s, L, B_L P)$	$s' \models B_L B_L P$
(c) $Sp = v$	$operation(s, Sp, B_L P)$	$s' \models B_{Sp} B_L P$

Table 4.2: Effects of perspective on operation performed and result, for actual presupposition P ($operation = AP$ or RP).

The Retract Presupposition operation is affected in the same manner when we take v 's perspective. Table 4.2 summarizes the operations performed depending on our perspective.

4.5 Examples

The following examples show how to determine whether a proposition is a potential presupposition of a sentence, and how to check if it is also an actual presupposition. They also illustrate how other inferences are excluded by our definitions of presupposition.

4.5.1 A Presupposition from Various Views

In this example, we will look for potential presuppositions of a sentence, and then put the sentence into a context and check for actual presuppositions from various views.

Determining the potential presuppositions of the sentence

Let $S = \text{"I'm not glad that Chris is taking gymnastics"}$.

- $S^+ = \text{"It is not true that I'm not glad that Chris is taking gymnastics"}$, which is equivalent to $\text{"I'm glad that Chris is taking gymnastics"}$, and $S^- = S$.
- For any speaker Sp , listener L , and state s , the utterance of S^+ by Sp would allow L to conclude $B_{Sp}(Chris\ is\ taking\ gymnastics)$. For example, if Tom said $\text{"I'm glad that Chris is taking gymnastics"}$ to Diane, she could conclude that Tom believed that Chris is taking gymnastics. We can confirm this by noting that the utterance of $\text{"I'm glad that Chris is taking gymnastics, but he isn't"}$ would be infelicitous.
- For any speaker Sp , listener L and state s , the utterance of S^- by Sp would also allow L to conclude $B_{Sp}(Chris\ is\ taking\ gymnastics)$, unless $B_{Sp}(Chris\ is\ taking\ gymnastics)$ were inconsistent with s . For example, if Tom said $\text{"I'm not glad that Chris is taking gymnastics"}$ to Diane, she could conclude that Tom believed that Chris is taking gymnastics, unless that were inconsistent with what she already believed, *i.e.* unless she thought that Tom thought Chris wasn't taking gymnastics.

- Therefore (*Chris is taking gymnastics*) is a potential presupposition of Sentence S .
- Let $P = (\textit{Chris is taking gymnastics})$.

Determining whether the presupposition is actual

Let the context be as follows. L is Diane, Sp is Tom, and the state is s where

$$\begin{array}{ll} s \not\models B_{Diane}B_{Tom}\neg P & s \not\models B_{Diane}B_{Diane}B_{Tom}\neg P \\ s \models B_{Tom}B_{Diane}B_{Tom}\neg P & s \not\models B_{Karlin}B_{Diane}B_{Tom}\neg P \end{array}$$

(a) from a God's-eye view.

- $P = (\textit{Chris is taking gymnastics})$ is a potential presupposition of Sentence S (as shown above).
- Since S is negative ($S = S^-$), we must perform the consistency check from clause (b) of the actual presupposition definition.
- $s \not\models B_L B_{Sp} \neg P$, i.e. $s \not\models B_{Diane} B_{Tom} \neg P$. Nothing contradicts for Diane the thought that Tom believes Chris is taking gymnastics.
- Therefore, $B_{Sp}(\textit{Chris is taking gymnastics})$ is an actual presupposition to L , of the utterance by Sp of Sentence S in state s . That is $B_{Tom}(\textit{Chris is taking gymnastics})$ is an actual presupposition to Diane of the utterance of the sentence “*I'm not glad that Chris is taking gymnastics*” by Tom, in this state.
- This is asserted by performing the Add Presupposition operation $AP(s, L, B_{Sp}P)$, i.e. $AP(s, Diane, B_{Tom}P)$. We then have $s' \models B_{Diane}B_{Tom}P$.

(b) from the speaker's (Tom's) view.

- $P = (\textit{Chris is taking gymnastics})$ is a potential presupposition of Sentence S (as shown above).
- Since S is negative ($S = S^-$), we must perform the consistency check from clause (b) of the actual presupposition definition.
- $s \models B_{Sp}B_L B_{Sp} \neg P$, i.e. $s \models B_{Tom}B_{Diane}B_{Tom} \neg P$. Tom thinks Diane would find the potential presupposition of his sentence contradictory; he thinks that she thinks he thinks Chris isn't taking gymnastics.
- Therefore, $B_{Sp}(\textit{Chris is taking gymnastics})$ is not an actual presupposition to L , of the utterance by Sp of Sentence S in state s , according to Sp . That is, $B_{Tom}(\textit{Chris is taking gymnastics})$ is not an actual presupposition to Diane of the utterance of the sentence “*I'm not glad that Chris is taking gymnastics*” by Tom, in this state, according to Tom.
- Therefore, no AP operation is required.

(c) from the listener's (Diane's) view.

- $P = (\textit{Chris is taking gymnastics})$ is a potential presupposition of Sentence S (as shown above).

- Since S is negative ($S = S^-$), we must perform the consistency check from clause (b) of the actual presupposition definition.
- $s \not\models B_L B_L B_{Sp} \neg P$, i.e. $s \not\models B_{Diane} B_{Diane} B_{Tom} \neg P$. Diane realizes that nothing contradicts for her the thought that Tom believes Chris is taking gymnastics.
- Therefore, $B_{Sp}(Chris\ is\ taking\ gymnastics)$ is an actual presupposition to L , of the utterance by Sp of Sentence S in state s , according to the listener. That is, $B_{Tom}(Chris\ is\ taking\ gymnastics)$ is an actual presupposition to Diane of the utterance of the sentence “*I’m not glad that Chris is taking gymnastics*” by Tom, in this state, according to Diane.
- This is asserted by performing the Add Presupposition operation $AP(s, L, B_L B_{Sp} P)$, i.e. $AP(s, Diane, B_{Diane} B_{Tom} P)$. We then have $s' \models B_{Diane} B_{Diane} B_{Tom} P$.

(d) from a third party’s (Karin’s) view.

- $P = (Chris\ is\ taking\ gymnastics)$ is a potential presupposition of Sentence S (as shown above).
- Since S is negative ($S = S^-$), we must perform the consistency check from clause (b) of the actual presupposition definition.
- $s \not\models B_v B_L B_{Sp} \neg P$, i.e. $s \not\models B_{Karin} B_{Diane} B_{Tom} \neg P$. Karin thinks that nothing contradicts for Diane the thought that Tom believes Chris is taking gymnastics.
- Therefore, $B_{Sp}(Chris\ is\ taking\ gymnastics)$ is an actual presupposition to L , of the utterance by Sp of Sentence S in state s according to v . That is, $B_{Tom}(Chris\ is\ taking\ gymnastics)$ is an actual presupposition to Diane of the utterance of the sentence “*I’m not glad that Chris is taking gymnastics*” by Tom, in this state, according to Karin.
- This is asserted by performing the Add Presupposition operation $AP(s, v, B_L B_{Sp} P)$, i.e. $AP(s, Karin, B_{Diane} B_{Tom} P)$. We then have $s' \models B_{Karin} B_{Diane} B_{Tom} P$.

4.5.2 An Entailment Rejected by the Definition

We will show that an entailment can pass clause (a) of our potential presupposition definition. It is only clause (b) which allows us to reject it.

Let $S =$ “*Ben has exactly twelve insecticon toys.*”

- $S^+ = S$ and $S^- =$ “*It is not true that Ben has exactly twelve insecticon toys.*”
- For any speaker Sp , listener L , and state s , the utterance of S by Sp would allow L to conclude $B_{Sp}(Ben\ has\ at\ least\ one\ insecticon\ toy)$. For example, if Tom said “*Ben has exactly twelve insecticon toys*” to Diane, she could conclude that Tom believed Ben has at least one insecticon toy. We can confirm this by noting that the utterance of “*Ben has exactly twelve insecticon toys, but he doesn’t have any*” would be infelicitous.

- However, the utterance of S^- by Sp in state s would not allow L to conclude that $B_{Sp}(Ben\ has\ at\ least\ one\ insecticon\ toy)$, even if it were consistent with L 's beliefs. For example, if Tom said “*It’s not true that Ben has exactly twelve insecticon toys*” to Diane, she could not conclude that Tom believes that Ben has at least one.
- Therefore (*Ben has at least one insecticon toy*) is not a potential presupposition of Sentence S (although it is an entailment of the sentence).

4.5.3 A Conversational Implicature Rejected by the Definition

Let $S =$ “*Dan was dressed as either Batman or Robin*”.

- $S^+ = S$ and $S^- =$ “*It is not true that Dan was dressed as either Batman or Robin*”.
- For any speaker Sp , listener L , and state s , the utterance of S by Sp would allow L to conclude $Bel_{Sp}(It’s\ possible\ that\ Dan\ was\ dressed\ as\ Batman)$. For example, If Tom said “*Dan was dressed as either Batman or Robin*” to Diane, she could conclude that Tom believed that Dan may have been dressed as Batman. We can confirm this by noting that the utterance of “*Dan was dressed as either Batman or Robin, but he couldn’t have been dressed as Batman*” would be infelicitous.
- However, the utterance of S^- by Sp in state s would not allow L to conclude that $B_{Sp}(Dan\ may\ have\ been\ dressed\ as\ Batman)$, even if it were consistent with the state. For example, if Tom said “*It’s not true that Dan was dressed as either Batman or Robin*” to Diane, she could not conclude that Tom believes that Dan may have been dressed as Batman.
- Therefore (*It’s possible that Dan was dressed as Batman*) is not a potential presupposition of Sentence S (although it is a conversational implicature of the sentence).

4.5.4 A Conventional Implicature Rejected by the Definition

Let $S =$ “*Even Andrew was surprised by their engagement*”.

- $S^+ = S$ and $S^- =$ “*It is not true that even Andrew was surprised by their engagement*”.
- For any speaker Sp , listener L , and state s , the utterance of S by Sp would allow L to conclude $Bel_{Sp}(Andrew\ wasn’t\ likely\ to\ be\ surprised\ by\ their\ engagement)$. For example, if Tom said “*Even Andrew was surprised by their engagement*” to Diane, she could conclude that Tom believed Andrew wasn’t likely to be surprised by their engagement. We can confirm this by noting that the utterance of “*Even Andrew was surprised by their engagement, but he was likely to be*” would be infelicitous.
- However, the utterance of S^- by Sp in state s would not allow L to conclude that $B_{Sp}(Andrew\ wasn’t\ likely\ to\ be\ surprised\ by\ their\ engagement)$, even if it were consistent with L 's beliefs. For example, if Tom said “*It’s not true that even Andrew was surprised by their engagement*” to Diane, she could not conclude that Tom believes that Andrew wasn’t likely to be surprised.

- Therefore (*Andrew wasn't likely to be surprised by their engagement*) is not a potential presupposition of Sentence S (although it is a conventional implicature of the sentence).

4.6 Markedness of Presuppositions

The notions introduced in this section are intended to capture the distinction between presuppositions which are just consistent with the beliefs of an agent and will thus surprise him somewhat, and presuppositions which are already believed by an agent. We will call the former “marked” and the latter “unmarked” for that agent. We will view markedness from any particular agent’s perspective. These notions can be defined as follows:

DEFINITION 7: An actual presupposition P for listener L of the utterance of Sentence S by speaker Sp in state s is **marked** according to agent i iff $s \not\models B_i B_L P$.

Of course, i may be an uninvolved viewer, or the speaker or listener.

It may also be useful to be able to determine when the speaker is *intentionally* attempting to surprise the listener. The following definition captures this.

DEFINITION 8: An actual presupposition P for listener L of the utterance of Sentence S by speaker Sp in state s is **intentionally marked** according to agent i iff $s \not\models B_i B_{Sp} B_L P$.

Again, i may be the listener, the speaker, or neither.

These notions can be useful for a speaker wishing to achieve certain effects, or for a listener or other agent trying to detect such attempts. Consider the speaker. When he is planning an utterance, the speaker needs to know how the presuppositions of a sentence will be perceived by his listeners. He may use a presupposition to surprise or impress the listener. For example, if Tim just bought a new Porsche, he might utter Sentence 5 to Mike in order to impress him.

(5) Sorry I was late Mike. I got carried away with waxing my Porsche.

The speaker may want to use a marked presupposition to present new information as if it were innocuous or uncontroversial. This was illustrated in the television advertisement and cross-examination examples of Chapter 1. Alternatively, a speaker may wish to rephrase an utterance in order to introduce new information directly. This provides a better opportunity to defend the information.

The concept of markedness is also useful for the listener. If he can determine that the speaker is intentionally using a marked presupposition, then the listener may be able to discern that the speaker is trying to use one of the devices described above, for example to surprise him.

We are now ready to apply our definitions to first-order presuppositions and the projection problem.

Chapter 5

The First-Order Presuppositions

In this chapter we will examine a representative list of presupposition triggers and, keeping in mind our approach and definitions, determine for each what first-order potential presuppositions are indicated. The technique is that shown in the examples of Section 4.5. Sentences will be examined out of context, so the definition of potential presupposition where only the sentence is known will be used. We now reiterate that definition.

DEFINITION 1: Sentence S **potentially presupposes** proposition P iff for any speaker Sp , listener L and state s ,

- (a) The utterance of S^+ by Sp to L in state s would allow L to infer $B_{Sp}P$.
- (b) The utterance of S^- by Sp to L in state s would allow L to infer $B_{Sp}P$ unless L already believed $B_{Sp}\neg P$, *i.e.* unless $s \models B_L B_{Sp}\neg P$.

The other definitions of potential and actual presupposition make clear what should be done if some or all contextual information is known.

We will ignore, for the time being, problems of tense and temporal reference. Suggestions for dealing with these are given in Chapter 7.

For each trigger we do two things. First, we determine which propositions P require consideration as candidate potential presuppositions. Second, we determine which forms of each P (*i.e.* modified by belief operators) are potential presuppositions. For many triggers, we will choose as potential presuppositions the usual propositions given in the literature — propositions with no belief operators. Of course, when any potential presupposition P of a sentence is put into context and checked as an actual presupposition of an utterance of the sentence, its form becomes $B_{Sp}P$. So even if a potential presupposition carries no belief operators, its related actual presupposition will have the form $B_{Sp}P$. If these were the only belief operators required, the use of belief operators would be trivial, and would provide no significant advantage over accounts of presupposition which do not use them. However, for sentences which mention any agents, the operators required may be more complex. For example, consider the following sentence:

- (1) Dave called Howie a gonk, and then Howie insulted him back.

If it was decided that $P = \text{“calling someone a gonk is an insult”}$ requires consideration, then at least the following must be viewed as candidate potential presuppositions:

$$\begin{array}{c}
 P \\
 B_{Howie}P \quad B_{Dave}P \\
 B_{Howie}B_{Dave}P \quad B_{Dave}B_{Howie}P
 \end{array}$$

As we look at each presupposition trigger, the most important issue will be whether or not a presupposition generated by that trigger requires belief operators to be correctly expressed. This is more important than any other conclusions we draw about the trigger.

Note that many sentences imply a proposition $B_X(P)$ (where X is an agent mentioned in the sentence), which may appear to be a potential presupposition of the sentence but is not. For example,

(2) I regret that John left the party.

potentially presupposes (*John left the party*), but what about $B_{John}(\textit{John left the party})$? This is certainly implied by the sentence, however, the implication is due to the nature of the verb “leave”. One normally cannot leave a place without being aware of it. For verbs which describe an action which can be done without awareness of it, the implication does not hold. “Annoy” is one such verb. For example, John can annoy Brenda without realizing it.

(3) I regret that John annoys Brenda.

$\not\Rightarrow B_{John}(\textit{John annoys Brenda})$.

For sentences such as 2, where a proposition is implied by an element of the sentence other than a presupposition trigger and is thus intermittent with respect to the trigger, we will not consider the proposition to be a potential presupposition for that trigger. No information is lost, however, since when such propositions are appropriate, they are implied by the potential presupposition itself.

In our example sentences, the relevant trigger will be underlined.

5.1 Definite Descriptions

Definite descriptions¹ imply the existence of the entity which they describe, which may be not only an object, but an event or state.

(4) That’s not the The Prime Minister!

(5) His loneliness was profound.

(6) Their first performance was last year.

For example, Sentence 4 presupposes

(7) There is a Prime Minister.

This presupposition can be written as $\exists X : X \textit{ is a } D$, where D is the definite descriptor.

There are several difficult issues associated with definite descriptions which bear on these presuppositions. Although we cannot give definitive solutions for these problems, they do deserve mention.

¹See Appendix A of [Fawcett 1985] for a list of the various forms which a definite description can take.

Complex Noun Phrases

One complication arises when the noun phrase under consideration contains other, nested noun phrases such as in:

(8) I spoke to the man wearing the jacket with the crest.

For this sentence, the presupposition is not simply “*There is a man*”, nor is it “*There is a man and there is a jacket and there is a crest*”, for even the latter form does not express information about the relationships among the man, the jacket, and the crest. The presupposition must be “*There is a man wearing a jacket with a crest*”, which can be written as

$$\exists X, Y, Z : man(X) \wedge jacket(Y) \wedge crest(Z) \wedge wearing(X, Y) \wedge on(Y, Z).$$

This carries the extra information about relationships (and entails the other forms mentioned above).

Sometimes an embedded noun phrase is indefinite, as in:

(9) The woman wearing a tiara looks rather pretentious.

The presupposition here is “*there is a woman wearing a tiara*” which can be written as $\exists X, Y : woman(X) \wedge tiara(Y) \wedge wearing(X, Y)$, which entails $\exists Y : tiara(Y)$. However, indefinite descriptions not appearing within a definite description do not necessarily imply the existence of the entity described. For example, compare the following:

(10) Mary found a unicorn.

\gg There is a unicorn.

(11) Mary seeks a unicorn.

$\not\gg$ There is a unicorn.

Those cases where the inference holds correspond to what have been called **transparent contexts**, and those where it does not, to **opaque contexts**. (See [Fawcett 1985] for both a syntactic and a semantic characterization of the opaque constructs.)

Ambiguity With Respect to Specificity

Another difficulty for definite descriptions is that in opaque contexts they exhibit ambiguity with respect to specificity, *i.e.* they are ambiguous at least between a reading in which a specific referent of the description is referred to (**referential reading**), and one in which the class of things which satisfy the description is referred to (**attributive reading**). The following sentence has this ambiguity:

(12) John wants to meet the head of the C.I.A.

(a) John knows of the head of the C.I.A. and wants to meet him.

(b) John wants to meet whoever is the head of the C.I.A.

Presuppositions from referential and attributive readings of definite descriptions require different representations. The presupposition for a referential reading of the descriptor D can be represented as $\exists X : B_{Subj}(X \text{ is } D)$ and that for an attributive reading as $B_{Subj}(\exists X : X \text{ is } D)$. Determining whether a definite description requires a referential or an attributive reading, or if it is ambiguous between them is a difficult problem which we will not address. To indicate the possible ambiguity, we will mark the existence quantifier as \exists' .

Agents of Descriptions

A descriptor can be attributed not only to the speaker, but also to any other agents mentioned in the utterance². For each agent A to whom a definite description D is attributed, we have the extra implication $B_A(\exists' X : X \text{ is } D)$. However, in some contexts, definite descriptors are ambiguous with respect to attribution [Fawcett 1985, Fawcett and Hirst 1986]. For example,

(13) Nadia said that the King of Swaziland is handsome.

exhibits this ambiguity. One reading, in which the descriptor “King of Swaziland” is attributed to Nadia, could occur in a situation like the following: Nadia saw a picture of the King of Swaziland. Nadia said ‘the King of Swaziland is handsome’ and this is being reported. On another reading, the description is not attributed to Nadia: Nadia saw a picture of the King of Swaziland, but didn’t realize who he was. Nadia said ‘that man is handsome’, and this is being reported.

Since we cannot be sure whether the description is attributed to any agents, candidate propositions involving their beliefs are not potential presuppositions.

Uniqueness

Not only does a definite description imply the existence of the entity described, but also its uniqueness. This uniqueness is, of course, only within the context of the utterance. For example,

(14) The singer has a good voice.

does not imply the existence of exactly one singer in the universe, but the existence of exactly one distinguishable singer within the context of utterance. This context can be created by previous discourse, or such tricky things as physical gestures or prior expectations about the utterance. While the last two of these are probably beyond the scope of existing natural language understanding systems, prior discourse is not. Strzalkowski and Cercone [1985] give some interesting ideas on how to establish uniqueness within the linguistic context.

²By “descriptor X is attributed to agent A ” we mean that A knows how to use descriptor X to refer. He does not necessarily know the extension of X .

Referring to a Concept

The final difficulty which we will address involves definite descriptions which refer, not to a physical entity, but to a concept, as in

(15) The man in the moon is an important concept for children.

(16) The boogiemán doesn't exist!

These, of course, do not carry the usual presupposition. We could designate two existence quantifiers — one for the usual “real-world” existence, and one for existence in the platonic universe of concepts. Hobbs suggests using as a model a “Platonic universe which contains everything that can be spoken of — objects, events, states, conditions — whether they exist in the real world or not. It then may or may not be a property of such entities that they exist in the real world” [Hobbs 1985, 62].

Explicitly representing the beliefs of agents about concepts as well as real-world entities might prove useful, since we cannot assume that all people share the same concepts. However, actually determining which sort of reference (real-world or platonic universe) is intended for a given descriptor is a problem which we will not address.

5.2 Factive Verbs

Factive or factual verbs ([Kiparsky and Kiparsky 1971], [Quirk and Greenbaum 1973]) give a factual report. Hence, they have been said to presuppose that their complements are true.

(17) John regrets leaving school.

(18) I'm happy that you can come.

(19) It was odd that he didn't come.

In order to determine if belief operators are necessary for presuppositions of sentences with factive verbs, we will examine two sorts of factive individually.

Factives of the form “*It is X that Y*”, such as 19, have no subject, so the answer is simple in these cases — the potential presupposition of an utterance is simply C where C is the complement of the factive verb.

For factives with a subject, such as 17 and 18, we must determine which of C and $B_{Subj}(C)$ are potential presuppositions. In fact, a factive sentence can be valid even if its C is false. Consider:

(20) John regrets making a fool of himself, but he really didn't.

$\not\Rightarrow$ John made a fool of himself.

We argue that this is not a case of cancellation since it has occurred in a positive sentence. Hence, C is not a potential presupposition. However, $B_{Subj}(C)$ normally is. For the above example, we have the presupposition:

(21) B_{John} (John made a fool of himself).

There is a class of factive verbs (with subjects) for which $B_{Subj}(C)$ is not a potential presupposition. Sentences of this class are characterized by having as their meaning either $B_{Subj}(C)$ or $\neg B_{Subj}(C)$. For example

(22) John is aware that the car won't start.

is of the first sort, *i.e.* its meaning is $B_{John}(\text{the car won't start})$. Sentences of this sort contradict the presupposition when they are negated. The sentence

(23) Mary is ignorant of the fact that it's raining.

is of the second sort, *i.e.* its meaning is $\neg B_{Mary}(\text{it's raining})$. Sentences of this sort contradict the presupposition as they are. Since presupposition is constant under negation, the utterance of both types of sentence cannot carry the presupposition $B_{Subj}(C)$.

There is a parallel set of subject-less factive verbs which do not carry the usual presupposition that their complements are true. Sentences of this class, such as 24, are characterized by having “ C is true” as their meaning.

(24) It's true that John failed.

Such sentences cannot presuppose that their complement is true, because this proposition is directly contradicted in their negated forms, while presupposition is constant under negation.

(25) It's not true that John failed.

✗ John failed.

So the presupposition of an utterance of a sentence containing a factive verb is C (where C is the complement of the factive) if the factive has no subject, and $B_{Subj}(C)$ if the factive has a subject, with the exceptions noted³.

5.3 Contrafactive Verbs

Contrafactive verbs are similar in structure to factives, but with the opposite implication — that their complement is false.

(26) I wish that I were Queen.

(27) He pretended that he had seen a U.F.O.

Contrafactives do not have a subject-less form comparable to that of factives so there is only one case to consider. A sentence containing a contrafactive with subject $Subj$ and complement C presupposes $B_{Subj}(\neg C)$ but not $\neg C$. This is parallel to our conclusion about factives with a subject, and is supported by the following example:

³We could alternatively have divided the class of factives into two. The first would contain those whose meaning is either $B_{Subj}(C)$ or $\neg B_{Subj}(C)$, and hence do not presuppose $B_{Subj}(C)$; the second would contain all other factives and they would have the potential presupposition. This would complicate the classification of triggers, but maintain the homogeneity of each class.

Verb type	Implications
Implicative	S^+ implies C S^- implies $\neg C$
Factive	S^+ implies C S^- implies C
Contrafactive	S^+ implies $\neg C$ S^- implies $\neg C$

Table 5.1: Comparison between implicative and other verb types

- (28) Ron wishes that he was healthy, but he's a perfectly healthy hypochondriac.
 $\gg B_{Ron}(\text{Ron is not healthy})$
 $\not\gg \text{Ron is not healthy.}$

So a presupposition of the utterance of a contrafactive sentence with complement C and subject $Subj$ is $B_{Subj}(\neg C)$.

5.4 Implicative Verbs

- (29) He didn't dare show up.
 (30) Gerhard took the time to explain it to me.

This class of verbs is defined in [Karttunen 1971] by giving a list of properties which distinguish verbs in the class from all others. We will describe what appear to be necessary and sufficient conditions for a verb to be implicative.

DEFINITION 2: Verb v occurring as the main verb in Sentence S , and with complement⁴ C is **implicative** iff

1. S^+ implies C
2. S^- implies $\neg C$

For example, “*dare*” is an implicative since “*he didn't dare show up*” implies that “*he didn't show up*”, while “*he dared to show up*” implies that “*he did show up*”. Table 5.1 summarizes the differences between these and other verbs.

Consider the following argument. Let S be a positive implicative sentence with complement C . Because it is implicative, S^+ implies C , and S^- implies $\neg C$. Because it is positive, $S^+ = S$ and $S^- = \neg S$. By substitution we have S implies C and $\neg S$ implies $\neg C$. If we used a strictly logical analysis, we could conclude that C implies S , and in fact $S \equiv C$. This would predict, for example, that Sentence 31 implies 32.

⁴This use of the term “complement” is loose.

(31) John came.

(32) John managed to come.

Of course 32 carries more information than just that stated by 31. Sentence 31 is necessary but insufficient for the truth of 32. The extra, unstated, information which makes “ C implies S ” possible, is the presupposition of S , in this case something of the sort “*John tried to come*”, or “*It was hard for John to come*”.

So the presupposition of the utterance of a sentence containing an implicative depends on the implicative verb.

5.5 Change-of-state Verbs

Sentences with a change-of-state verb express that a change occurred at some time which may be only vaguely described, and they presuppose that a particular state existed before that change. The description of the state depends on the verb used.

(33) Alena will finish reading the book on Tuesday.

(34) John continues to annoy Brenda.

(35) It's starting to get cold.

For example, Sentence 34 presupposes

(36) John has been annoying Brenda.

while 35 presupposes

(37) It hasn't been cold.

The presupposition of the utterance of a sentence containing a change-of-state verb is thus St , where St describes a state which depends on the change-of-state verb.

Perhaps change-of-state verb is a misnomer because the class includes verbs such as “*continue*” which do not indicate a *change* in state. The cohesive property of this class is that the members describe a state from which one can infer something about some state occurring at another time. In contrast,

(38) John will be home at 2:00.

while describing a state, does not tell us anything about states occurring before or after 2:00, and does not fall into the change-of-state class.

The problem of tense is particularly important for change-of-state verbs. As mentioned in Chapter 1, it is not sufficient for the presupposition to express that the state expressed by St exists. It must express that the state exists *before the change*, and this is reflected in the verb tense used. For example, a presupposition of the utterance of 39 should be not simply 40, but 41.

(39) John moved out of the house in March.

(40) John lived in the house.

(41) John had been living at the house before March.

This requirement is most obvious with sentences, like 39, containing a temporal reference.

5.6 Iteratives

Iterative constructions express that some event or state will be repeated, and presuppose that this event or state occurred before the repeating.

- (42) John won't do that again.
- (43) Y'all come back now, y'hear?
- (44) Reagan was re – elected in 1984.

For example, 44 presupposes that Reagan was elected before 1984. So the presupposition of the utterance of an iterative sentence depends on the iterative construct used.

5.7 Temporal Clauses

Temporal clauses trigger a presupposition that the event in the clause did occur.

- (45) While it rained, I climbed El Castillo.
- (46) After we had dessert, the band played some jazz.
- (47) Perhaps when I am famous and my diary is discovered people will understand the torment of being a 13 $\frac{3}{4}$ -year-old undiscovered intellectual⁵.

For example, the utterance of 46 presupposes that we had dessert. In sentences such as this, where the temporal clause has a subject, we must consider whether or not $B_{Subj}(E)$ (occurred) is also a presupposition of the utterance. This is one of the cases where, if the inference is valid, it is due to the nature of the verb, and not the presupposition trigger. Hence, this proposition is not a potential presupposition of such sentences.

So the presupposition of the utterance of a sentence containing a temporal clause is that E occurred (or will occur).

5.8 Cleft and Pseudo-cleft Structures

- (48) It was Bill who kissed Mary on the steps.
- (49) What we need is a trip to Montréal.
- (50) A new school uniform is what Adrian longed for.

Sentence 48 exhibits cleft structure [Quirk and Greenbaum 1973, 414–417] dividing what is a single clause in

- (51) Bill kissed Mary on the stairs.

⁵Sue Townsend, *The Secret Diary of Adrian Mole aged 13 3/4*, Methuen London Ltd., 1982, p. 23.

into two pieces, each with its own verb. Clefts place focus on a particular element of the sentence. By rearranging the cleft, one can focus on any element of the sentence:

(52) It was Mary who Bill kissed on the stairs.

(53) It was on the stairs that Bill kissed Mary.

The focus in a cleft sentence is contrastive, that is, a contrast is implied between the focus and other fillers which might have occurred in its place. The rest of the sentence is accepted as true. For example, Sentence 53 can be interpreted to mean “*We all know Bill kissed Mary, but where he did it is the question. In fact, he did it on the stairs*”.

A typical cleft sentence has the form “*It be X that Y*”. A pseudo-cleft structure has the same purpose and interpretation but a different structure. We will denote these as “*Wh-element Y is X*” or “*X is Wh-element Y*”. Sentences 49 and 50 are examples of pseudo-clefts of these forms.

The presupposition associated with both cleft and pseudo-cleft structures is roughly that *Y* is factual for some *X*. For example, a presupposition of the utterance of 48 is “*Mary was kissed by someone on the stairs*”, and of 50 is “*Adrian longed for something*”.

So the presupposition of the utterance of a cleft or pseudo-cleft sentence is that *Y* is true for some *X*.

5.9 Implicit Clefts

Implicit clefts are semantically and pragmatically equivalent to their corresponding cleft or pseudo-cleft structures. They focus on an element of a sentence. However, they indicate this focus using phonetic stress rather than syntactic form.

(54) BILL kissed Mary on the stair.

(55) Adrian longed for A SCHOOL UNIFORM.

Implicit clefts provide the opportunity to choose the focus, as before:

(56) Bill kissed MARY on the stairs.

(57) Bill kissed Mary ON THE STAIRS.

The presupposition of such a sentence parallels that of an ordinary cleft. It is that the sentence is true for some *X*, where *X* is the stressed item. For example:

(58) Tom didn't put THE LAMP by my desk.

»Tom put something by my desk.

So the presupposition of an utterance containing an implicit cleft is that *S* is true for some *X*, where *X* is the stressed item.

5.10 Verbs of Judging

(59) Kryz criticized Greg for chasing the cat.

(60) Diane accused Howie of using her last staple.

We can write sentences with verbs of judging in the form “*Subj Verb Y about Z*”.

Levinson [1983, 182] argues that when utterances of sentences containing verbs of judging are considered,

this kind of implication is, arguably, not really presuppositional at all; for, unlike other presuppositions, the implications are not attributed to the speaker, so much as to the subject of the verb of judging.

For example, Levinson would claim that an utterance of 59 implies that “*Kryz thinks that Greg chased the cat*” rather than “*The speaker thinks that Greg chased the cat*”, and this is not a presupposition. Here is a case where our approach is useful, for surely the utterance does have a presupposition — it is that “*The speaker thinks that Kryz thinks that Greg chased the cat*”, *i.e.* $B_{Sp}B_{Kryz}(Greg\ chased\ the\ cat)$ So the implication is attributed to the speaker; it just happens to be an implication concerning the beliefs of others.

Levinson divides the verbs-of-judging category into two. Members of the first group, containing the verb *criticize*, trigger a presupposition about the occurrence of event *Z*, while members of the second, including *accuse*, trigger instead a presupposition about some judgement of event *Z* (*e.g.* it’s bad, unfortunate, or sad). The difference between the two groups is rather subtle. Presumably it has to do with the fact that the level of certainty about the occurrence of event *Z* is less for verbs in the second group. We believe that the quality judgement presupposition exists for verbs in *both* classes. In fact, we will consider all verbs of judging to carry both presuppositions.

Since verbs of judging all have a subject, we must consider the subject’s beliefs about each of the two propositions. The candidate set of potential presuppositions is:

$$\begin{array}{ll} Z\ occurred & Z\ is\ bad/sad\ \dots \\ B_{Subj}(Z\ occurred) & B_{Subj}(Z\ is\ bad/sad\ \dots) \end{array}$$

Since the *Subj*’s judgement is being reported, both propositions prefixed by B_{Subj} are in fact potential presuppositions. If either one were contradicted, the result would be an infelicity or the indication that *X* has been uncooperative by making either a judgement that he doesn’t feel, or making a judgement of an event that he doesn’t think occurred. For example, under our assumptions of sincerity and straightforwardness, the following sentences are infelicitous:

(61) * Mom criticized Ron for leaving the car lights on, but she doesn’t think he did.

(62) * Mrs. Brown congratulated them on their engagement, but she really is upset that they’re getting married.

The status of the other two candidate potential presuppositions, which are not modified by belief operators, is less clear. Of the two, “*Z occurred*” seems more strongly implied. For example, the contradiction of this in 64 seems more unexpected than that of “*Z is bad*” in 63.

(63) Mary criticized Bob for leaving early, but there wasn't anything wrong with him doing so.

(64) Mary criticized Bob for leaving early, but he didn't.

However, since neither sentence is infelicitous, these two presuppositions do not pass clause (a) of the definition of potential presupposition.

So the potential presuppositions of the utterance of a sentence containing a verb of judging are $B_{Subj}(Z \text{ occurred})$ and $B_{Subj}(J)$ where J is a judgement about event Z which depends on the verb of judging.

5.11 Direct Comparisons

(65) John isn't as messy as Bill.

(66) "The Trouble With Normal" wasn't a bigger hit than "Tokyo".

Two syntactic patterns account for most direct comparisons. The first,

(i) X be as *Adjective* as Y

covers Sentence 65 and triggers the presupposition that " X is somewhat *Adjective*", for this sentence, that John is somewhat messy. The second form,

(ii) X be *Comparator Noun* than Y

covers Sentence 66 and triggers the presupposition that " X is a *Noun*", for this sentence, that "*The Trouble With Normal was a hit*".

So, a presupposition of the utterance of a direct comparison of form (i) is $B_{Sp}(X \text{ is somewhat } Adjective)$, and of the form (ii) is $B_{Sp}(X \text{ is a } Noun)$.

5.12 Comparisons by Parallel Structure

(67) Dave called Howie a gonk, then Howie insulted him back.

(68) George tripped and Susan did something clumsy too.

(69) Harry made a faux pas, then MAUDE made a blunder.

In this class of trigger we have a comparison which is made not explicitly, but implied by a parallel construction in the sentence or by phonetic stress, as in Sentence 69. We will represent sentences with this sort of trigger as

$$V \text{ did } X \text{ Conjunction } W \text{ did } Y \left\{ \begin{array}{l} \text{back} \\ \text{in return} \\ \text{too} \\ \text{etc.} \end{array} \right\}$$

The proposition of interest to us here is $P = \text{“Doing } X \text{ is like doing } Y\text{”}$. In sentences of this category we have at least agents V and W to consider, making the determination of potential presuppositions difficult. We argue that for such a sentence to be felicitous, P must be true, P must be believed by V and W , and V and W must each think the other believes it; otherwise use of the parallel structure would be infelicitous. The following sentences illustrate this for some of the propositions:

(70) * Mark called Rick a geek and Rick insulted him back, but geek is not an insult.

(71) * Mark called Rick a geek and Rick insulted him back, but Rick doesn't think geek is an insult.

(72) * Mark called Rick a geek and Rick insulted him back, but Rick didn't realize Mark meant it as an insult.

So the potential presuppositions of an utterance of a sentence with comparison by parallel structure are:

$$\begin{array}{cc} P & \\ B_V(P) & B_W(P) \\ B_V B_W(P) & B_W B_V(P) \end{array}$$

5.13 Non-restrictive Relative Clauses

(73) Neil hopes that Peter Gabriel, who used to be in Genesis, will tour this year.

(74) John, who played Romeo, is a great actor.

There are two sorts of relative clause — those which restrict, such as

(75) His speech was aimed at voters who are strong Liberal supporters.

and those which do not, such as in 73 and 74. Quirk and Greenbaum [1973, 376] define these as follows:

Modification can be restrictive or non-restrictive. That is, the head can be viewed as a member of a class which can be linguistically identified only through the modification that has been supplied (*restrictive*). Or the head can be viewed as unique or as a member of a class that has been independently identified . . . ; any modification given to such a head is additional information which is not essential for identifying the head, and we call it *non-restrictive*.

Non-restrictive relative clauses carry the presupposition that the clause is true of the noun phrase which they modify. For example, the utterance of 73 presupposes

(76) Peter Gabriel used to be in Genesis.

In sentences which mention an agent A , we must consider whether $B_A(P)$ is also presupposed. This depends upon to whom the description in the relative clause is attributed. If the description is attributed to the agent, then the presupposition holds, otherwise it does not. Determining the agents of a description is necessary for validating other inferences such a substitution of equivalents [Fawcett 1985, Fawcett and Hirst 1986]. Chapter 3 of [Fawcett 1985] gives some ideas about how to do this for various contexts. Since we cannot assume that the speaker is attributing the description to the agent, we cannot assume that the presupposition holds.

So the presupposition of an utterance of sentence containing a non-restrictive relative clause C which modifies noun phrase NP is that C is true of NP .

5.14 Unreal Conditionals

(77) If New York had lost, Tom would have been happy.

(78) If I was King for just one day, I would give it all away⁶.

(79) Who knows what would have happened if he had won the election.

[Huddleston 1984, p. 129] defines this class as follows:

DEFINITION 3: A conditional is **unreal** iff

- (a) the subordinate clause is in the past tense, and
- (b) the main clause's verb phrase begins with a modal auxiliary.

Conditionals of this sort trigger the presupposition that the proposition expressed by the subordinate clause is false [Quirk and Greenbaum 1973, 325]. For example, Sentence 77 presupposes

(80) New York didn't lose.

There has been some confusion about the presuppositions associated with conditionals, probably because the criteria which dictate when a presupposition exists have sometimes been misstated and sometimes omitted entirely. For example, the presuppositions of "subjunctive conditionals", *i.e.* conditionals in which the subordinate clause is subjunctive, are discussed in [Karttunen and Peters 1979]. In fact, the subjunctive is neither necessary for the existence of this presupposition:

(81) If Bill came, we could have played bridge.

 >>Bill did not come.

nor sufficient for it:

(82) If I were to go, you could have my seat.

 >>I will not go.

⁶Bailey, Tom, Alannah Currie and Joe Leeway. 1985. "King for a Day." On *Here's to Future Days*, Thompson Twins.

So subjunctive mood is actually irrelevant. The requirement for having the presupposition is simply that the conditional be unreal, as defined above.

So the presupposition of a sentence containing an unreal conditional with subordinate clause C is that C is false.

5.15 Questions

(83) Is Toronto playing tonight?

(84) Is Toronto playing in New York, Detroit, or Baltimore tonight?

(85) Who is playing Baltimore tonight?

Questions can be classified into three groups — yes/no questions, alternative questions, and *wh*-questions. We will consider each separately.

Yes/no questions, such as 83, offer the respondent a choice only between answering yes and no. They presuppose that the speaker feels one of the choices is correct, a proposition which is vacuous. For example the utterance of 83 presupposes

(86) Either Toronto is playing tonight or Toronto is not playing tonight.

Alternative questions, such as 84, offer the respondent a choice between several given answers. They also presuppose that the speaker thinks one of the choices is correct. For these questions, the presupposition is not necessarily vacuous, as in the following presupposition of 84:

(87) Toronto is playing in either New York, Detroit, or Baltimore.

However, the presupposition *is* vacuous for some alternative questions.

(88) Are you coming with us or staying?

» You are either coming with us or staying.

Note that some questions are ambiguous between a yes/no reading and an alternative reading. For example

(89) Did he sing, dance, or play the banjo?

could be read to mean either “Did he do any of the following — sing, dance, or play the banjo?” (a yes/no reading), or “we know he did some sort of entertaining, but which was it — singing, dancing, or playing the banjo?” (an alternative reading).

Question 85 is an example of a *wh*-question. These have the form “*Wh-element X?*” and carry the presupposition that X is true for some value. For example, question 85 presupposes that

(90) Someone plays Baltimore tonight.

There is a conceptual parallel between *wh*-questions and *it*-clefts. Consider:

(91) It is Texas that plays Baltimore tonight.

(92) \gg Someone plays Baltimore tonight.

In Sentence 91 we are assuming 92 and giving the answer at the same time, whereas in 85 we are assuming it and asking for the answer.

We will say that the presupposition of a *wh*-question $S = \text{“Wh-element } X\text{”}$ is that X is true for some value of *Wh-element*.

The behaviour of all three types of question is difficult to analyze under negation because, for a given question, it is difficult to determine what form of the question gives unambiguously external or internal negation. Since any conclusions we might draw about this problem would not affect the main point of the chapter, we will do no more than agree that there are complications for negated question sentences.

5.16 Summary of the Triggers

Table 5.2 summarizes our conclusions for each trigger.

The particular conclusions we have drawn regarding the first-order presuppositions of some triggers are not entirely firm. However, we have illustrated that some first-order presuppositions could not even be expressed without the mention of beliefs of agents.

In the next chapter we go on to see that an analysis of projection requires the representation of the beliefs of agents.

Trigger	Potential presupposition of a sentence containing this trigger	where
Definite Description <i>e.g.</i>	$\exists' a \text{ unique } X$ <i>The big dog barked</i> \gg <i>There is a unique big dog in this context</i>	X is the thing described
Factive verb (a) without subject <i>e.g.</i>	C , with exceptions <i>It's too bad that he left</i> \gg <i>He left</i>	C is the complement
(b) with subject <i>e.g.</i>	C , with exceptions <i>Dave is happy that Corinna called</i> $\gg B_{\text{Dave}}(\text{Corinna called})$	
Contrafactive verb <i>e.g.</i>	$B_{\text{Subj}}(\neg C)$ <i>Sue wishes she was Queen</i> $\gg B_{\text{Sue}}(\text{Sue is not Queen})$	C is the complement
Implicative verb <i>e.g.</i>	I <i>Tom managed to arrive on time</i> \gg <i>It's hard for Tom to arrive on time</i>	I depends on the verb
Change-of-state verb <i>e.g.</i>	St <i>John stopped singing</i> \gg <i>John had been singing</i>	St depends on the verb
Iterative <i>e.g.</i>	O <i>Tom is late again</i> \gg <i>Tom was late before</i>	O depends on the construct
Temporal clause <i>e.g.</i>	E occurred <i>I felt very sad when Margot left</i> \gg <i>Margot left</i>	E is the event
Cleft or Pseudo-cleft Structure <i>e.g.</i>	Y is true for some X <i>It will be Meryl Streep who wins</i> \gg <i>Someone will win</i>	$S = \text{It be } X \text{ that } Y$ OR $S = \text{Wh-element } Y \text{ is } X$ OR $S = X \text{ is Wh-element } Y$
Implicit Cleft <i>e.g.</i>	S is true for some X <i>GRAEME didn't suggest the new meeting time</i> \gg <i>Someone suggested the new meeting time</i>	X is the stressed item
Verb of judging <i>e.g.</i>	$B_{\text{Subj}}(E \text{ occurred})$ $B_{\text{Subj}}(J)$ <i>Krys criticized Greg for chasing the cat</i> $\gg B_{\text{Krys}}(\text{Greg chased the cat})$ $\gg B_{\text{Krys}}(\text{For Greg to do so was bad})$	E is the event J is a judgement of E

continued ...

... from last page

Trigger	Potential presupposition of an sentence containing this trigger	where
Direct Comparison (a)	X is somewhat Adj	$S = X$ be as Adj as Y
	<i>e.g.</i> $John$ isn't as messy as $Bill$ \gg $John$ is somewhat messy	
(b)	X is a N	$S = X$ be Comp N than Y
	<i>e.g.</i> $Bill$ is a better student than $Mary$ \gg $Bill$ is a student	
Comparison by Parallel Structure	X is like Y $B_V(X$ is like $Y)$ $B_W(X$ is like $Y)$ $B_V B_W(X$ is like $Y)$ $B_W B_V(X$ is like $Y)$	$S = V$ did X Conj W did Y
	<i>e.g.</i> $Dave$ called $Howie$ a gonk and $Howie$ insulted him back \gg $B_{Howie}(Calling$ someone a gonk is like insulting them)	
Non-restrictive relative clause	C is true of NP	C is the relative clause NP is the noun phrase it modifies
	<i>e.g.</i> $John$, who played $Romeo$, is a great actor \gg $John$ played $Romeo$	
Unreal Conditional	C is false	C is the subordinate clause
	<i>e.g.</i> If she were $Queen$, she'd pardon him \gg She is not $Queen$	
Questions (a) Yes/no	X is either true or false	$S = Is$ X true?
	<i>e.g.</i> Did $John$ leave? \gg Either $John$ did leave, or he didn't leave	
(b) Alternative	One of the alternatives is correct	
	<i>e.g.</i> Did he laugh or did he cry? \gg He either laughed or cried	
(c) Wh	X is true for some value	$S = Wh$ -element X ?
	<i>e.g.</i> Who married $Margaret$? \gg Someone married $Margaret$	

Table 5.2: Summary of the first-order presuppositions

Chapter 6

The Projection Problem

Recall from Chapter 1 that the projection problem is the problem of determining the presuppositions of a compound sentence from the presuppositions of its parts. In this chapter we will enumerate a representative list of compounding sentential contexts and consider the effect of each on the potential presuppositions of their embedded subparts. We expect that any sentential contexts which are not examined here can also be accounted for within our framework.

As in Chapter 5, where the first-order presuppositions were examined, the particular conclusions made about each context are not the main concern here. What is important is the illustration that there are phenomena that can be accounted for if the beliefs of agents are considered, and that could not be accounted for otherwise.

We will divide the sentential contexts into two categories — subordinating and coordinating — and consider each in turn. “Both coordination and subordination involve the linking of units; but with the latter, one of the units is subordinated to the other” [Quirk and Greenbaum 1973, 254].

Note that some of these sentential contexts trigger their own first-order presuppositions. For example, conditionals have the form “*If X then Y*” and require consideration as to their effect on projection of the presuppositions of both X and Y . In addition, if the *if*-clause in a sentence is syntactically “unreal” (see Chapter 5), the sentence triggers a first-order presupposition regarding the falsity of X . In such cases the reader is referred to Chapter 5 for a discussion of the first-order presuppositions involved.

In our example sentences, the coordinating and subordinating constructs will be underlined, and conjoined or embedded clauses enclosed in parentheses.

6.1 Subordinating Constructions

The subordinating constructions are generally straightforward with respect to projection. Most act as holes, that is, they allow the presuppositions of their subordinate or embedded clauses to project. As we will see, a few require the addition of an extra belief operator. These constructs had previously been considered plugs, but our approach makes it possible to modify the presuppositions with belief operators, thereby saving them from being blocked.

6.1.1 Modal Verbs

- (1) John should (regret that he failed).
- (2) You must (stop being foolish).

Modal verbs behave as holes with respect to projection. If a clause embedded under a modal verb carries a presupposition, as is the case in 1, the presupposition projects to become a presupposition of the whole sentence. In this case, we have the presupposition

- (3) John failed.

6.1.2 Negation

- (4) It is not true that (Sue Ellen has stopped drinking).
- (5) (Jane does not regret quitting her job).

We argued in Chapter 1 that negation is ambiguous but that one normally assumes the reading intended was one in which the main proposition is negated. By this assumption, presuppositions survive negation. For example, Sentence 5 presupposes

- (6) Jane quit her job.

The only time this assumption is not made (and the presupposition does not survive), is when the presupposition is inconsistent with some established information. So for potential presupposition, where inconsistency with established information is not required, negation acts as a hole. The consistency check can be made later when we determine whether or not the potential presupposition is actual for some given context.

If we already have an actual presupposition of a sentence in a given context, and then want to determine if the negated form of the sentence carries the actual presupposition in that context, then the consistency check must be done during projection.

6.1.3 Verbs of Saying

- (7) Nadia said that (Graeme forgot to buy batteries for the penguin).
- (8) Harry announced that (as the King of France, he will hold a Royal Ball).

Verbs of saying do not allow the presuppositions of their embedded clauses to project unaltered. For example, Sentence 7 does *not* presuppose:

- (9) Graeme intended to buy batteries for the penguin.

However, if a belief operator is added to the presupposition of the embedded clause, the resulting proposition *is* a potential presupposition.

- (10) Nadia said that Graeme forgot to buy batteries for the penguin.
 $\gg B_{Nadia}(\text{Graeme intended to buy batteries for the penguin})$

So for a sentence of the form “*X Verb Y*” where *Verb* is a verb of saying and *Y* alone has the presupposition *P*, proposition $B_X P$ is a potential presupposition.

6.1.4 Verbs of Propositional Attitude

(11) Bill hopes (that the Vax will come up soon).

Here we have a case where belief operators are necessary to account for projection. Verbs of propositional attitude require that their presuppositions be modified by belief operators; otherwise, presuppositions of their embedded clauses would not be able to project. For example, 11 does not presuppose:

(12) The Vax is down.

It does, however, carry a presupposition. A belief operator is simply added to the presupposition of the embedded clause to get:

(13) $B_{Bill}(\text{The Vax is down})$

This phenomenon could not be accounted for without the mention of beliefs.

The general rule is that for a sentence of the form “ X *Verb* Y ” where *Verb* is a verb of propositional attitude and Y alone has the presupposition P , we have the projected presupposition $B_X P$.

6.1.5 *It*-Clefts Taking Sentential Complements

(14) It is odd that (he stopped playing).

(15) It is great that (they won).

Normally, *it*-clefts taking sentential complements¹ act as holes to projection. So the presupposition:

(16) He had been playing.

of the embedded clause in 14 projects to become a presupposition of the whole sentence.

In considering first-order presuppositions, we classified these sentences as factives which do not take a subject, and assigned them the presupposition that their complement is true (see Chapter 5). Hence, *it*-clefts taking sentential complements generate their own first-order presuppositions as well. For example, 14 presupposes:

(17) He stopped playing.

¹These differ from the clefts examined in Chapter 5, which did not take sentential complements. Ordinary clefts take a verb phrase as in:

(i) It was Chuck who played hockey,

while pseudo-clefts take a noun phrase as in:

(ii) What I want is a holiday.

which in turn presupposes 16. So there is redundancy. Proposition 16 is a second-order presupposition of 14 via projection, and it is also a first-order presupposition of a first-order presupposition of 14. This redundancy generally exists for constructs in this class.

In this class, there is one case requiring extra consideration. Sentences of the form “*It’s possible that X and Y*” behave differently. These are discussed in the section on conjunction, 6.2.2.

6.1.6 Sentential Adverbs of Attitude

(18) Understandably, (Margot started to laugh).

These adverbs generally behave as holes. For example, the above sentence does carry the presupposition of its embedded clause, *i.e.*,

(19) Margot hadn’t been laughing.

As for the class of *it*-clefts taking sentential complements, possibility environments must be treated as special cases. See section 6.2.2 for a discussion of the sentential adverb “*possibly*”.

The behaviour of sentential adverbs of attitude parallels that of *it*-clefts taking sentential complements. This seems reasonable, since a sentence of either sort has a corresponding sentence of the other type. For example, the following sentences are equivalent with respect to presuppositions:

(20) It is strange that (the donkey behaved itself on stage).

(21) Strangely, (the donkey behaved itself on stage).

6.2 Coordinating Constructions

We will consider three coordinating constructions — conjunction and disjunction over sentences, and conditional (*if-then*) constructions. Usually, none of these constructions blocks presuppositions from projecting. However, for each there is a case involving the description of hypothetical situations, where presuppositions are blocked.

6.2.1 Conditionals

(22) If (Graeme is in his office), (he forgot to go to the meeting).

(23) If (Graeme forgot to go to the meeting), then (Diane will regret that she went).

For most sentences of the form “*If A then B*”, presuppositions of both *A* and *B* project to become presuppositions of the entire sentence. This is the case for the sentences above. For example, 23 presupposes two things:

(24) Graeme intended to go to the meeting.

(25) Diane went [to the meeting].

However, some conditional sentences block presuppositions, such as the following:

(26) If (he kissed her) then (he'll do it again).
 ➤He did it before, *i.e.* he kissed her before.

(27) If (she mails that letter) (she'll regret that she did).
 ➤She did, *i.e.* she mailed the letter.

There is a pattern across all such cases. A presupposition of the *then*-clause is blocked exactly if the *if*-clause has set up that proposition as hypothetical, *i.e.*, not necessarily true. For example, the *if*-clause in the following sentence establishes that Bet may or may not go to Blackpool with Mavis and Rita. In fact, these are conversational implicatures of the sentence.

(28) If Bet goes to Blackpool with Mavis and Rita, Mavis will be annoyed.
 →It's possible that Bet will go.
 →It's possible that Bet will not go.

An *if*-clause can establish a proposition as hypothetical either by stating the proposition directly (as in the example above), or, possibly with the help of background information, by entailing it.

Presuppositions of a *if*-clause, on the other hand, are never blocked. An *if*-clause that presupposes a proposition that has already been established as hypothetical is infelicitous.

(29) * Maybe Carol had the baby today. If (Allan is surprised that she did), ...

However, in an *if* that contains conjunction, presuppositions of conjuncts other than the first can be blocked if previous conjuncts establish them as hypothetical. For example,

(30) If ((Carol had the baby) and (Allan is surprised that she did)), ...
 ➤Carol had the baby.

We now give examples of how the presuppositions of a *then*-clause can be prevented from projecting. Sentence 32 is a normal presupposition of Sentence 31's *then*-clause. However, since the *if*-clause establishes it as hypothetical, the presupposition doesn't survive projection.

(31) If (Pandora stops seeing Nigel), (Adrian will be glad that she did).

(32) She did, *i.e.* Pandora stopped seeing Nigel.

In the next example, an *if*-clause establishes a proposition as hypothetical and this proposition, together with background information, entails a presupposition of the *then*-clause, thereby preventing projection of the first-order presupposition.

(33) If (Harry joined that group), (he'll regret that he shaved his head).

(34) Harry shaved his head.

The *then*-clause of 33 presupposes 34. The *if*-clause establishes that Harry may or may not have joined, *i.e.* that his joining is only hypothetical. “All members of that group shave their heads” plus this *if*-clause entail 34. So if “all members of that group shave their head” were in the background information, 34 would be only hypothetical and would thus not be a presupposition of Sentence 33. This gives an interpretation of 33 which can be paraphrased as “if Harry joined that group he would have been forced to shave his head, and he’s going to regret that”. If, on the other hand, “all members of that group shave their heads” were not in the background information, presupposition 34 would hold. This interpretation can be paraphrased as “if Harry, a man with a shaved head, joined that group, he’s going to regret that he ever shaved his head”².

Background information can affect projection in the other coordinating constructions as well. The role of background information in projection affects the definitions of potential and actual presupposition. This is discussed in section 6.3.

So the potential presuppositions of a sentence “*If A then B*” are all the presuppositions of *A*, plus all those presuppositions of *B* which are not entailed by *A*. If *A* and some other fact *Q* together entails a presupposition of *B*, then *Q* becomes an “anti-condition” for the potential presupposition (see section 6.3).

This is approximately the analysis which is given in [Karttunen 1973]. A similar analysis (but without the consideration of effects of context) is given in [Weischedel 1979]. However, rather than block a presupposition of a *then*-clause in the cases where the *if*-clause entails it, Weischedel modifies it. In fact, he modifies presuppositions of *then*-clauses in all cases. For conditional sentence “If *A* then *B*”, the presuppositions *P* of *B* project, but in the form “If *A* then *P*”. This approach yields tautological, and arguably harmless, presuppositions in cases where *A* does entail a presupposition of *B*:

(35) If (he kissed her) then (he’ll do it again).

 >>If he kissed her before then he did it before, *i.e.* if he kissed her before then he kissed her before.

However, the result in all other cases (which are much more numerous) is simply incorrect.

(36) If (Peter calls) (remind him that dinner is at 7:00).

 >>If Peter calls then dinner is at 7:00.

We will see shortly that this approach was also used for conjunctions and disjunctions, with similar results.

6.2.2 Conjunction

(37) (He stopped singing) and (the audience began to applaud).

²We are being imprecise here about what is meant by “background information” and about the distinction between potential and actual presupposition. Section 6.3, which discusses the impact of cases where background information affects projection, makes these things clear.

(38) (He cheated before) and (he'll do it again).

In a sentence of the form “*A and B*”, the presuppositions of both conjuncts normally project, unaltered, to become presuppositions of the sentence. But again there are cases in which this does not happen. And again, these cases are characterized by their mention of hypothetical situations. When a conjunction occurs in the context of a possibility construction and a presupposition of the second conjunct is stated to be only *possibly* true by the first conjunct, then that presupposition does not survive the double projection. For example,

(39) It is possible that ((he cheated before) and (he'll do it again)).
 ⤵ He did it before, *i.e.* he cheated before.

As for conditionals, background facts can affect projection in this environment. This is illustrated by the following example. The presupposition, 41, of the second conjunct in Sentence 40 does not project to become a presupposition of the whole sentence if it is a background fact that all long-distance runners get injuries.

(40) It is possible that ((Brenda will become a long-distance runner) and (her injuries will take their toll)).

(41) Brenda has injuries.

So the presuppositions of a sentence “*A and B*” are all the presuppositions of *A* and of *B*, but with a special case occurring when the conjunction is in the scope of a possibility construction. In such cases we consider the double projection (over the conjunction and the possibility environment) in one step. The rule here is that the presuppositions of a sentence “It is possible that *A and B*” or “Possibly *A and B*” are all the presuppositions of *A* and all those presuppositions of *B* which are not entailed by *A*. If *A* plus some other fact *Q* together entail a presupposition of *B*, then *Q* becomes an “anti-condition” for that potential presupposition (see section 6.3).

If we have a sentence with more than one conjunction inside the scope of a possibility construction, then only the presuppositions of the first conjunct are guaranteed to survive the projection. The presuppositions of the remaining conjuncts are subject to the condition that no previous conjunct (plus possible background facts) entails them. For example, the first conjunct of 42 entails 43, which is a presupposition of the third conjunct. Therefore this presupposition does not project to become a presupposition of Sentence 42.

(42) It is possible that ((the leopard approached the house) and (killed the dog Chang) and (will come to the house again, looking for Zena)).

(43) ⤵ The leopard came to the house before.

In dealing with conjunction, Weischedel again incorporates the entailment check into the presupposition itself. For him, all presuppositions *P* of a second conjunct, project in the form “If *A* then *P*”. When the conjunction occurs within a possibility environment and *A* does entail the presupposition of *B*, we get a harmless tautological presupposition. For example,

- (44) Possibly ((he kissed her before) and (he'll do it again)).
 »If he kissed her before then he did it before, *i.e.* if he kissed her before then he kissed her before.

However, the result is incorrect if A does not entail the presupposition P , regardless of whether or not we have a possibility construction. For example, by Weischedel's approach, both of 45 and 46 would presuppose 47.

- (45) (The pavlova is too sweet) and (I regret that I ordered it).
 (46) Possibly ((the pavlova will be too sweet) and (I will regret that I ordered it)).
 (47) If the pavlova is too sweet then I ordered it.

This is clearly not warranted. The correct presupposition is simply:

- (48) I ordered it [the pavlova].

When a conjunction is not in the scope of a possibility construction, Weischedel's modification of the presuppositions is simply unnecessary.

6.2.3 Disjunction

- (49) Either (you begin to spend money responsibly) or (I'll stop giving you an allowance).

Our final example of coordinating constructions behaves quite like the previous ones. A disjunction usually allows the presuppositions of its disjuncts to project unaltered, as in the above sentence which presupposes two things:

- (50) You haven't been spending money responsibly.
 (51) I have been giving you an allowance.

However, there are cases in which a presupposition is prevented from projecting over disjunction. For example,

- (52) Either (he didn't cheat) or (he'll cheat again).
 »he cheated before.

In all such cases, A and B are related — the negation of A entails B — and the sentence seems to be a paraphrase for “Either $\neg A$ or $(A \text{ and } B)$ ”.

Why is it that with disjunction, the presupposition P of clause B is blocked when the *negation* of A entails it? As before, the blocking occurs because the A clause has established the presupposition of the B clause as only possible; not necessarily true. With disjunction, this could have been accomplished either by A entailing P or by A 's negation doing so — because we have a disjunction, either approach would have said that P is merely hypothetical. However, we never see a presupposition of B established as hypothetical by A stating it; such sentences do not sound correct. The following sentence tries to do this:

(53) ? Either (he did cheat) or (he'll cheat again).

In order to understand why this sentence sounds unacceptable, consider the possible truth value assignments to its *A* and *B* clauses. If both *A* and *B* are false the sentence is false, so that configuration is not acceptable. *A* cannot be false and *B* be true, since *B* presupposes *A*. If both *A* and *B* are true, we violate the rule that “or” is an exclusive-or in English [Quirk and Greenbaum 1973, 258]. The only remaining choice is that *A* is true and *B* false. So in a sentence “Either *A* or *B*” where *B* presupposes *A*, there is only one configuration of truth values to *A* and *B* which is acceptable, and hence the use of disjunction is inappropriate. This is why a presupposition of a *B* clause cannot be established as hypothetical, and hence prevented from projecting, by the *A* clause stating it. By a similar argument, a presupposition of *B* cannot be set up as hypothetical by *A* entailing it.

As before, background information can play a role in projection over disjunction. For example, the second disjunct of Sentence 54 presupposes 55 and this presupposition normally projects over the disjunction. However, if a background fact stated that all smokers suffer from lung disease, this plus the first disjunct would entail 55 and 55 would fail to project.

(54) Either (quit smoking) or (accept that you'll suffer from lung disease).

(55) You'll suffer from lung disease.

Compare this against the following example. Assume that it has not been established that being a smoker implies that one does not get one's teeth cleaned. Then the presupposition, 57, of Sentence 56's second conjunct is not entailed by its first conjunct, and it succeeds in projecting to be a presupposition of 56.

(56) Either (quit smoking) or (start getting your teeth cleaned).

(57) You haven't been getting your teeth cleaned.

So the presuppositions of a sentence “*A* or *B*” are all the presuppositions of *A*, plus all those presuppositions of *B* which are not entailed by the negation of *A*. If *A* plus some other fact *Q* entails a presupposition of *B*, then *Q* is an “anti-condition” of that presupposition (see section 6.3).

As before, Weischedel lets all presuppositions in a disjunction project, with the entailment consideration incorporated in the presuppositions themselves. A presupposition *P* of *B* is filtered to become “If $\neg A$ then *P*”. And as before, we get a harmless, tautological presupposition when the negation of *A* does entail *P*, but an incorrect presupposition when it does not, as the following example illustrates:

(58) Either (give me a lift) or (let me borrow your big umbrella).

»If you don't give me a lift then you have a big umbrella.

6.3 Impact on the Definitions

Recall that for each of the coordinating constructions, background information may affect the projection of presuppositions. For example, if it has been established that all long-distance runners get injuries, the presupposition of Sentence 59's *then*-clause, 60, does not project to become a presupposition of the whole sentence. This gives an interpretation of 59 on which Brenda might get injuries from long-distance running if she takes it up.

(59) If (Brenda becomes a long-distance runner), (her injuries will take their toll).

(60) Brenda has injuries.

Alternatively, if it has not been established that all long-distance runners get injuries, the presupposition would hold. In this case we would have an interpretation on which Brenda already has injuries and they will really bother her if she takes up long-distance running. To be more precise, the proposition expressed by 60 is a *potential* presupposition of Sentence 59 and, depending on whether or not it has been established that all long-distance runners get injuries, might be an actual presupposition.

Of course, saying “it has been established that X ” is not precise enough. The extra condition on projection must specify exactly who believes X . A correct statement of the condition is that 60 is an actual presupposition of the utterance of Sentence 59 by speaker S_p to listener L in state s only if the listener doesn't think the speaker thinks that all long-distance runners get injuries, *i.e.* only if $s \not\models B_L B_{S_p}(\text{All long-distance runners get injuries})$.

This example, and in fact the whole class of examples in which background information affects projection, does not conform to our current definition of actual presupposition. This definition only requires that a candidate actual presupposition P have an appropriate corresponding potential presupposition, and if the sentence in question is negative, that $s \not\models B_L B_{S_p} \neg P$. However, for this class of examples, an additional constraint is necessary that for some Q , $s \not\models B_L B_{S_p} Q$. We call such a Q an **anti-condition**, since its truth prevents the existence of an actual presupposition.

In order to accommodate this fact, a new clause involving anti-conditions must be added to the definition of actual presupposition; and in order that it may know what anti-condition to test, the definition of potential presupposition must specify this and pass it on to the definition of actual presupposition. A pair of definitions which incorporate this new information follows:

DEFINITION 1: Sentence S **potentially presupposes** proposition P with anti-condition Q iff for any speaker S_p , listener L , and state s ,

- (a) The utterance of S^+ by S_p to L in state s would allow L to infer $B_{S_p} P$ unless L already believed $B_{S_p} Q$, *i.e.* unless $s \models B_L B_{S_p} Q$.
- (b) The utterance of S^- by S_p to L in state s would allow L to infer $B_{S_p} P$ unless L already believed $B_{S_p} \neg P$ or $B_{S_p} Q$, *i.e.* unless $s \models B_L B_{S_p} \neg P$ or $s \models B_L B_{S_p} Q$.

DEFINITION 2: The utterance of Sentence S by speaker S_p in state s **actually presupposes** proposition $B_{S_p} P$ for listener L iff

- (a) P is a potential presupposition of S , with anti-condition Q .
- (b) If $S = S^-$, $s \not\models B_L B_{Sp} \neg P$.
- (c) $s \not\models B_L B_{Sp} Q$

In the example above, the proposition expressed by Sentence 60 would be a potential presupposition of Sentence 59, with the anti-condition “all long-distance runners have injuries”. If we had a state s in which $s \not\models B_{Diane} B_{Tom}(\textit{All long-distance runners have injuries})$, then the utterance of Sentence 59 by Tom to Diane in state s would have the actual presupposition $B_{Tom}(\textit{Brenda has injuries})$.

Since background information only has this extra impact on projection over coordinating constructions, none of the earlier material on first-order presuppositions or projection over subordinating constructions is affected by the new definitions. In these earlier cases, the anti-condition Q would always be nil, and hence the old definitions would suffice.

6.4 Finding Actual Presuppositions of a Complex Sentence

After the definitions of potential and actual presupposition were developed in Chapter 4, examples were given demonstrating how to determine the actual presuppositions of a simple sentence S . The performance of this task, using the new definitions given above, can be summarized as follows:

1. Find the potential (first-order) presuppositions of S , and their anti-conditions (if any). This can be done by using the definition of potential presupposition directly (as demonstrated in Section 4.5), or by utilizing the rules compiled in Chapter 5.
2. For each potential first-order presupposition of S , determine if it is an actual first-order presupposition of S . All potential first-order presuppositions must pass the anti-condition test given in the definition of actual presupposition. In addition, if the sentence is negative, each potential first-order presupposition must pass the test for consistency with established information, also given in the definition of actual presupposition.

This procedure is illustrated in Figure 6.1.

Potential and actual presuppositions of complex sentences can also be determined by direct appeal to their definitions. However, the analysis of projection given in this chapter, and the Chapter 5 rules for finding first-order presuppositions can be exploited to make the task more mechanical:

1. For each coordinated or subordinated clause C of S , find the potential (first-order) presuppositions of C . Again, this can be done by using the definition of potential presupposition directly, or by utilizing the list of first-order presuppositions compiled in Chapter 5.

Figure 6.1: Procedure for finding actual presuppositions of a simple sentence.

2. For each potential presupposition P_C of a clause C of Sentence S , determine if it is a potential presupposition of S . This can be done using the projection rules given in this chapter.
3. For each potential presupposition P of S , determine if it is an actual presupposition of S . All potential presuppositions of S must pass the anti-condition test given in the definition of potential presupposition. In addition, if the sentence is negative, each must pass the test for consistency with background information, also given in the actual presupposition definition.

This procedure is illustrated in Figure 6.2.

Figure 6.2: Procedure for finding actual presuppositions of complex sentences.

Construct	Structure of the Sentence	Potential Presuppositions of the Sentence
Modal Verb <i>e.g.</i>	<i>Subject Modal-verb A</i> <i>You ought to stop working.</i> \gg <i>You have been working.</i>	• all potential presuppositions of <i>A</i>
Negation <i>e.g.</i>	It's not true that <i>A</i> <i>It wasn't Joe who went to Greece.</i> \gg <i>Someone went to Greece.</i>	• all potential presuppositions of <i>A</i>
Verb of Saying	<i>Subject Saying-verb A</i>	• $B_{Subj}P$ for each potential presupposition <i>P</i> of <i>A</i>
Verb of Propositional Attitude <i>e.g.</i>	<i>Subject Attitude-verb A</i> <i>Tom wants Ben to stop being silly.</i> \gg $B_{Tom}(Ben\ is\ being\ silly)$	• $B_{Subj}P$ for each potential presupposition <i>P</i> of <i>A</i>
<i>It</i> -Cleft Taking Sentential Complement <i>e.g.</i>	It be <i>Adjective</i> that <i>A</i> <i>It's surprising that he forgot to come.</i> \gg <i>He meant to come.</i>	• for <i>Adjective</i> = "possible" and <i>A</i> is conjoined we have a special case (see below) • otherwise, all potential presuppositions of <i>A</i>
Sentential Adverb of Attitude <i>e.g.</i>	<i>Adverb A</i> <i>Surprisingly, he forgot to come.</i> \gg <i>He meant to come.</i>	• for <i>Adjective</i> = "possible" and <i>A</i> is a conjunction we have a special case (see below) • otherwise, all potential presuppositions of <i>A</i>

continued ...

6.5 Summary of the Projection Problem

Our conclusions about projection for each construct are summarized in Table 6.1.

After examining first-order presuppositions we saw that some could not be correctly expressed without the use of belief operators to modify them. We have now seen that some second-order presuppositions which should project cannot, unless belief operators are available for modifying the propositions.

... from last page

Construct	Structure of the Sentence	Potential Presuppositions of the Sentence
Conditional	If A then B	<ul style="list-style-type: none"> • all potential presuppositions of A • all potential presuppositions P of B which A does not entail, with anti-condition Q for all Q such that A and Q entails P
e.g.	<i>If Brenda comes back from Europe I'll announce her return.</i> \gg <i>Brenda is in Europe.</i> \gg <i>Her return has occurred.</i>	
e.g.	<i>If Harry joined that group, he'll regret that he shaved his head.</i> \gg <i>Harry shaved his head,</i> with anti-condition “all members of that group shave their heads”.	
Conjunction	A and B	<ul style="list-style-type: none"> • all potential presuppositions of A and of B • when in a possibility environment we have a special case (see below)
e.g.	<i>He started doing circuit training and his knee began to hurt.</i> \gg <i>He hadn't been doing circuit training.</i> \gg <i>His knee hadn't been hurting.</i>	
Disjunction	A or B	<ul style="list-style-type: none"> • all potential presuppositions of A • all potential presuppositions P of B not entailed by $\neg A$, with anti-condition Q for all Q such that $\neg A$ plus Q entails P
e.g.	<i>Either Peter is late again, or I got the time wrong.</i> \gg <i>Peter has been late before.</i>	
e.g.	<i>Either Paul is still here or I missed his departure.</i> \gg <i>His departure took place.</i>	
Special Case	It's possible that A and B OR Possibly A and B	<ul style="list-style-type: none"> • all potential presuppositions of A • all potential presuppositions P of B not entailed by A, with anti-condition Q for all Q such that A plus Q entails P
e.g.	<i>Possibly he was murdered and the murderer is still here!</i> \gg <i>There is a murderer.</i>	

Table 6.1: Summary of the projection problem

Chapter 7

Conclusions

Now that our approach has been completely presented, we will make a final comparison with the most influential theory of presupposition to date — that of Gazdar. This chapter then briefly discusses some areas for future work, both on theoretical issues and questions of implementation, and ends with a summary of this work.

7.1 Comparison With Gazdar’s Theory

The emphasis in Gazdar’s theory is on a rigorous explanation of how the presuppositions of a complex sentence can be determined from those of its constituents, and on how presuppositions and implicatures interact with each other and with the context of utterance. Rather than consisting of an unmotivated list of rules, the theory handles projection in a uniform manner, based on pragmatic principles involving consistency. We agree with its view that the survival of candidate presuppositions depends on consistency.

The emphasis in this work is different. It was intended to examine the relevance of the beliefs of agents to presupposition, and if warranted, to develop a theory that is sensitive to their beliefs. Upon examining presuppositions of simple and complex sentences, we found that beliefs of agents mentioned in the sentence, and in the case of an utterance, beliefs of the speaker and listener, can all be relevant. (If we wish to take an agent’s perspective, that agent’s beliefs are also important.) We then developed an account of presupposition with beliefs as an integral part.

So the key difference between the two approaches is that they emphasize different aspects of presupposition. In addition, although the account we have developed is similar to Gazdar’s in structure, they differ in several key ways. We will now summarize these differences.

Summary of the two Approaches

Figure 6.2 showed the two ways in which the actual presuppositions of a complex sentence can be determined in our theory. One method first finds potential presuppositions by direct appeal to their definition, and the other uses the “compiled out” rules of Chapter 5 and Chapter 6 for finding potential presuppositions. The former is appropriate for comparison with other theories since it is where our theory lies, while the latter is merely

Figure 7.1: Summary of technique for computing actual presuppositions of complex sentences.

a shortcut. It is therefore redrawn in Figure 7.1 for comparison with Gazdar's approach, a summary of which is shown in Figure 7.2. While these structures look very similar, the details are different in important ways.

Pre-suppositions vs. Potential Presuppositions

Even if a given sentence can NEVER on any occasion of use actually presuppose one of its pre-suppositions, this fact in no sense makes the assignment of that pre-supposition to the sentence incorrect: Pre-suppositions are notional entities whose only role is a technical one in the process of assigning actual presuppositions to utterances [Gazdar 1979b, 64].

For example, Sentence 1 pre-supposes 2 even though it can never be presupposed.

(1) If their pictures of California are ready, they'll be happy that they are.

Figure 7.2: Summary of Gazdar's approach to computing presuppositions of complex sentences.

(2) They are, *i.e.* their pictures of California are ready.

Our potential presuppositions do not correspond to these pre-suppositions. To say that a Sentence S potentially presupposes proposition P in our theory, is to make a general statement about Sentence S : it tends to imply P . So our potential presuppositions are more than convenient intermediate propositions.

Computing pre-suppositions vs. computing potential presuppositions

The function f_p for computing pre-suppositions of S corresponds approximately to the application of our potential presupposition definition to find the potential presuppositions of S . However, Gazdar's f_p is based on a set of unconnected and unmotivated rules (each expressed as a function) whereas our definition of presupposition, which subsumes the detection of potential presuppositions in our theory, lends coherence to the class of apparently independent potential presuppositions. Also, f_p is committed to taking all pre-suppositions of S 's constituents to be pre-suppositions of S . (Some may later be cancelled during the context check.) It is this fact that permits cases where a sentence pre-supposes a proposition that it can never actually presuppose in any context of utterance.

Context

During the context check in Gazdar's theory, only the beliefs of the speaker are discussed as a relevant part of the context. We have a richer view of context which involves beliefs of the listener and other observers, and have given a method of modelling this context. Such models make it possible to describe presupposition as perceived by other agents than the speaker, and to express the subtle propositions involved in the use and detection of sarcasm and marked presuppositions.

Checking for consistency with the context

The context check is done on *all* sentences in Gazdar's theory, whereas we only perform the check for negative sentences, based on the principle that presuppositions of positive sentences generally cannot be retracted. For example, the following pair of sentences is not felicitous because Sentence 4 tries to retract a presupposition of Sentence 3:

(3) Lorene went to the ballet.

(4) She regrets that she didn't go.

This principle is implicit in our definition of actual presupposition. Our theory says that the second sentence potentially presupposes that Lorene went, and since that sentence is positive, it must actually presuppose it. This actual presupposition directly contradicts the first sentence, and hence the second sentence is infelicitous. Gazdar handles this kind of example by also classifying presuppositions of positive sentences as entailments¹.

¹Actually, he only makes a commitment to this in the case of presuppositions of factive verbs and definite descriptions[Gazdar 1979a, 123].

Now the observation that only negative sentences can experience cancellation is not entirely true. There is a class of positive sentences, discussed in Chapter 6 and united by the fact that they express hypothetical situations, that can experience cancellation. For example, Sentence 5 potentially presupposes that Brenda has injuries.

(5) If Brenda becomes a long distance runner, her injuries will take their toll.

However, this presupposition is blocked from being an actual presupposition if it has already been established that all long distance runners get injured.

Such sentences could not be handled by the first version of our definitions, given in Chapter 4. They also pose a problem for theories that treat presuppositions of positive sentences as entailments. Since Gazdar does not make a commitment on whether or not presuppositions stemming from *all* positive sentences are also entailments, it is unclear whether or not his theory can explain these sentences. In order to handle them, we augmented our definitions of potential and actual presupposition with clauses involving anti-conditions. We are not entirely satisfied with this complication of the definitions. Yet we find our choice of performing the check only on negative sentences, and the anti-conditions to which it leads us, preferable to adopting a context check on all sentences. This choice allows us to maintain the view that positive sentences usually do not allow retraction, and to predict the infelicity of sentences such as those in the above example. In addition, there is a common thread shared by negative sentences and sentences expressing hypothetical situations — the description of “non-events” — and this commonality is reflected in the version of our definitions that includes anti-conditions.

Retraction of presuppositions

Although Gazdar discusses the retraction of presuppositions due to contradictory information that follows, it appears that his formal definitions of presupposition cannot handle such phenomena if the contradictory information occurs in a separate sentence.

Consider the case in which the contradictory information is directly stated in a separate sentence, as in

(6) Hilary isn't a widow.

(7) Hilary isn't female.

Gazdar's definitions compute an accumulating context. For sentence number n , the new “context of utterance”, e_u^n , is the union of the previous context and the speaker's knowledge of Sentence n . The total context which results from the utterance of Sentence n , e_U^n , is calculated from e_u^n and the presuppositions and implicatures of the sentence. For simplicity, in this example we will assume that the context up to the point of utterance is nil. For the first sentence, after computing the presupposition that [K Hilary is female], Gazdar's definition determines the total context resulting from the utterance, e_U^1 , to be:

$$\left\{ \begin{array}{l} [K \text{ Hilary isn't a widow}] \\ [K \text{ Hilary is female}] \end{array} \right\}$$

This then becomes the context for the next sentence. The context of utterance for the second sentence, e_u^2 is:

$$\{ \begin{array}{l} [K \text{ Hilary isn't a widow}] \\ [K \text{ Hilary is female}] \\ [K \text{ Hilary isn't female}] \end{array} \},$$

an inconsistent set. The final context e_U^2 resulting from the utterance of Sentence 7 in the context of 6 is by definition² a superset of e_u^2 . It is, therefore, also inconsistent.

Now consider a presupposition that is contradicted by information that is indirectly stated, for example by presupposition, in a separate sentence.

(8) Hilary isn't a widow.

(9) Hilary is a widower.

For the first sentence, e_U^1 is again

$$\{ \begin{array}{l} [K \text{ Hilary isn't a widow}] \\ [K \text{ Hilary is female}] \end{array} \}$$

However in this case, e_u^2 , the union of e_U^1 and the speaker's knowledge of the second sentence, is

$$\{ \begin{array}{l} [K \text{ Hilary isn't a widow}] \\ [K \text{ Hilary is female}] \\ [K \text{ Hilary is a widower}] \end{array} \}$$

The problem arises when the final context e_U^2 is computed from e_u^2 and the presupposition $[K \text{ Hilary is male}]$. Because this presupposition contradicts an element of e_u^2 , and by the definition³ of e_U^n , $[K \text{ Hilary is female}]$ is not retracted and replaced by $[K \text{ Hilary is male}]$ as it should be. Instead, e_U^2 is

$$\{ \begin{array}{l} [K \text{ Hilary isn't a widow}] \\ [K \text{ Hilary is female}] \\ [K \text{ Hilary is a widower}] \end{array} \}$$

Hence, Gazdar's definitions cannot handle retraction which occurs over sentence boundaries.

7.2 Future Work

7.2.1 Belief Revision

Given a particular notion of belief and a formalism for representing it, the question of how to revise a set of beliefs arises. We have presented ideas towards two operators for this purpose, but formal definitions are still required. If this were accomplished, it would then be desirable to move to a weaker, and hence more realistic, notion of belief such as that presented in [Levesque 1984a]. Using the definitions of the operations in

²This follows from definitions XVII and XVI[Gazdar 1979b, 67–68].

³See definition XVII[Gazdar 1979b, 68].

the first logic for intuition, an attempt could then be made to define them within the new framework.

There are some special concerns associated with retracting beliefs. In the time between asserting and retracting a particular belief, inferences may be made which rely on that belief as part of their justification. Thus, they too may need to be retracted. The problems associated with representing the supporting relationships between propositions and acting upon them are called problems of **truth-maintenance** (see, for example, [Doyle 1979] or [de Kleer 1986]).

7.2.2 Belief Modelling in General Natural Language Understanding

This thesis has discussed how beliefs affect one's perception of presuppositions, and how this can be modelled. An obvious extension is to examine how beliefs affect other aspects of natural language understanding. The inference classes we have mentioned are all affected by beliefs in a manner similar to presuppositions. For example, consider the following conversation:

(10) **Kay:** *Will Chris and Ben be eating lunch with us?*

Ed: *Ben won't — Tom took him to McDonald's for lunch.* [This sentence conversationally implicates that Chris *didn't* have lunch at McDonald's.]

Tom: *Actually, Chris had lunch at McDonald's also.*

To understand this conversation, one must not only appreciate the conversational implicature of Ed's utterance, but also the distinction between Ed believing it to be true, and the others believing it (and, in fact, Tom realizing that Ed believes it to be true, and hence deciding to correct his mistake).

All the inferences we have discussed share with presupposition the projection problem, and the mention of beliefs is important during their projection as well. In the following examples, a conversational implicature and an entailment require a belief operator in order to project over a verb of saying.

(11) Kay said that some of the boys went to the beach.

$\rightarrow B_{Kay}(\text{Not all of the boys went to the beach})$

(12) Kay said that Chris brought three Gobot toys.

$\models B_{Kay}(\text{Chris brought some Gobot toys})$

Belief modelling is central to all aspects of natural language understanding. Whenever more than one person is involved in discourse, the beliefs of each person must be distinguished in order to fully understand.

7.2.3 Breaking the Gricean Maxims

In Chapter 2 the simplifying assumptions that the speaker is both sincere (*i.e.* doesn't deliberately utter false statements) and straightforward (*i.e.* doesn't use sarcasm) were made. What happens if these assumptions are removed, allowing for a speaker who breaks the associated Gricean maxims?

By our approach, a listener could only detect deceit if a speaker uttered a Sentence S and the listener thought that the speaker believed the sentence to be false. This is reasonable given that we are trying to model people rather than telepathic beings. Also, only with a notion of belief can the subtle propositions which would be necessary for detecting deliberate deceit, such as $B_L B_{Sp} \neg \hat{S}$, be captured.

Our approach could also contribute to the detection of sarcasm by making available propositions involving beliefs. For example, one kind of sarcasm, in which the speaker and listener share, might be defined as follows:

DEFINITION 1: The utterance of Sentence S by speaker Sp to listener L in state s is considered sarcastic by L iff

- $s \models B_L B_{Sp} \neg \hat{S}$
- $s \models B_L B_{Sp} B_L \neg \hat{S}$

7.2.4 The Problem of Tense

We have so far avoided addressing the problem of determining *when* an event expressed by a presupposition must have occurred, and from this, the appropriate tense for expressing the presupposition. Generally, the event described by a presupposition must occur in some particular temporal relation to the event described by the presupposition's trigger, and this relation is determined by the trigger. For example, the presupposition of Sentence 13 must have occurred *before* the stopping event, and is correctly expressed in 14.

(13) Heather stopped taking piano lessons.

(14) \gg Heather had been taking piano lessons (until the time she stopped).

It appears that mechanical calculations could determine from the tense of a trigger's auxiliary verbs the appropriate tense to use for the presupposition's auxiliary verbs. In Table 7.1 a relation between the two is proposed for change-of-state verbs, and an example is given for each tense. In addition to the usual terminology for expressing tenses, they are also expressed in the table as lists, with one element — for either “past”, “present”, or “future” — for each auxiliary verb. When expressed in this manner, it is easier to see that the tense of the presupposition's auxiliary verb is generally “more past” than that of the original sentence.

7.2.5 Implementing the System

Modelling Beliefs

Since our model requires a set which is not only infinite itself, but whose elements are also infinite, it cannot be implemented by creating a symbolic object for each of these entities. Of course, this does not mean that the model cannot be directly implemented⁴.

⁴Such an implementation would be comparable to Morgan's implementation of Montague's intentional logic [Morgan 1980]. Morgan replaces Montague's infinite models with dynamic, partially-specified ones.

Tense of Sentence	Tense of Presupposition
Simple Present [pr] (present reading) <i>John stops dancing</i>	Present Perfect [pr pa] » <i>John has been dancing</i>
Simple Present [pr] (future reading) <i>John stops dancing (tomorrow)</i>	Future Perfect [fu pa] » <i>John will have been dancing</i>
Simple Past [pa] <i>John stopped dancing</i>	Past Perfect [pa pa] » <i>John had been dancing</i>
Simple Future [fu] <i>John will stop dancing</i>	Future Perfect [fu pa] » <i>John will have been dancing</i>
Present Progressive [pr pr] (present reading) <i>John is stopping dancing</i>	Present Perfect [pr pa] » <i>John has been dancing</i>
Present Progressive [pr pr] (future reading) <i>John is stopping dancing (tomorrow)</i>	Future Perfect [fu pa] » <i>John will have been dancing</i>
Present Perfect [pr pa] <i>John has stopped dancing</i>	Present Perfect [pr pa] » <i>John has been dancing</i>
Past Progressive [pa pr] <i>John was stopping dancing</i>	Past Perfect [pa pa] » <i>John had been dancing</i>
Past Perfect [pa pa] <i>John had stopped dancing</i>	Past Perfect ^a [pa pa] » <i>John had been dancing</i>
Future Progressive [fu pr] <i>John will be stopping dancing</i>	Future Perfect [fu pa] » <i>John will have been dancing</i>
Future Perfect [fu pa] <i>John will have stopped dancing</i>	Future Perfect [fu pa] » <i>John will have been dancing</i>

Table 7.1: Suggested tense relationships for change-of-state verbs.

^aThere is no verb tense in English for expressing that something occurred before a past perfect tense. If one wishes to explicitly state this a relative time can be used, as in the following:

(i) By the time we left, John had stopped dancing. He had been dancing up a storm *before then*.

Another method of implementation would involve moving to a “syntactic” approach — first-order logic with an added belief operator. For example, sentences of \mathcal{L} and a proof theory for \mathcal{L} could be encoded in Prolog. Of course, all the standard objections to such syntactic approaches would apply (see, for example, [Levesque 1984a]). To add a new presupposition an “assert” predicate could be used; to remove one, a “retract” predicate. In order to check whether an agent already believes the negation of a potential presupposition, a simple query would suffice.

Calculating Potential Presuppositions

The actual calculation of potential presuppositions is relatively straightforward to implement. Mechanical rules can be added to any parsing scheme in order to reflect rules chosen for first-order presuppositions and projection. For example, [Weischedel 1975] demonstrates how this can be done with augmented transition networks (see Chapter 2). While we disagree with some aspects of his approach, the basic mechanism behind it is suitable for finding *potential* presuppositions; actual presuppositions require the additional ability to model the beliefs of agents and to query the model.

It would be desirable to move away from specific rules for each trigger towards more general rules which capture regularities across all triggers. As was noted in Chapter 2, some work has been done with regard to this, but there is not yet an approach which provides adequate coverage.

Calculating Actual Presuppositions

Once potential presuppositions have been found, all that remains for determining which are actual is the ability to query the knowledge base. In accordance with our definitions, for determining whether or not potential presupposition $B_{Sp}P$ is actual, the proposition $B_L B_{Sp}Q$ must be checked against the knowledge base for any anti-condition Q , and for negative sentences, $B_L B_{Sp}\neg P$ must also be checked.

7.3 Summary

We began this thesis by examining the phenomenon called presupposition and noting that previous attempts to characterize it have generally made two inappropriate assumptions. They assume, first, that presuppositions of sentences or utterances are actually true; second, that all participants in discourse share knowledge of these presuppositions. We treat presuppositions as beliefs in order to avoid these assumptions. Before exploring the effects which this would have on an analysis of first-order presuppositions and projection, two things were done. First, a formalism for modelling beliefs and a language for expressing propositions involving beliefs were developed. In addition, operations were discussed with which the current state of a beliefs model could be altered in order to update the beliefs of agents as presuppositional information is added and retracted. Second, two separate notions of potential and actual presupposition were distinguished, and definitions were given for each. These definitions are a significant improvement over earlier ones because they are more precise, and more importantly, because they capture

the phenomena of presupposition more accurately.

With the belief modelling formalism and the new definitions in mind, we then examined first-order presuppositions and the projection problem. From this it was learned that, for correctness, more is required than simply modifying presuppositions to specify that they are beliefs of the speaker. In some cases, reference must be made to the beliefs of other agents either mentioned in the sentence in question, or involved in the discourse. We also saw that, during projection, some presuppositions which should survive cannot, unless they can be modified to specify exactly who it is that believes them.

So the inclusion of belief operators in presuppositions not only provides a more correct approach by avoiding the two assumptions we have argued against; it also makes it possible to account for presuppositional phenomena which could not be explained otherwise. These results provide strong support for our approach.

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