The Logic of English Predicate Complement Constructions

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0. INTRODUCTION. The title of my paper is an intentional variation on the name of Peter Rosenbaum's (1965) well-known MIT dissertation 'The Grammar of English Predicate Complement Constructions'. It is intended to be suggestive of a difference in emphasis between the early work on complement constructions by Rosenbaum and others, and the more recent studies by Paul & Carol Kiparsky, George Lakoff, Jerry Morgan, and myself - just to mention a few.[2] It is these newer developments that I will discuss in my report.

In the appendix to this thesis, Rosenbaum provided a classification of English verbs in terms of the complement structures in which the verbs may participate. His analysis of complementation has since been challenged, and the basic criteria for his classification have now generally been rejected.[3] But of course, the general principle of classifying verbs in terms of their syntactic properties continues to be valid. For example, it must be stated somewhere in the lexicon that verbs like order and force take sentential complements only in the presence of a real noun phrase object, but believe and realize can have complements as their objects. Or, if you prefer another terminology, realize is a two-place and force a three-place predicate. On the basis of such simple criteria, one might arrive at the conclusion that the verbs listed in (1) divide naturally into the four groups which are indicated there.

(1) (a) order(x, y, S) force(x, y, S)
(b) realize(x, S) believe(x, S)
(c) manage(x, S) decide(x, S) able(x, S)
(d) seem(S) happen(S) certain(S) odd(S) possible(S)

For instance, on syntactic grounds there are good reasons for regarding the verbs happen and seem as similar, since they both take sentential subjects and undergo many of the same syntactic transformations.

In selecting these examples in (1), I have not been quite as arbitrary as it first appears. It does not take long to notice that just those verbs which here fall into the same class on the basis of some superficial syntactic criteria turn out to be different when the same verbs are grouped on the basis of their semantic properties. At this point, you might take a look at the classification in (2), which gives a preview of what is to come, and compare it with (1).

(2) FACTIVES: realize, odd
IMPLICATIVES: manage, happen
IF-VERBS: force, certain
ONLY-IF VERBS: able, possible

Sometimes it is possible to show that there is a definite connection between the semantic properties of a verb and certain syntactic characteristics. For instance, it has been observed (Kiparsky 1968) that all of the factive verbs of the type (1d) are exceptions to the transformation that relates (3a) and (3b). Therefore, (3d) is ungrammatical.

(3) (a) It was certain that Bill was alone.
(b) Bill was certain to be alone.
(c) It was odd that Bill was alone.
(d) *Bill was odd to be alone.

However, I do not believe that the validity of the proposed classification crucially depends on us being able to find

syntactic parallels for every distinction; and here I will not try to present any. For the purpose at hand, it is sufficient to demonstrate their semantic reality, to show that they actually play a part in our everyday reasoning.

1. FACTIVE VERBS. The term 'factive verb' is due to a pioneering study by Paul and Carol Kiparsky (1968).[4] An illustrative sample of these verbs is provided in (4).

(4) FACTIVE VERBS:

significant	resent
tragic	know
relevant	realize
odd	bear in mind
	take into account
regret	make clear
ignore	find out

What is common to them is that any simple assertion with a factive predicate, such as (5a), commits the speaker to the belief that the complement sentence, just by itself, is also true.

(5) (a) It is odd that Bill is alone.
(b) Bill is alone.
(c) It is possible that Bill is alone.

It would be insincere for anyone to assert (5a) if he did not believe that (5b) is true. Intuitively, in uttering (5a) the speaker must take it for granted that Bill is alone; he is making a comment about that fact. The same relation holds between (6a) and (6b).

(6) (a) Mary realized that it was raining.
(b) It was raining.
(c) Mary believed that it was raining.

Notice that these relations break down if we replace odd by possible and realized by relieved. (5c) and (6c) do not carry a commitment to the truth of the complement sentence.

With factive verbs, it does not make a difference whether the main sentence is affirmative or negative. The negations

of (5a) and (6a) , which you find in (7), also obligate the speaker to accept the complement as true.

(7) (a) It isn't odd that Bill is alone.
(b) Mary didn't realize that it was raining.

Even the illocutionary force of the main sentence is irrelevant. The question in (8) carries along the same commitment as (5a) and (7a).

(8) Is it odd that Bill is alone?

These facts about negation and questions become important later on when we have to distinguish between factive and implicative verbs.

1.1. PRESUPPOSITION. What the above examples show is that a sentence with a factive predicate indicates belief on the part of the speaker in the truth of the complement sentence. This relation is usually described by saying that the complement of a factive predicate is a 'presupposition' for the sentence as a whole. The term 'presupposition' comes from logic but it is currently used in linguistics in a more general way than the common logical definition would actually allow. In logic, it is customary to give some definition such as (9).[5]

(9) P presupposes Q iff
$T(P) \supset T(Q)$ and $F(P) \supset T(Q)$
[T(_) = '_ is true' , F(_) = '_is false']

That is, P presupposes Q just in case Q is true whenever P has a truth value.

However, this definition in terms of truth values is not very helpful to linguists. They tend to rely on a more or less intuitive notion of presupposition, which I have tried to explicate in (10) - rather unsuccessfully, I must say.[6]

(10) P presupposes Q just in case that
if P is asserted, denied, or questioned then the speaker ought to believe that Q.

1.2. POSSIBLE WORLDS. In his paper on presuppositions, Jerry Morgan (1969) pointed out that there are sentences such as the examples in (11).

(11) (a) If I had missed the train, I would have regretted it.
(b) I dreamed that I was a German and that nobody realized it.

The problem with these examples is that, in both cases, the speaker apparently does not believe that the complement of the factive verb is true. In (11a), the pronoun it stands for the sentence 'that I had missed the train'. Since regret is a factive verb, the second clause of (11a) presupposes that the speaker has missed the train. However, this is just what is denied by the preceding counterfactual conditional. According to what we just said about factive verbs, (11a) ought to be self-contradictory. Similarly, (11b) ought to imply that the speaker believes that he is a German, even when he is not dreaming. Both of these predictions are clearly wrong. On the other hand, the examples in (12), which are very similar to those in (11) pose no problems at all.

(12) (a) If I had regretted that I missed the train, I would not have mentioned it.
(b) *I* dreamed that nobody realized that I was a German.

(12a) can be sincerely asserted only by someone who believes that he has missed the train; in (12b), the speaker must believe that he really is a German. The crucial difference between (11) and (12) is that, in (12a), the sentence with a factive predicate is the antecedent clause of a counterfactual conditional construction and, in (12b), it is the first sentence following the verb dream.

Morgan concludes from examples of this sort that the conditional if, the word dream and all similar verbs are to be regarded as 'world-creating' predicates . A sentence in the scope of a world-creating predicate is assumed to be true, not in the actual world, but in a 'possible world'.[7] A possible world receives its characterization in the usual left-to-right order of discourse. For instance, in (11b) the first sentence following the verb dream, 'I was a German', is understood to be a fact in the context of my dream world; therefore, it can stand as a presupposition for the following sentence, 'nobody realized that I was a German', which also is in the scope of dream. Similarly, in (11a) the antecedent clause of the conditional construction, 'I had missed the train', defines a possible world in which it may then also be true that I regret that fact.

This analysis explains the difference between the examples in (11) and (12). In (12b), the complement of realize has not been established as a fact of the dream world; therefore, it ought to be a fact in the actual world of the speaker. (12b) can only be said by someone who believes that he is a German. In (11b) , the complement is introduced as a fact in a dream. It does not matter if the speaker does not believe it to be true in the actual world.

I don't intend to try to give any formal account of how possible worlds ought to be incorporated into a theory of language. I don't think that there is, at this point, much to be said about it beyond the kind of suggestive remarks that I have presented. This is an area where there is bound to be some exchange of ideas between linguists and modal logicians, who have traveled in possible worlds far more extensively than we have. But neither linguists nor philosophers have actually been thinking about sentences like those in (11) for very long.

1.3. DEGREES OF FACTIVITY. Another outstanding problem is that some of the factive verbs in (4) do not carry along the expected presupposition in all syntactic environments. For example, there is an unexplained difference between verbs like regret and realize in conditional clauses. Although both verbs are factive as far as simple assertions are concerned, if-clauses with realize as predicate do not presuppose the truth of the complement. Consider the difference between (13a) and (13b).

(13) (a) If I realize later that I have not told the truth, I will confess it to everyone.
(b) If I regret later that I have not told the truth, I will confess it to everyone.

It is obvious that (13a), with realize in the if-clause, does not presuppose that the speaker has not told the truth; it merely admits that there is such a possibility. On the other hand, one cannot utter (13b) without thereby conceding that one has not told the truth. Another ordinarily factive verb which loses its factivity under the same circumstances is the verb find out.

As far as I know, anomalies of this sort are still largely unexplored und poorly understood.

2. IMPLICATIVE VERBS. The next class of verbs I will discuss is illustrated by the examples in (14).

(14) IMPLICATIVE VERBS:

manage	have the {misfortune / foresight}
bother	
happen	take (the) {time / opportunity / trouble}
see fit	
get	
care	condescend

If we "Just look at affirmative assertions, implicative verbs are very similar to factives. A sentence like the examples

in (15) commits the speaker to the belief that the complement sentence is true.

(15) (a) Yesterday, Bill happened to break a window.
(b) To everyone's surprise, Sam managed to solve the problem.

(16) (a) Yesterday, Bill broke a window.
(b) To everyone's surprise, Sam solved the problem.

Asserting (15a) obligates the speaker to accept (16a) as true. The same goes for (15b) and (16b). But if we replace manage with a verb like decide, the same relation does not hold anymore. There is no such connection between (17) and (16b).

(17) To everyone's surprise, Sam decided to solve the problem.

However, notice that the adverbial modifiers of the main sentence, yesterday in (15a) and the phrase to everyone's surprise in (15b), by implication also seem to belong to the complement sentence. Another striking difference between factive and implicative verbs shows up in negative assertions. This can be observed by comparing the examples in (18) with those in (7). As you remember, in case of factives, negation in the main sentence has no effect on the assumed truth of the complement. But when a sentence with an implicative predicate is negated, it commits the speaker to the view that the complement *is* false. For instance, one cannot sincerely assert (18a) unless one believes (19a).

(18) (a) Sheila didn't bother to come.
(b) Max didn't have the foresight to stay away.

(19) (a) Sheila didn't come.
(b) Max didn't stay away.

It would be contradictory to say something like (20).

(20) *Sheila didn't bother to come, but she came nevertheless.

Similarly, (18b) implies (19b).

2.1. IMPLICATION. In saying that (18b) implies (19b), I am not using the term 'imply' in the sense of 'logically implies' or 'entails'. The relation is somewhat weaker, as indicated by the definition in (21).

(21) P implies Q iff
whenever P is asserted,
the speaker ought to believe that Q.

I believe this to be the same sense in which J. L. Austin (1962) has used the term. It is also closely related to B. C. Van Fraassen's (1968) notion of 'necessitation'[8]. Note that, for our weak sense of 'imply', the rule of inference known as 'Modus Tollens' does not apply. It is not required in (21) that asserting in ~Q should, in turn, obligate the speaker to believe that ~P. The reason why this point is worth making is that Modus Tollens is a valid argument form for the two other common senses of the term 'imply', 'materially implies' and 'logically implies', which we do not want to get mixed up with. Using the term in the sense of (21), we can say that (22a) implies (22b).

(22) (a) John managed to kiss Mary.
(b) John kissed Mary.

But it would be mistaken to conclude from this, by Modus Tollens, that the negation of (22b) implies the negation of (22a); in other words, that (23a) also implies (23b).

(23) (a) John didn't kiss Mary.
(b) John didn't manage to kiss Mary.

If you contemplate for a while the two sentences in (23), you will soon realize that one can perfectly well assert (23a) without committing oneself to the belief that (23b) is true.

The verb manage in (23b) carries along an extra assumption that is not shared by (23a). It would be appropriate to use (23b) only if John had actually made an unsuccessful attempt to kiss Mary. Therefore, these two sentences are not logically equivalent; the implication only holds in one direction, from (23b) to (23a) and from (22a) to (22b).

2.2. MEANING POSTULATES. Let us now consider the problem how these facts about implicative verbs ought to be accounted for. One might, for example, propose that the semantic representation of (15a) actually contains the implied sentence, (16a), as a subpart. If one is a generative semanticist, one might even assume that (15a) be transformationally derived from some structure that properly includes the underlying structure of (16a). Under this proposal, there would be no distinction between the semantic representation of a single sentence and the set of inference derivable from it; the two notions would be equivalent.[9] This is not the approach that I have chosen. Instead, I assume that the implied sentence is not included in the underlying representation of its antecedent but is to be derived from it by means of meaning postulates and general rules of inference.

I have proposed (Karttunen 1970a) that the facts about implicative verbs be accounted for in the following manner. What all verbs such as manage, bother, etc. have in common is that they are understood to represent some necessary and sufficient condition which alone determines whether the event described in the complement takes place. They all have the same two meaning postulates associated with them.[10] Using v for any arbitrary implicative verb and S for its complement, we can represent these two meaning postulates roughly as in (24).

(24) (a) $v(S) \supset S$ 'v(S) is a sufficient condition for S'

(b) $\sim v(S) \supset \sim S$ 'v(S) is a necessary condition for S'

What actually constitutes this decisive condition depends on the particular implicative verb. It may consist of making a certain effort, as in bother, showing enough skill and ingenuity, as in manage, or it may be a matter of chance, as in happen. A sentence with one of these verbs as predicate can be looked upon as a statement about whether this decisive condition is fulfilled, and under what spatial and temporal circumstances this is the case. From an affirmative assertion, we can then infer that the complement is true; from a negative assertion that the complement is false. The rule of inference I am assuming here is, of course, the familiar Modus Ponens, which is illustrated in (25).

(25) MODUS PONENS:

(a)
$$\begin{array}{l} P \supset Q \\ P \\ \hline \therefore Q \end{array}$$

(b)
$$\begin{array}{l} \sim P \supset \sim Q \\ \sim P \\ \hline \therefore \sim Q \end{array}$$

For example, note that although all the sentences in (26a) assume a different kind of decisive condition for the truth of the complement, they all assert that, yesterday, this condition was not fulfilled.

(26) (a) Yesterday, John did not $\left\{\begin{array}{l}\text{happen}\\ \text{manage}\\ \text{bother}\\ \text{see fit}\end{array}\right\}$ to kiss Mary.

(b) Yesterday, John did not kiss Mary.

Therefore, (26b) can be derived in all cases as a legitimate inference in the manner illustrated in (25b) above.

2.3. NEGATIVE IMPLICATIVES. Next I would like *to* point out a group of verbs that are in every other respect like the implicative verbs in (14) except that they work the opposite way. A short list of these negative implicatives is given in (27) .

(27) NEGATIVE IMPLICATIVES: forget (to) decline
fail avoid
neglect refrain

An affirmative assertion with one of these verbs as predicate implies the negation of the complement. For instance, (28a) implies (28b).

(28) (a) John avoided getting caught in the traffic,
(b) John didn't get caught in the traffic.

On the other hand, a negative assertion results in a positive implication, just as we would expect on the basis of the Law of Double Negation. Thus (29a) implies (29b).

(29) (a) John didn't avoid getting caught in the traffic.
(b) John got caught in the traffic.

There are in principle two ways to account for these facts in our analysis. One way is to say that we have a separate pair of meaning postulates for negative implicative verbs. This set would be the pair given in (30).

(30) (a) $v(S) \supset \sim S$ 'v(S) is a sufficient condition for ~S'
(b) $\sim v(S) \supset S$ 'v(S) is a necessary condition for ~S'

The other possibility is to assume that negative implicatives in fact contain negation in their underlying syntactic structure and that there is a process of lexical insertion that can replace some ordinary implicative verb and the preceding negation marker with one of the verbs in this special class. For instance, there would be rules such as (31), which

says that the verb fail, in one *of* its senses, is equivalent to not succeed. This equivalency may then be interpreted as permission to substitute fail for not succeed in some underlying syntactic structure.

(31) fail ≡ not succeed

One immediate advantage of such an analysis is that only one set of meaning postulates is needed, namely the pair in (24). On the other hand, there is the apparent problem that most of the verbs in (27) do not have any implicative positive counterpart. What, for instance, would be the positive counterpart of avoid?

At this time, I do not know of any decisive argument for choosing between the two alternative analyses that are available for negative implicatives.

2.4. SPECIAL CASES. In addition to the verbs listed in (14) and (27), there are of course many other implicative verbs. After one becomes aware of their existence, they are not hard to catch. There are some that are especially interesting. For instance, the words true and false, at least in their everyday sense, are implicative. They would, in fact, be the best example to use, if one wanted to argue that negative implicatives are to be defined in terms of positive ones. Nobody but a three-valued logician would refuse to accept the word false as the equivalent of not true. Another implicative word is the noun fact, which is not factive, as one might expect from the name. For that reason, it may be appropriate at this point to sound a warning and say that the verb imply, in turn, is not implicative. On one hand, it is a factive verb; on the other hand, it may also be a member of another category that we have not discussed yet: the if-verbs.

3. IF-VERBS AND ONLY-IF VERBS. The next two classes of verbs also give rise to implicative relations, although in a less perfect fashion than implicative verbs proper. What is common to both of these types is a kind of asymmetry between negative and affirmative sentences, so that the implication holds only in one of them. It appears to me that these verbs are associated with only one of the two meaning postulates in (24). Verbs of one group express a sufficient condition for the truth of the complement. For that reason - and for the sake of brevity -I refer to them as 'if-verbs'. Verbs in the other group express a necessary condition; they are the 'only-if-verbs'. Later on, I will sometimes refer to if-verbs and only-if-verbs jointly as 'one-way implicatives' in order to distinguish them from 'two-way implicatives' discussed above, that is, from verbs which yield an implication both in negative and in affirmative assertions.

3.1. IF-VERBS. The set of if-verbs includes those in (32).

(32) IF-VERBS:

cause	make sure	?	certain	mean
make	bring about			imply
have	see to it			indicate
force			prove	show

If one of these verbs appears as the main verb of an affirmative assertion, the complement is implied to be true. For instance, consider the examples in (33a).

(33) (a) John {forced / made / caused} Mary to stay home.

(b) John {ordered / asked / advised} Mary to stay home.

In all of the a-sentences, the speaker is committed to the belief that Mary stayed home. It would not be honest to assert

any of the sentences in (33a) if one thought otherwise. This fact distinguishes the verbs in (33a) from such syntactically very similar verbs as those in (33b) . It is clear that none of the sentences in (33b) has a definite implication one way or the other.

On the other hand, in negative assertions, the difference between *if*-verbs and those in (33b) disappears entirely. In (34), *force* and *order* are just alike; both are equally non-committal with respect to the complement sentence.

(34) (a) John did not force Mary to stay home.
(b) John did not order Mary to stay home.
(c) … { and she didn't. / but she stayed home anyway. }

As you can easily observe, (34c) is an acceptable continuation for both of the preceding sentences. This fact indicates that, although the verb *force* expresses a sufficient condition for the truth of the complement sentence, it does not express a necessary condition. We can only assign to it the first of the two meaning postulates in (24), namely

(24a) $v(S) \supset S$ 'v(S) is a sufficient condition for S'.

Thus far I have only discussed *if*-verbs which take infinitive complements. But in general there appears to be no connection between the semantic properties of a verb and the syntactic type of complement clause it takes. Just as there are factive verbs with infinitive complements, such as *wise* and *proud*, there are also *if*-verbs which take *that*-complements; for example, *bring about*, *see to it*, and *make sure.* That these verbs really are *if*-verbs and not factives can be shown by pointing out that (35) can be asked felicitously by someone who does not know whether Mary got what she wanted.

(35) Did Bill see to it that Mary got what she wanted?

Furthermore, an affirmative answer commits you to the claim that Mary actually got what she wanted; a negative answer is non-committal in this respect.

It is interesting to notice that all the clear *if*-verbs seem to be, in some intuitive sense, causative verbs. It would be very interesting to find some clear cases of non-causative *if*-verbs, but all the likely candidates that I have come across appear to involve some additional complications. For example, consider the word *certain*. There is no doubt that *certain* is an *if*-verb in constructions like (36a).

(36) (a) It is certain that Sheila left with Max.
(b) Bill is certain that Sheila left with Max.

Surely, it would be dishonest to say (36a) if you did not believe that Sheila left with Max. But it is also clear that *certain* is not an *if*-verb in (36b). It seems likely that, in addition to the complement clause, the verb *certain* always involves another underlying noun phrase, in Fillmore's terms, an 'experiencer'.[11] This noun phrase may remain unexpressed if it is identical with the speaker, as in (36a). The verb *certain* does not count as an *if*-verb unless the experiencer and the speaker are the same person.

The same problem shows up in verbs like *mean* and *imply*, as you can observe from the examples in (37).

(37) (a) That the grass is wet implies that it has been raining.
(b) For Bill, it means that somebody has watered the lawn.

In (37a), the speaker commits himself to the view that is has been raining. But (37b), where the experiencer is not identical with the speaker, is non-committal with regard to the complement. Another fact about these verbs is that, as far as the subject

complement is concerned, they are factive. (37a) and (37b) both presuppose that the grass *is* wet. Because of these complications, it is not clear whether these verbs should really be regarded as if-verbs at all.

Another interesting case is the verb prove. Unlike the verbs just mentioned, prove meets the criteria for if-verbs no matter who the 'experiencer' is. All of the examples in (38) imply the truth of the complement.

(38) (a) Bill proved to me that Max was a liar.
(b) Bill proved to Sally that Max was a liar.
(c) That there is no money in the bag proves that Max is a liar.

On the other hand, the corresponding negative assertions are non-committal.

(39) That there is no money in the bag doesn't prove that Max is a liar; perhaps he is, perhaps he isn't.

As far as these data are concerned, there is no reason not to consider prove as an if-verb.

However, it is also possible to account for just the same facts by a more complex analysis of prove. Let us assume that prove is associated with the meaning postulate in (40), in which the consequent consists of a causative sentence with a factive complement.

(40) $\text{prove}(x, y, S) \supset \text{cause}(x, \text{know}(y, S))$

The fact that all the examples in (38) imply their complement can now be explained by the combined effect of cause and know. For example, given the meaning postulate in (40), (38b) implies (41a), which in turn implies (41b). The latter sentence has a factive predicate; therefore, it presupposes (41c), which is the desired inference.

(41) (a) Bill caused Sally to know that Max was a liar.
(b) Sally knew that Max was a liar.
(c) Max was a liar.

On the other hand, the fact that (39) is non-committal with respect to (41c) is explained by the fact that, since cause yields no implication in a negative assertion, one cannot infer from (39) either that I know Max to be a liar or that I don't know that he is.

The same type of analysis can also be applied to verbs like indicate, show, etc. Assuming that such verbs are analyzed roughly as in (42), we can explain some of the puzzling facts mentioned earlier.

(42) indicate(x, y, S) $\supset$ cause(x, believe(y, S))

For example, we have an explanation for the fact that only the first of the following two examples commits the speaker to the complement sentence.

(43) (a) That there is no money in the bag indicates to me that Max is a liar. (*But I don't think that he is.)
(b) That there is no money in the bag indicates to Sally that Max is a liar. (But I don't think that he is.)

The fact that, in (43), the identity of the 'experiencer' determines whether or not the implication holds can be attributed to the fact that the complement of cause in (42) contains a non-factive verb. For this reason, (43b) only implies that Sally believes Max to be a liar; it is non-committal as far as the speaker is concerned.

3.11. NEGATIVE IF-VERBS. There is also a class of negative if-verbs, which includes the verbs listed in (44).

(44) NEGATIVE IF-VERBS: prevent discourage
dissuade
keep (from)

Like their positive classmates, negative if-verbs carry along a commitment with regard to the complement in affirmative assertions. The difference is that the complement is implied to be false. For example, (45a) definitely implies that Mary did not leave.

(45) (a) John prevented Mary from leaving.
(b) ...*but she left anyway.

On the other hand, a negative assertion such as (46a) is noncommittal. It is compatible with either one of the two continuations in (46b). It is this fact which distinguishes prevent from avoid and other such two-way implicatives listed in (27). They are committal even in negative assertions.

(46) (a) John didn't prevent Mary from leaving.
(b) ... { and she left. / but she chose not to leave. }

Negative if-verbs bring up the same problem as negative implicatives. In principle, there are three ways to account for their negative properties. One way is to postulate for them the first of the two meaning rules in (30):

(30a) $v(S) \supset \sim S$ 'v(S) is a sufficient condition for ~S'.

The other possibility is by way of lexical insertion rules that replace some piece of underlying syntactic structure including a negation marker by one of the verbs in (44). This alternative has been proposed by George Lakoff (1969). It is easy to see, for instance, that we could account for the negative implication of discourage by defining it as in (47a).

(47) (a) discourage ≡ cause not to have courage
(b) keep ≡ cause not to be able

On the other hand, it is a little harder to see what the underlying structure of keep might be. (47b) is an educated guess. Of course, it remains to be shown that the logical properties of keep really correspond to those of the complex predicate cause not to be able. That this is really the case will hopefully become clear later on when we discuss the semantics of be able and other 'only-if-verbs'.

The third possible way to account for negative if-verbs is the same that was already suggested in connection with prove and indicate: setting up new meaning postulates. Obviously, these meaning postulates would be similar to Lakoff's lexical insertion rules. Instead of having a rule for replacing the structure cause not to be able with the single lexical item keep, one would set up a meaning postulate such as (47b*), which allows one to derive the former from the latter as a logical inference.

(47b*) keep(x, y, S) $\supset$ cause (x, ~able(y, S))

It is doubtful whether there is any conclusive argument for choosing between the last two alternatives. However, note that (47b*) makes a weaker claim than its predecessor. Unlike a Lakoff-type insertion rule, it is not open to objections which are based on the claim that the transformationally inserted lexical item is not really synonymous with its supposed paraphrase.

Instead of trying to settle the issue here, I will simply assume that negative if-verbs are associated with the meaning postulate (30a), which is also shared by avoid and other similar two-way implicatives.

3.12. OTHER IMPLICIT CAUSATIVES. One interesting side result from the study of if-verbs is that it lends some new support to the so-called 'causative analysis' of verbs like kill and break. James D. McCawley (1969) and others have proposed that such verbs should not be treated as unanalyzed lexical items in underlying syntactic representations. Instead, they should be

inserted transformationally by a rule that replaces a subtree in which cause is the topmost predicate. According to this view, the underlying structure of kill is roughly as in (48).

(48) kill ≡ cause to become not alive

Since cause is an if-verb, it follows from this analysis that kill should also belong to this semantic category. As the following example shows, this prediction seems to be in agreement with out intuitive judgements. An affirmative assertion with kill as predicate implies that the person referred to by the object NP dies (i.e. 'becomes not alive'). Thus (49a) implies (49b).

(49) (a) John killed Harry.
(b) Harry died.
(c) John didn't kill Harry.

A negative assertion, such as (49c), is non-committal in this respect. (49c) is compatible with the belief that Harry is still alive, or with the belief that Harry is dead but somebody else killed him. The causative analysis of kill, with no further assumptions, correctly explains the semantic relations between the three sentences in (49). Again, if it should become impossible to maintain the view that kill is introduced transformationally, there will have to be a corresponding meaning postulate, such as (48*).

(48*) kill(x, y) ⊃ cause(x, become (~alive (y)))

3.2. ONLY IF-VERBS. The second major group of one-way implicatives that deserves our attention are the only-if-verbs, of which a sample is given in (50).

(50) ONLY-IF-VERBS:

can able possible be in the position	have (the)	time opportunity patience courage

If one of these verbs appears as the main verb of a negative assertion, the complement is implied to be false, as shown by

the examples in (51).

(51) (a) Sebastian did not have an opportunity to leave the country.
(b) Sebastian was not able to leave the country.
(c) ...*but he left anyway.

In (51) and (51b), the speaker is committed to the view that Sebastian did not leave. It would be contradictory to continue either sentence with (51c). This fact indicates that the verbs in (50) express a necessary condition for the truth of the complement. That is, they are associated with the second meaning postulate in (24), namely

(24b) '~v(S) ⊃ ~S 'v(S) is a necessary condition for S'.

Given this meaning postulate, we can infer from a negative assertion like (51a) and (51b) that the complement is implied to be false.

In the corresponding affirmative assertions, however, there is no definite implication one way or the other. The two examples in (52) are both compatible with the continuation in (46c).

(52) (a) Sebastian had an opportunity to leave the country.
(b) Sebastian was able to leave the country.
(c) ... but he chose not to do so.

Therefore, the verbs in (50) are not two-way implicatives; they do not express a sufficient condition for the truth of the complement.

It is perhaps worth pointing out that there are at least three semantically different groups of predicates that all appear in the same surface construction, have the X (to). Some of them are full two-way implicatives like have the foresight and have the misfortune, which we encountered in (14); those in (50) are only one-way implicatives. The third class consists of predicates which do not carry along any implication at all with respect to the complement sentence. A sample of them is given in (53).

(53) have (the) { right / authority / permission / orders }

It is easy to see that a negative assertion with any of these verbs as predicate is non-committal. Unlike the similar examples in (51), (54) leaves open the possibility that Sebastian may have left anyway.

(54) Sebastian did not have a permission to leave the country.

3.21. NEGATIVE ONLY-IF-VERBS. Since there are both negative two-way implicatives and negative if-verbs , one expects to find some negative only-if-verbs as well. A verb of this sort would be like be able and other positive only-if-verbs in the respect that it would yield a definite implication only in negative assertions. However, the implication must be of the opposite kind, that is, a positive implication. These verbs would be associated with the second meaning postulate in (30), namely

(30b) $\sim v(S) \supset S$ 'v(S) is a necessary condition for ~S'.

On the other hand, affirmative assertions with such a verb as predicate should be non-committal.

The class of verbs which have the desired properties appears very small. The only verb I know of which certainly is a negative only-if-verb is the word hesitate.[12] Consider the following example.

(55) (a) Bill did no hesitate to call him a liar.
(b) Bill called him a liar.

Whoever asserts (55a) commits himself to (55b).However, the corresponding affirmative assertion, (56a),is non-committal. It is compatible with either one of the two continuations in (56b).

(56) (a) Bill hesitated to call him a liar.

(b) $\ldots \left\{ \begin{array}{l} \text{Therefore, he didn't say anything.} \\ \text{but his conscience forced him to do so.} \end{array} \right\}$

That is, hesitate is not a two-way implicative like avoid.

There is no obvious reason why hesitate should be the only verb of its kind, but thus far I have not found any other negative only-if-verbs.

Note that hesitate and prevent, which is a negative if-verb, both share one of the two meaning postulates in (30), which jointly account for the semantics of two-way implicatives such as avoid. These three verbs stand in the same relation to each other as their corresponding positive counterparts be able, cause, and manage, which share the meaning postulates in (24). As we mentioned above, it may be possible to eliminate the class of negative if-verbs, such as prevent, with the help of their positive classmates by regarding them as replacements for structures like cause not to be able. If this method were applicable to all negative implicatives, there would be no need for the second pair of meaning postulates in (30). However, it is doubtful whether verbs like avoid and hesitate can be lexically decomposed in a similar manner. Therefore, I will assume for the time being that the two sets of meaning postulates, (24) and (30), are both needed.

4. APPLICATIONS. I have now introduced six categories of implicative verbs: two types of two-way implicatives and four types of one-way implicatives. Most of the examples thus far have been very simple sentences with no more than one level of embedding. It is now time to look at some more complicated cases, in which verbs of different types alternate with negation in the same complex sentence. We should check that the semantic relations predicted by our analysis continue to agree with our intuitive judgements. Consider first the example in (57).

(57) (a) Bill saw to it that the dog did not have an opportunity to run away.
(b) The dog did not have an opportunity to run away.
(c) The dog did not run away.

Since (57a) is an affirmative assertion and has an if-verb as predicate, it implies (57b). This is a negative sentence with an only-if-predicate; therefore, it implies the negation of its own complement, which is (57c). Thus there is a chain of implications from (57a) to (57c). Since the notion 'implies' obviously is a transitive relation, (57a) should imply that the dog did not run away. Now, look at another configuration of the same verbs in (58).

(58) (a) Bill had an opportunity to see to it that the dog did not run away.
(b) Bill saw to it that the dog did not run away.
(c) The dog did not run away.

Since have an opportunity is an only-if-predicate, although (58a) is an affirmative assertion, it does not imply the truth of its complement sentence, which is (58b). If (58b) were itself implied to be true, it would in turn imply (58c). But since (58b) is not implied by (58a), there is no chain of implications that would link (58a) with its lowest embedded sentence. Therefore, (58a) should not commit the speaker to any view whatever about the dog. It seems clear that the predicted semantic relations in these and other similar cases turn out to match our intuitive judgements.

Incidentally, note that the example in (59) carries along the same implication as (57a).

(59) John prevented the dog from running away.

Note also that the negations of (57a) and (59) are equally non-committal with regard to the truth of the complement.

Negative if-verbs, such as prevent, are in this respect equivalent to the configuration: if-verb ... negation ... only-if-verb. It is this fact which makes it possible to propose that they be introduced by a transformation.

As a final example, consider the sentence in (60).

(60) Bill did not have the foresight not to force Mary to prevent Sheila from having an opportunity to try that new detergent.

The question is whether (60) is non-committal with respect to the truth of its lowest embedded clause or whether one is justified in inferring from it that Sheila either tried or did not try the new detergent. Although most people at first do not feel sure one way or the other, it does not take long to discover that (60) must mean that she did not try it. We can show this formally in the following way. Let us represent (60) schematically as (61).[13]

(61) $\sim V_1 (\sim V_2 (V_3 (V_4 (S))))$

Where V_1 = have the foresight [two-way implicative]

V_2 = force [if-verb]
V_3 = prevent [negative if-verb]
V_4 = have an opportunity [only-if-verb]
S = Sheila tried that new detergent.

Assuming that the verbs in question have the semantic properties that we have assigned to them, it can be shown that (61) yields the desired inference. In the following, the number on the right of each line refers to the meaning postulate that was used in deriving that line from the preceding one.

(62) (a) $\sim V_1 (\sim V_2 (V_3 (V_4 (S))))$ [= (61)]

(b) $\sim\sim V_2 (V_3 (V_4 (S)))$ - (24b)

(c) $V_2 (V3 (V_4 (S)))$ - Law of Double Negation

(d) $V_3 (V_4 (S))$ - (24a)

(e) $\sim V_4$ (S) - (30a)

(f) ~S - (24b)

The last line of (62) indicates that, according to the proposed analysis, (60) implies (63).

(63) Sheila did not try that new detergent.

The present example may well be too complicated for some speakers to understand. However, it seems that, as far as people have any intuitions at all about its meaning, their judgements support the proposed analysis.

5. INVITED INFERENCES. There are certain important facts that have not yet been accounted for. Consider the example in (64a).

(64) (a) John's wooden leg didn't keep him from dancing with Mary.

(b) John danced with Mary.

If one reads (64a) in isolation without thinking too much about it, one is very likely to get the impression that John danced with Mary, in spite of his wooden leg. However, a more careful analysis of (64a) shows immediately that this sentence does not imply (64b). As a negative if-verb, keep (from) should yield an inference only in affirmative assertions. Since (64a) is a negative assertion, it should be non-committal, as far as (64b) is concerned. This is certainly not a false prediction, as shown by the fact that (64a) can, without any contradiction, be embedded into a context where it is made clear that John did not dance with Mary. For example, (64a) can be expanded to (65).

(65) John's wooden leg didn't keep him from dancing with Mary, but her husband did.

Nevertheless, in the absence of any contrary evidence, (64a) seems to suggest that John danced with Mary.

The following example is similar. Since force is an if-verb and it occurs here in a negative assertion, (66a) should be non-committal with respect to (66b).

(66) (a) Bill did not force Mary to change her mind.
(b) Mary did not change her mind.

However, it seems that there is a temptation to conclude (66b) from (66a) if no further information is given.

The same phenomenon shows up with only-if-verbs. If there is no particular reason to believe otherwise, most people will take (67a) to mean that John in fact left early.

(67) (a) John was able to leave early.
(b) John left early.

Again, (67a) should be non-committal. Since be able is classified as an only-if-verb, it yields an implication only in a negative assertion. Why should it be that, although (67a) does not logically imply (67b), it nevertheless strongly suggests that (67b) is true? Here, as in the two preceding examples, a one-way implicative predicate invites one to draw a conclusion which would logically follow only from a two-way implicative verb. That is, in concluding (67b) from (67a) one interprets be able as if it were a verb like manage.

It is very likely that this problem is another manifestation of a principle which Michael Geis and Arnold Zwicky (1970) have discussed in connection with conditional sentences. As Geis and Zwicky point out, there is a natural tendency in the human mind to perfect conditionals to biconditionals. Students in an elementary logic course often propose that examples such as (68) are to be formalized as biconditionals rather than conditionals.

(68) If you mow the lawn, I'll give you five dollars.

Thus, most people feel that the appropriate logical form of statements like (68) is the conjunction of (69a) and (69b).

(69) (a) $S_1 \supset S_2$
(b) $\sim S_1 \supset \sim S_2$

This is not quite right since (69a) alone is enough. However,

it is clear that in a great majority of cases where a conditional like (68) is uttered, the corresponding statement of the form (69b) is also tacitly assumed. In natural language, (68) suggests rather strongly that, if you don't mow the lawn, I won't pay you five dollars. What would be the point in stating a condition which was not a necessary condition for the truth of the consequent? According to the principle proposed by Geis and Zwicky, any assertion of the form (69a) suggests, or "invites the inference", that the corresponding statement of the form (69b) is also true. However, this is only an "invited inference" and the speaker may indicate that it does not hold without thereby contradicting himself. This is the case in (70).

(70) If you mow my lawn, I'll give you five dollars, but I'll give you five dollars even if you don't.

The only thing that is odd about (70) is that it makes one wonder why anyone would bother to set a condition which is not a necessary one. (70) may be pointless but it is not contradictory.

Similarly, we can say that, although an if-verb, such as force in the example (66a), strictly speaking is associated only with the meaning postulate (24a) $v(S) \supset S$, it also "invites" the corresponding negative meaning postulate (24b) $\sim v(S) \supset \sim S$. This explains why (66a) suggests (66b), although it does not actually imply (66b). On the other hand, an only-if-verb like be able, which is associated with the meaning postulate (24b) $\sim v(S) \supset \sim S$, "invites" (24a) $v(S) \supset S$. This is the reason for the temptation to conclude (67b) from (67a). Something like the Geis-Zwicky principle is clearly involved in the general tendency to understand one-way implicatives as full two-way implicatives, unless the context makes it necessary to interpret them more strictly.[14]

6. SUMMARY. The following chart is a review of the semantic classes of verbs which have been discussed in this paper. The chart indicates under what circumstances a main sentence implies the complement or its negation in each of the seven categories. The '+' sign is used when a sentence is to be regarded as true; '-' is a symbol for a false sentence. The '+/-' sign means that a sentence may either be regarded as true or regarded as false. The variable 'α' may take either + or - as its value. It is used to indicate that the complement has the same truth value as the main sentence. A complement which has the opposite truth value with respect to the main sentence is marked with '-α'.

(72)

CLASS	MAIN SENTENCE	COMPLEMENT SENTENCE	EXAMPLE
Factive	+/-	+	regret
Implicative	α	α	manage
Negative Implicative	α	-α	avoid
If-Verb	+	+	cause
Negative If-Verb	+	-	prevent
Only-If-Verb	-	-	be able
Negative Only-If-Verb	-	+	hesitate

From the first column of features one can see under what conditions the main sentence carries along a commitment with respect to the truth of falsity of its complement. For example, it shows that a sentence with a negative if-verb as predicate just in case it is to be regarded as true. The second feature column indicates what is implied. In the case of negative if-verb the complement is implied to be false. On the other hand, sentences with an only-if-verb as predicate carry along an implication with respect to the complement only if they are to be regarded as false. Full two-way implicatives such as manage and avoid, yield an implication both in affirmative and negative assertions and the implication is affirm-

ative or negative depending on the main sentence and the type of the verb.

Finally, the next chart gives a sample verb from each category of implicative verbs and the meaning postulate(s) it is associated with.

(72)

(24)	(a)	v(S) ⊃ S	cause	manage
	(b)	~v(S) ⊃ ~S	be able	
(30)	(a)	v(S) ⊃ ~S	prevent	avoid
	(b)	~v(S) ⊃ S	hesitate	

It is evident that logical relations between main sentences and their complements are of great significance in any system of automatic data processing that depends on natural language. For this reason, the systematic study of such relations, of which this paper is an example, will certainly have a great practical value, in addition to what it may contribute to the theory of the semantics of natural languages. It also seems to be the case that logical relations are also involved in a number of problems that have sometimes been regarded as purely syntactic. Two well-known examples of such phenomena are the constraints on coreference (Karttunen 1969) and the problem of polarity-sensitive lexical items (Baker 1970).

FOOTNOTES

[1]This report is an extended version of a paper that was originally written under the auspices of the 1970 MSSB Advanced Research Seminar in Mathematical Linguistics and presented at the Annual Meeting of the Association for Computational Linguistics, July 23, 1970, in Columbus, Ohio.

[2] The following are some of the relevant papers: Karttunen 1970a and 1970b, Kiparsky 1968, Lakoff 1969 and 1970, Morgan 1969.

[3]A summary of various arguments against Rosenbaum is presented in the Final Report of the UCLA Syntax Project (UESP Vol. II).

[4] In their paper, the Kiparskys distinguished between 'semantically factive' and 'syntactically factive'. The reason for this distinction was that a few words, e.g. know and realize, which would otherwise qualify failed to meet some of the syntactic criteria the authors had established for factivity. I will use the term 'factive' as equivalent to their 'semantically factive'. Also, I do not see any reason to assume, as they did, that surface complements of factive verbs are commanded by the noun fact in the deep structure.

[5] This particular definition is due to Van Fraassen 1968.

[6] Currently, there are at least three different locutions in use; sometimes they can all be found in the same article:

(i) [in uttering the sentence X] 'the speaker presupposes that ...'

(ii) 'the verb X presupposes that ...'

(iii) 'the sentence X presupposes that ... '

Actually, (i) and (ii) seem to be some sort of shorthand formulas for longer expressions that involve (iii). For example, (ii) is generally intended to mean something like 'any sentence with the verb X as predicate presupposes that ...'. It need not be the case that there is really a genuine confusion in the mind of the users about whether 'presupposition' is an act by the speaker, a relation between a verb and its complement, or a relation between two propositions. However, the indiscriminate usage of (i-iii) is likely to breed such confusion in the minds of others.

The notion of 'possible world' is borrowed from modal logicians; e.g. see Hintikka 1967.

[8]Van Fraassen 1968 gives the following definition for 'necessitation':

P necessitates Q if and only if, whenever P is true, Q is also true.

This relation has also been called 'semantic entailment'.

[9] These are equivalent concepts for some writers. For example, Irene Bellert (1969) explicitly defines the semantic representation of an utterance as the set of consequences which can be derived from it.

The notion of 'meaning postulate' comes from Rudolf Carnap (1947). As he uses the term, a meaning postulate is a sentence of a formalized language which expresses a relation that holds between some primitive predicates of that language. For example, if the analyticity of the English sentence "If Sheila is a spinster, then she is not married" is to be preserved in translating it into a formal language, the language has to include the statement

$$(x)\ \text{spinster}(x) \supset \sim\text{married}(x)$$

as a meaning postulate.

In our case, we need meaning postulates to account for logical relations between main sentences and their complements.

Verbs of this kind were discussed by Charles Fillmore in his lectures at the 1970 Linguistic Institute. The 'Experiencer' case together with another new case, 'Goal', have replaced what Fillmore used to call the 'Dative' case in earlier presentations of his case theory.

[12] The verb be afraid comes close to being a negative only-<u>if</u>-verb. Although one can argue that

(i) The princess wasn't afraid to kiss the frog.

does not actually imply that she kissed him, the suggestion that she did is quite strong unless something is said to indicate otherwise.

Another possible candidate is help in the construction can't help ...ing. If help were a negative only-if-verb, (ii) should imply(iii) and (iv) ought to be non-committal.

(ii) The frog couldn't help feeling happy.
(iii) The frog felt happy.
(iv) *The frog helped feeling happy.

Indeed, (ii) implies (iii). But help could also be a two-way implicative like avoid, in which case (iv) ought to imply that the frog didn't feel happy. Since (iv) is ungrammatical, it is hard to decide one way or the other.

[13] For the sake of simplicity, I treat all the verbs in (60) as if they were one-place predicates. As throughout this paper, I

also ignore the problem how the correct tense is assigned to implied sentences.

[14] This observation may also explain the alternation between and and but, in certain cases. For example, consider the example (46a) with its two alternative continuations. Since prevent is a negative if-verb, (46a) suggests, but does not imply, that Mary left. We get but instead of and as the conjunctive particle if the conjoined sentence cancels the suggested inference.

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