

ADVERBS AND OPACITY: A Reply to Stalnaker*

George Lakoff, University of Michigan, November, 1970

In his "Notes on Adverbs in Response to Thomason and Lakoff", Robert Stalnaker proposes four criteria for distinguishing predicate modifiers from sentence modifiers.

- (1) Only if an adverb is a sentence modifier can it give rise to quantifier scope ambiguities in universal or existential sentences [in the subject position].

(In the text of the paper he limits this criterion to subject position.)

- (2) Only if an adverb is a sentence modifier can it give rise to opaque contexts in the subject position.

(1) and (2) are essentially the same criterion if one assumes (as do Thomason and Stalnaker in their "Modality and Reference") that opacity is to be accounted for in terms of the difference in the scope of an operator binding a variable.

- (3) Only adverbs which are sentence modifiers can occur at the beginning of a complex sentence whose constituent clauses have different subjects.

By "complex sentence" Stalnaker means conjunctions, disjunctions, and if-then constructions, but not relative clauses, complements, etc.

- (4) If Q-ly occurs as the modifier of a closed sentence, then one can paraphrase the sentence by deleting the adverb and prefacing the resulting sentence by "it is Q-ly true that" or "it is true Q-ly that".

Stalnaker claims that these tests yield the following results:

Sentence modifiers: frequently, in the morning, necessarily, possibly, ...

Predicate modifiers: Carefully, with a knife, slowly, reluctantly,

(1) and (2) are the most interesting of these claims. They are correct as far as they go, and can be illustrated by sentences like the following.

- (5) a. Oedipus carelessly married his mother.
b. Oedipus carelessly married Jocasta.

In (5), we see that the object of "marry" is opaque when modified by "carelessly".

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(5a) can be true and (5b), false, given that Jocasta is Oedipus' mother. However, the subject of "marry" is not opaque in such examples.

(6) a. Oedipus carelessly married Jocasta.

b. Jocasta's son carelessly married her.

Given that Oedipus is Jocasta's son, the truth conditions for (6a) and (6b) must be the same.

Similar examples can be given for scope of quantification cases.

(7) a. Sam carelessly sliced all the bagels.

b. Sam sliced all the bagels carelessly.

Here (a) and (b) differ in meaning depending on whether "all" or "carelessly" has higher scope. (7b) means that Sam sliced each of the bagels carelessly.

(7a) has the meaning that Sam was careless in slicing all of them, instead of leaving some unsliced. However, in subject position, there is no scope ambiguity.

(8) a. All the men carelessly spat on the bagel.

b. Carelessly all the men spat on the bagel.

(8a) and (8b) have identical truth conditions. Thus, (5)-(8) are in accord with Stalnaker's claims (1) and (2). However, (1) and (2) are vague in that they mention the notion "subject" as though that were a single grammatical concept. There is, however, a distinction in grammar between an underlying subject and a derived subject. In (5)-(8) these distinct concepts happen to correspond. But in sentences containing a passive, for example, the underlying object becomes the derived subject and the underlying subject becomes the object of the by-phrase.

(9) The bagel was sliced by Sam.

In (9), "Sam" is the underlying subject, but "bagel" is the derived subject.

Now consider sentences with both "carelessly" and a passive.

(10) The bagel was carelessly sliced by Harry.

In (10), it is "Harry", the underlying subject, but not the derived subject, that is understood as being careless. Now the question arises as to whether we get a lack of opacity and scope ambiguities in the position of the underlying subject ("Harry" in (10)) or the derived subject ("the bagel" in (10)). Let us first try quantifier scope ambiguities in derived subject position.

(11) a. All the bagels were carelessly sliced by Harry.

b. Carelessly all the bagels were sliced by Harry.

(11a) and (11b) differ in meaning in the same way that (7b) and (7a) did. That is, quantifier scope ambiguities appear in derived subject position. Now let us try underlying subject position.

(12) a. The bagel was carelessly spat on by all the men.
 b. The bagel was spat on by all the men carelessly.

(12a) and (12b) have identical truth conditions. Thus, we do not find quantifier scope ambiguities in underlying subject position.

Let us now test for opacity. We would expect from the above result that the appropriate notion of "subject" in (1) and (2) should be revised to underlying subject. We would expect opacity to be lacking in the position of the underlying subject, but to appear in the position of the underlying object, even if it is a derived subject. Let us look at the latter case first.

(13) a. Jocasta was carelessly married by Oedipus.
 b. Oedipus' mother was carelessly married by him.

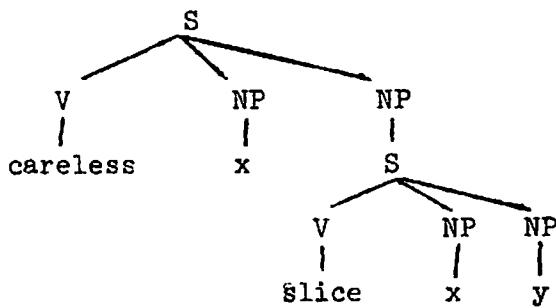
(13a) differs from (13b) in the same way as (5a) differs from (5b). (13a) can be false, while (13b) can be true. Thus we find opacity in a derived subject which is not an underlying subject. Correspondingly, we find no opacity in underlying subjects which are not derived subjects.

(14) a. Jocasta was carelessly married by her son.
 b. Jocasta was carelessly married by Oedipus.

Given that Oedipus is Jocasta's son, the truth conditions for (14a) and (14b) are the same.

Examples such as the above could be handled simply by changing "subject" in (1) and (2) to "underlying subject". But the question now arises as to why such conditions as our revised (1) and (2) should hold. Do such conditions follow naturally from independently motivated facts? I think that they do. Suppose we take as the logical form of sentences with "carelessly", "carefully", etc. the proposal made in [Lakoff, 1965, 1970] for the reasons given there. The proposal is that the logical form of a sentence like "Sam sliced the bagel carelessly" should be the same as the logical form of "Sam was careless in slicing the bagel". That is, "careless" is a two-place predicate relating an individual and an act performed by that individual. Schematically, this might be represented as:

(15)

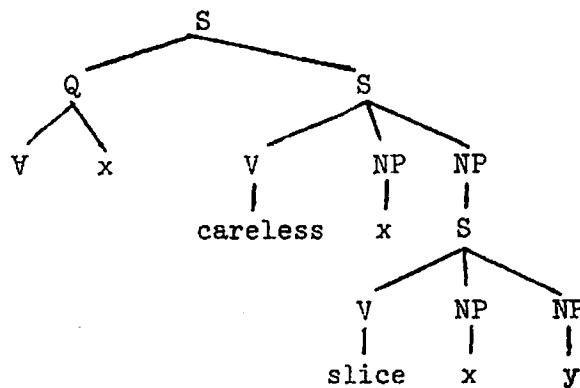


Assuming that the notion "underlying grammatical subject of an atomic predicate" is to be defined as "the first argument of that atomic predicate", we find that "careless" is constrained in the following way:

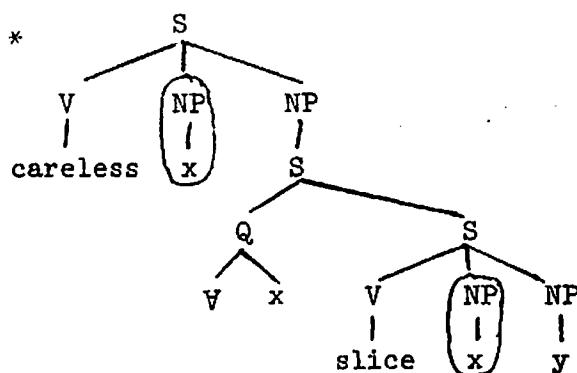
(16) The underlying subject of "careless" must be an occurrence of the same variable as the underlying subject of the activity predicate in the embedded sentence.

Constraints such as (16) are extremely common in grammar. (For a discussion, see [Perlmutter, 1969].) In the transformational derivation of the sentences with the adverb "carelessly", the upper occurrence of the variable is deleted, and "careless" is lowered into the lower clause, with "-ly" added on. We will call this process "adverb-lowering" and assume that it takes place in the transformational cycle. [Given that EQUI is cyclical (cf. Postal [1970]), sentences like "John wants to slice the salami carelessly" show that adverb-lowering cannot be post-cyclical. As we shall see below, the general rule cannot be precyclical either.] If (15) is to be the logical form of sentences of the form "x sliced y carelessly", then the facts mentioned above follow automatically, at least if one accepts the Thomason-Stalnaker account of opacity, or some account of the same sort. The reason is this: If the subject of "careless" and the subject of "slice" must be instances of the same variable, as stated in (16) and shown in (15), then any quantifier or other operator binding that variable must be outside the clause containing "careless". That is, (17) is possible, but (18) is not.

(17)

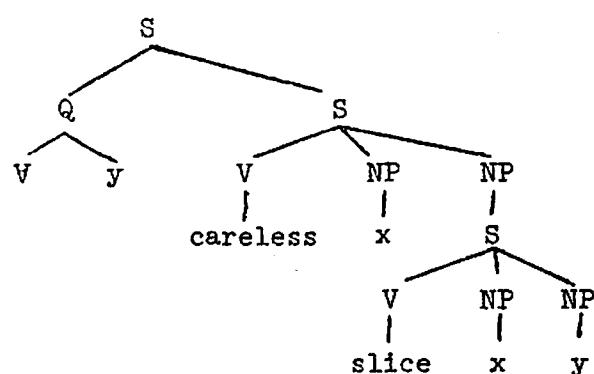


(18)

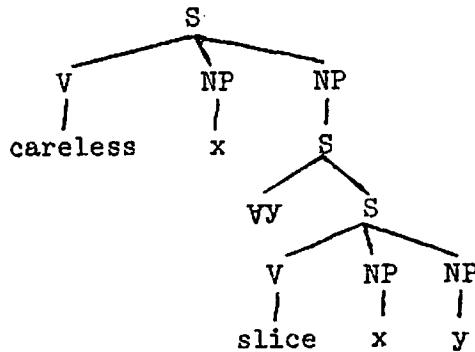


Since the topmost "x" in (18) is not bound by " $\forall x$ ", while the lower "x" is, they cannot be instances of the same variable, as (16) requires. For this reason, (18) is ill-formed. Thus, it follows that there can be no quantifier-scope ambiguities in the position of the underlying subject of "slice". Of course, there can be quantifier-scope ambiguities in other positions, like the object of "slice", since there is nothing forbidding a quantifier over the variable "y" in (15) from being either inside or outside "careless":

(19)

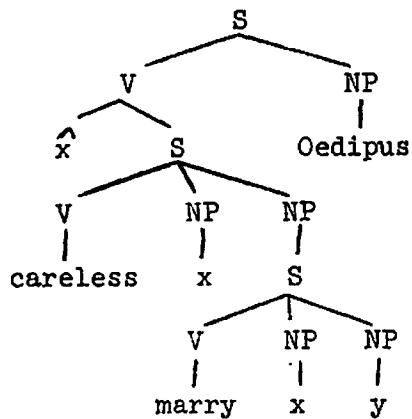


(20)

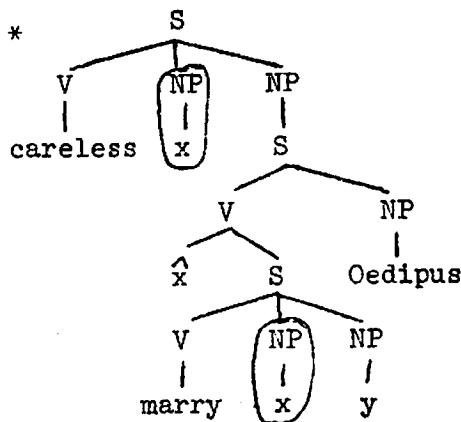


Given the analysis of adverbs like "carelessly" in (15) and given the constraint of (16), the facts of (5)-(14) follow automatically. No special principle like our revised version of (1) would be needed. (1) would simply be a consequence of (15) and (16). The same is true of (2), if we assume that opacity due to scope difference, as in the case of the Thomason-Stalnaker proposal using predicate abstraction. Under that proposal, the "x" position in "x carelessly married y" would not be opaque, since a predicate abstraction operator binding "x" in (15) could only be outside of "careless" as in (21), not inside as in (22).

(21)



(22)



As in (18), the two encircled occurrences of "x" cannot be instances of the same variable (which (16) requires) if the lower one is bound by " \hat{x} " while the upper one is not. As in the case of quantifiers, there is nothing to keep a predicate abstraction operator " \hat{y} " from being either inside or outside of "careless", hence the possibility of opacity in the place of "y".

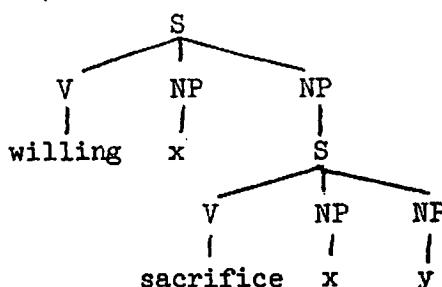
Let us now turn to an adverb that is not a sentence modifier in Stalnaker's terms, but which works somewhat differently than 'predicate modifiers' like "carelessly" with respect to opacity and quantifier-scope ambiguities. The adverb is "willingly". (Other examples are "reluctantly", "unwittingly", and "eagerly".) It is a classic case of an adverb that is ambiguous in passive sentences. (See the Appendix for a discussion of some further constraints on "willingly".) Compare the following:

(23) a. Harry was carefully sacrificed by the tribe.

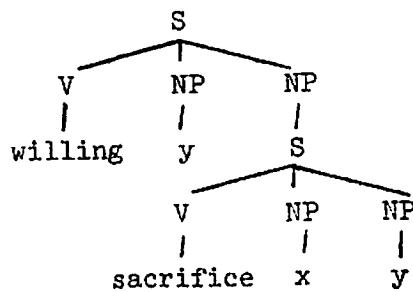
b. Harry was willingly sacrificed by the tribe.

(23a) is unambiguous. It means only that the tribe was careful, not Harry. But (23b) is ambiguous. It can be understood either as meaning that Harry was willing, or that the tribe was. We can represent ambiguous sentences of the form "y was willingly sacrificed by x" as follows:

(24)



(25)



(24) and (25) differ in their specification of the subject of "willing". Letting $x = \text{the tribe}$ and $y = \text{Harry}$, (24) give the reading of (23b) in which the tribe is willing and (25) represents the reading in which Harry is willing.

"Willing" and "careless" both require that their subjects be variables identical to a variable in the embedded sentence. "Careless" and other words like it also require condition (16), that its subject be identical to the underlying subject of the embedded sentence. "Willing", on the other hand, does not require condition (16). It is for this reason that we get the ambiguity in (23b). Note, however, that "willingly" (as well as similar adverbs like "reluctantly", "unwittingly", etc.) is ambiguous only in the passive. Compare:

(26) a. Harry was willingly sacrificed by the tribe.

b. The tribe willingly sacrificed Harry.

(26b) is unambiguous, having only the reading of (24). This can be accounted for by adding the following global condition on the process of adverb lowering:

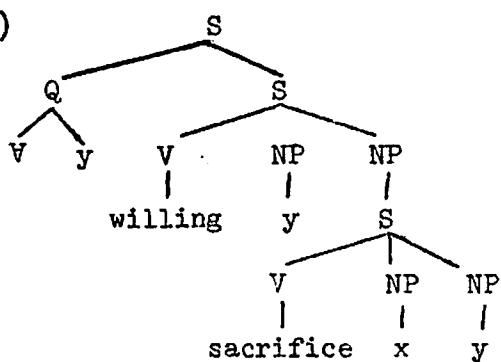
(27) The subject of the predicate which is to be lowered into surface adverb position must be an instance of the same variable as the subject of the embedded predicate at some point in the derivation. (See Appendix for further discussion.)

In the case of "willingly" (27) will permit lowering in either (24) or (25) if passive applies to "sacrifice". In (24), "y", the subject of "willing", is an instance of the same variable as the underlying subject of "sacrifice". In the case of (25), passive will turn "y", the object of "sacrifice" into a derived subject, and (27) will be met in this way. This will account for the ambiguity of (26a). The lack of ambiguity in (26b) is accounted for by the fact that the

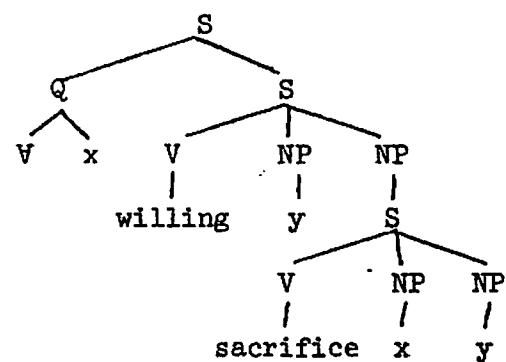
underlying subject of sacrifice is the same as its derived subject. Hence, by (27), only the reading of (24) and not that (25) will be allowed.

Let us now consider the ambiguous passive cases in detail, that is, sentences of the form "y was willingly sacrificed by x". Given the two logical forms that we have proposed in (24) and (25), what would be expected in the way of quantifier-scope ambiguities and opacity? Consider the trees in (28), on the next page. In (28a), "Vy" is outside of "willing" and binds both occurrences of "y". But in (28c), "Vy" is inside of "willing" and so can only bind the lower occurrence of "y", not the higher one. But since on this reading (the reading shown in (25)) both occurrences of "y" must be instances of the same variable, (28c) is not well-formed. Thus, on the reading of (25), the "y was willing" reading of "y was willingly sacrificed by x", we would predict no quantifier-scope ambiguity in the position of "y". However, we would predict a quantifier-scope ambiguity in the position of "x" on the "y is willing" reading, as (28b and d) show.

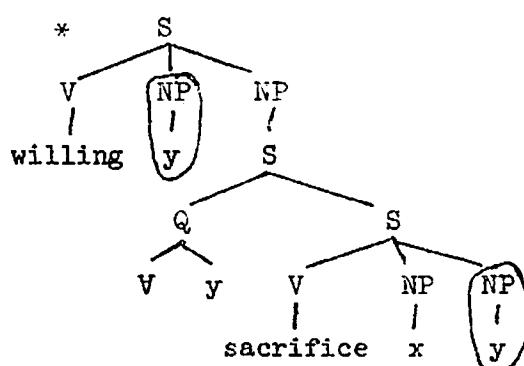
(28) (a)



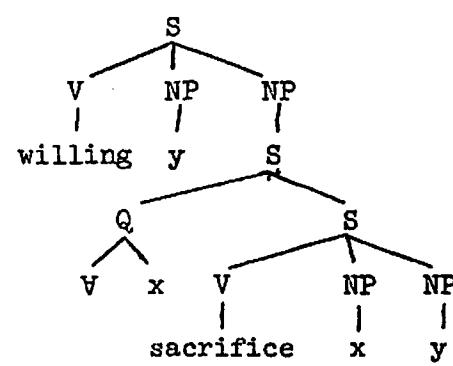
(b)



(c)

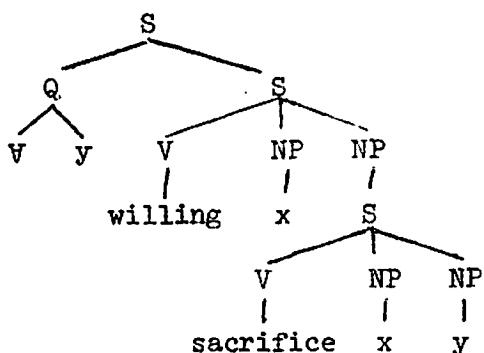


(d)

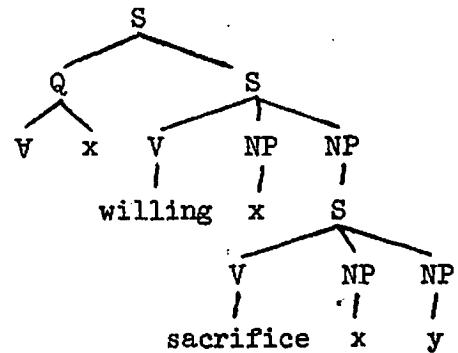


We would predict exactly the opposite on the "x is willing" reading of (24), the possibilities for which are given in (29), below. As (29a) and (29c) show, we would expect sentences of the form "y was willingly sacrificed by x" on the "x is willing" reading to permit quantifier-scope ambiguities in the "y" position. However, on this reading, we would expect a lack of quantifier-scope ambiguities in the "x" position, and the impossibility of (29d) shows. By the same kind of argument, it follows that on the "y is willing" reading we would expect a lack of opacity in the "y" position of "y was willingly sacrificed by x". And correspondingly, we would expect a lack of opacity in the "x" position on the "x is willing" reading. This is indicated in (30) and (31), where the usual abbreviated notation is used.

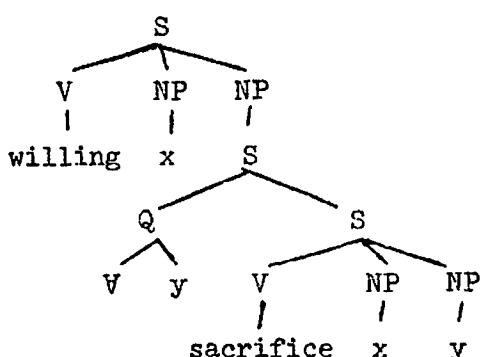
(29) (a)



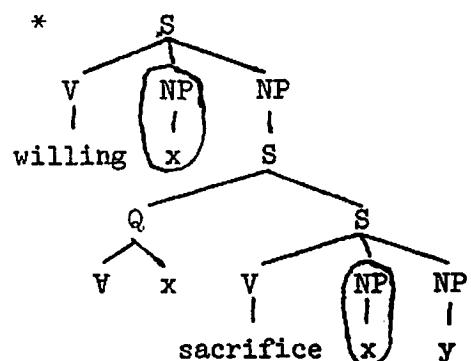
(b)



(c)



(d)



(30) a. $[(\hat{x})(\text{willing}(y, \text{sacrifice}(x, y)))]$ (a)

b. $[(\hat{y})(\text{willing}(y, \text{sacrifice}(x, y)))]$ (a)

c. $\text{willing}(y, [(\hat{x})(\text{sacrifice}(x, y))]$ (a))

d. $*\text{willing}(y, [(\hat{y})(\text{sacrifice}(x, y))]$ (a))

(31) a. $[(\hat{x})(\text{willing}(x, \text{sacrifice}(x, y)))] (a)$
 b. $[(\hat{y})(\text{willing}(x, \text{sacrifice}(x, y)))] (a)$
 c. $*\text{willing}(x, [(\hat{x})(\text{sacrifice}(x, y))]) (a)$
 d. $\text{willing}(x, [(\hat{y})(\text{sacrifice}(x, y))]) (a)$

Let us review our predictions.

(31) SENTENCE FORM: y was willingly VERBed by x

I. On the "x is willing" reading,

- there are quantifier scope ambiguities in the position of y, but not in the position of x; and
- there is opacity in the position of y, but not in the position of x.

II. On the "y is willing" reading,

- there are quantifier scope ambiguities in the position of x, but not in the position of y; and
- there is opacity in the position of x, but not in the position of y.

These predictions turn out to be true. Let us look first at the opacity cases.

(32) a. Harry was willingly sacrificed by the Fugawi tribe.
 b. Harry was willingly sacrificed by the tribe with the purple ears.
 c. The long lost son of the Fugawi chieftain was willingly sacrificed by the Fugawi tribe.
 d. The long lost son of the Fugawi chieftain was willingly sacrificed by the tribe with the purple ears.

Letting " $p \models q$ " stand for "if p is true, then q must be", and " $p \not\models q$ " stand for "if p is true, then it doesn't necessarily follow that q is true", we have the following results for the examples of (32).

(33) Assume that Harry = the long lost son of the Fugawi chieftain and that the Fugawi tribe = the tribe with the purple ears.

<u>"y is willing" reading</u>	<u>"x is willing" reading</u>
a \models c	a \models b
b \models d	c \models d
a $\not\models$ b	a $\not\models$ c
c $\not\models$ d	b $\not\models$ d

Suppose that Harry is the long lost son of the Fugawi chieftain. Then, on the "y is willing" reading, if Harry was willing to be sacrificed by the Fugawi tribe, then so was the long lost son of the Fugawi chieftain. If a is true on this reading then c is also true on this reading. Similarly, if b is true on this reading, then d is. However, supposing that the Fugawi tribe happens to be the notorious tribe with the purple ears (who paint their ears purple while sacrificing their captives in a most hideous way). Harry might be willing to be sacrificed by the Fugawi tribe (who have the false reputation of engaging in humane sacrifice), but might not be willing to be sacrificed by the tribe with the purple ears. Thus, if a is true on the "y is willing" reading, then it does not necessarily follow that b is true on that reading. Similarly, c does not necessarily entail d on the "y is willing" reading.

Let us now suppose that the Fugawi tribe does not know that their captive, Harry, is really the long lost son of their chieftain. Consider the "x is willing" reading. The Fugawi tribe might be willing to sacrifice Harry, but not the long lost son of their chieftain. So if a is true on this reading, it does not necessarily follow that c is. Similarly, if b is true on this reading, it does not necessarily follow that d is. However, if the Fugawi tribe is willing to sacrifice Harry, then it follows that the tribe with the purple ears is willing to sacrifice Harry. Thus, if a is true on this reading, then b must be. Similarly, if c is true on this reading, then d must be true on this reading.

So far we have seen that all our predictions are borne out in the opacity cases. Let us now turn to the quantification cases.

(34) I. All the y's were willingly examined by x.

- a. "y is willing" reading
 - (i) $(\forall y) (W(x, E(x, y)))$
 - (ii) $\% W(x, (\forall y)(E(x, y)))$
- b. "y is willing" reading
 - (i) $(\forall y) (W(y, E(x, y)))$
 - (ii) $* W(y, (\forall y)(E(x, y)))$

III. y was willingly examined by all the x 's.

- a. "x is willing" reading
 - (i) $(\forall x) (W(x, E(x, y)))$
 - (ii) * $W(x, (\forall x)(E(x, y)))$
- b. "y is willing" reading
 - (i) % $(\forall x) (W(y, E(x, y)))$
 - (ii) $W(y, (\forall x)(E(x, y)))$

(35) I. All the girls were willingly examined by Dr. Reuben.

II. Sue was willingly examined by all the doctors.

(35 I and II) are examples of the sentence forms of (34 I and II). Under I and II in (34) are listed the readings which always are possible for the given sentence form, those which are never possible because they are ill-formed (these are marked with a "*"), and those which are possible in some dialects but not others (these are marked with "%"). (I,a,ii) and (II,b,i) are dialect variation cases. Some speakers find these readings acceptable for the sentence forms given and other speakers do not. So far as I have been able to tell, this variation correlates with another dialect variation. Take the sentence "Everyone was seen by someone yesterday". For some speakers, this sentence can only have reading (A), while for others it can have reading (B) as well.

- (A) $(\forall y)(\exists x)(\text{SEE}(x, y))$
- (B) $(\exists x)(\forall y)(\text{SEE}(x, y))$

Those speakers who only get (A) as a possible reading have a rule in their speech which says roughly that in simple sentences with two quantifiers the leftmost quantifier ("every" in the above sentence) must be outermost in the logical form of the sentence. We will call this Dialect A. Other speakers do not have this rule in their speech and find both (A) and (B) permissible as readings for the above sentence. Call this Dialect AB. So far as I have been able to determine, "willingly" functions just like a quantifier with respect to the above dialect variation. Speakers of dialect A are those who cannot get the readings marked with "%" in (34) for the sentences given. Speakers of Dialect AB do get those readings. For a discussion of such rules, see [Lakoff, in press]. Taking this dialect difference as an independent phenomenon, we see that all the cases listed in (34) follow exactly the predictions made in (31).

Let us review what all this means. We have shown that Stalnaker's (1) and (2) are special cases in which the underlying and derived subjects are the same. In general, when one takes into account passives and their interaction with adverbs like "willingly" as well as "carefully" and "carelessly", the situation is more complex. However, all of the facts concerning opacity and quantifier-scope ambiguities in such cases can be predicted if one assumes that "carefully", "carelessly", "willingly", etc. are all two-place relations between an individual and an act or situation involving that individual, and certain additional rules of grammar. In other words, such adverbs take as their arguments in logical structure an individual variable and a propositional function containing that individual variable. So far as I can see, no analysis of such adverbs as one-place operators mapping propositional functions into propositional functions could conceivably handle all the facts cited above. Thus, adverbs like "carefully", "willingly", "reluctantly", etc. involve two arguments, and are very different from adverbs like "with a knife" on the one hand (Stalnaker's predicate modifiers) and adverbs like "necessarily", "possibly", and "frequently", on the other hand (Stalnaker's sentence modifiers). Adverbs like "slowly" and "with a knife" never show opacity or quantifier-scope ambiguities in any of the places of the sentences they are in.

- (36) a. Oedipus killed Laius with a knife.
- b. Oedipus killed his father with a knife.
- (37) a. Oedipus killed Laius with a knife.
- b. Jocasta's son killed Laius with a knife.

The cases in (36) and (37) show no opacity. Similarly, there are no quantifier-scope ambiguities.

- (38) a. With this knife, Sam sliced all the bagels.
- b. Sam sliced all the bagels with this knife.

However, with adverbs like "necessarily", "possibly", and "frequently" there is opacity and quantifier-scope ambiguity in every place in the sentence. (The reader can easily verify this.)

I conclude then that Stalnaker's criteria (1) and (2) characterize only special cases of adverbs that are two-place relations of the sort discussed above. They have nothing to do with the more general characterization of what he calls predicate modifiers and sentence modifiers.

Stalnaker's criterion (3) seems to work reasonably well for if-then constructions, but not for disjunctions and conjunctions. He would want to group "slowly" and "with this knife" together as predicate modifiers. As he points out, "slowly" obeys his disjunction test.

(39) *Slowly, John walked or Mary ran.

However, "with this knife" can occur in such constructions.

(40) With this knife, Sam will carve the turkey or Max will slice the bagels. The same results obtain with conjunctions. I doubt that such a test proves anything one way or the other. Clearly, conjunction reduction is applying in (40) and is somehow blocked in (39). This is an interesting fact, but there is no reason to believe that the vagaries of conjunction reduction distinguish between sentence modifiers and predicate modifiers in Stalnaker's sense. However, since conjunction reduction does not apply in if-then constructions, there is some reason to believe that adverbs that modify if-then constructions really are sentence modifiers in some significant sense of the term. As it happens all of Stalnaker's sentence modifiers work in this case.

- (41) a. In the morning, if John walks, Mary drives.
- b. Frequently, if John walks, Mary runs.
- c. Necessarily, if John leaves, Mary follows.
- d. In Columbus, if a hippie walks outside, a cop shoots at him.

Unfortunately, this test breaks down in part when extended to other cases.

- (41) e. *Seldom, if John walks, Mary runs.

If "frequently" is a sentence modifier, then one would certainly expect "seldom" to be one too. (For example, "seldom" works like "frequently" with respect to opacity phenomena, which will be discussed shortly). Presumably, the non-occurrence of (41e) is to be accounted for by some restriction on the occurrence of "seldom" in surface structure, rather than by the claim that it is not a sentence modifier like "frequently". If so, then the if-then part of Stalnaker's criterion (3) becomes a one-way test. If adverbs can occur as in (41 a-d), then they are sentence modifiers. If they cannot, nothing follows.

Incidentally, this test groups time adverbs like "at 10 o'clock" and "in the morning" together with frequency adverbs like "frequently" and "often". It should be noted, however, that these two groups differ with respect to opacity and quantifier-scope ambiguities. As Stalnaker points out, "frequently" and "often" create opaque contexts.

- (42) a. Frequently the President of the U. S. dies in office.
- b. Frequently Richard Nixon dies in office.

Given that Richard Nixon is the President of the U. S., the truth of (42a) does not entail the truth of (42b). Compare (42) and (43).

(43) a. At 10 o'clock, the President of the U. S. died in office.
 b. At 10 o'clock, Richard Nixon died in office.

Time adverbs like "at 10 o'clock" and "in the morning" do not create opaque contexts.

The same is true for quantifier-scope ambiguities.

(44) a. Frequently all the men went into the tavern.
 b. All the men went into the tavern frequently.

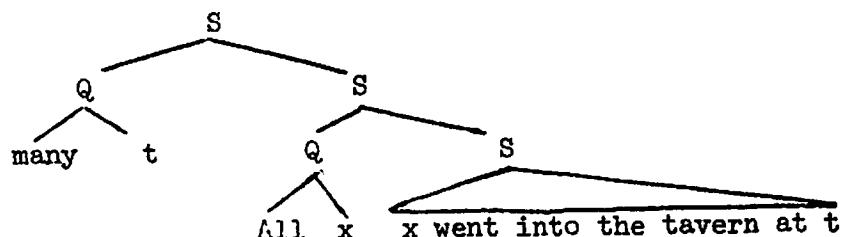
(45) a. At 10 o'clock all the men went into the tavern.
 b. All the men went into the tavern at 10 o'clock.

(44a) differs from (44b), but there is no corresponding difference in (45).

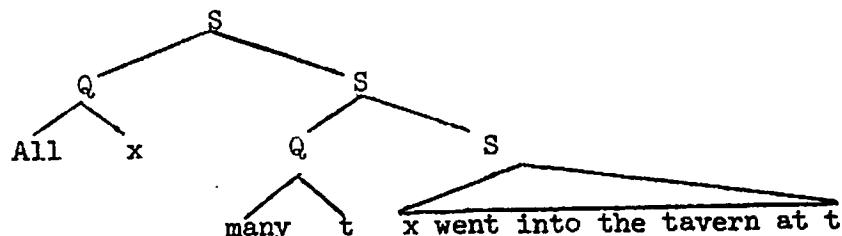
I believe that the difference between adverbs like "at 10 o'clock" and "frequently" can be accounted for in a relatively straightforward way.

Adverbs like "frequently" and "often" involve quantification over time variables. They can be paraphrased by such expressions as "many times" and "many were the times that". On the other hand, "at 10 o'clock" does not involve any quantification over a time variable. Thus, the difference between (44a) and (44b) can be represented as in (46).

(46) a.



b.



If (46) is approximately correct, "frequently" is a surface reflection of a logical structure that contains both a quantifier over times, "MANY t", and a time adverb containing a time variable, "at t". "At 10 o'clock" is simply a time adverb containing a constant, "10 o'clock", and neither a variable over times nor a quantifier over times. Thus, no scope difference parallel to (46) would be possible for "at 10 o'clock".

The fact that "frequently" creates contexts in which substitutivity of identicals appears not to be permitted is also a consequence of the fact that it contains within it a quantifier over time. This is due to the fact that many descriptions contain a bound time variable that does not show up in surface structure. For example, take sentences that contain descriptions like "Tommy Manville's wife".

(47) Frequently, Tommy Manville's wife was a chorus girl.

(47) is understood essentially as (48).

(48) At many times t, the person Tommy Manville was married to at t was a chorus girl.

In (48), we see that the surface description "Tommy Manville's wife" contains a time variable in its logical structure. Other descriptions containing time variables in logical form are "the President of the U. S." and "The Commander-in-chief of the U. S. Armed Forces". On the other hand, descriptions like "the father of Tricia Nixon" and proper names like "Richard Nixon" do not contain time variables. Given this, we would predict that a description not containing a time variable may not substitute for a description containing a bound time variable. Thus, if (42a) has a logical form essentially like (49), it is clear why substitutivity fails in going from (42a) to (42b).

(49) At many times t, the person who was President of the U. S. at t died in office.

Clearly we cannot substitute the proper name "Richard Nixon" for "the person who was President of the U. S. at t", since the identity does not hold for all times in the domain of the time variable, t. It is for this reason that substitutivity fails. It should be noted that substitutivity of identicals with "frequently" is permitted if (i) neither of the two descriptions involved contains a time variable or if (ii) identity holds between the two descriptions

for all times in the domain of the time variable. An example of (i) is:

(50) a. Frequently, the father of Tricia Nixon wears pancake makeup.
 b. Frequently, Richard Nixon wears pancake makeup.

In (50), substitution of "Richard Nixon" for "the father of Tricia Nixon" is permitted since neither description contains a time variable. Similarly, let us assume the equivalence of (51).

(51) $(\forall x)(\forall t) [x \text{ is President of the U. S. at } t \equiv x \text{ is Commander-in-chief of the U. S. Armed Forces at } t]$

Then, we would predict that substitutivity would be permitted in (52), which it is.

(52) a. Frequently, the President of the U. S. has died in office.
 b. Frequently, the Commander-in-chief of the U. S. Armed Forces has died in office.

If we adopt the approach to a semantics for tense logic taken by Prior, Montague, Cochiarella, Kamp, and Scott, namely, considering the state of the world at a given time as a possible world (or a "world-slice", as it is sometimes called), then the above approach to failure of substitutivity in the case of "frequently" might be extended to "necessarily" and "possibly" as follows. We might consider "necessarily" (in the logician's sense of the word) as containing a universal quantifier over situations (or possible worlds), and "possibly" as containing an existential quantifier. (David Lewis in his "Counterpart Theory and Quantified Modal Logic" has something of this sort.) I have not thought through the consequences, either for logic or for linguistics, of such a proposal, but it seems to me to be one worth at least thinking about, if only to force oneself to find reasons for rejecting it.

It should be pointed out incidentally that the sort of problem that arises with time variables and adverbs like "frequently" also arises with place variables and corresponding place adverbs.

(53) a. In many of the provinces of China, the local duck dish is served with hoisin sauce.
 b. In many of the provinces of China, Peking Duck is served with hoisin sauce.

Suppose (53a) is spoken in Peking, where the local duck dish is Peking Duck. (53a) may be false, while (53b) is true. The reason of course is that the word

"local" is understood in logical form as containing a bound variable over places. For a similar case, assume that Sergei speaks only Russian. In this country, Russian is a foreign language, but not in Russia.

(54) a. In all countries, Sergei speaks a foreign language.
b. In all countries, Sergei speaks Russian.

(54b) can be true, while (54a) would be false, for obvious reasons.

Let us now turn to Stalnaker's criterion (4). It seems to hold up pretty well for the cases Stalnaker considers, if one puts aside minor quibbles. For instance, "bewilderingly" and "strangely" would seem to be sentence modifiers, though one does not get (55).

(55) a. *It is bewilderingly true that Spiro is a Soviet agent.
b. *It is strangely true that Nixon looks like a fish.

However, these seem to be surface facts, since, for some inexplicable reason, these adverbs can occur in the appropriate position when followed by "enough".

(56) a. It is bewilderingly enough true that Spiro is a Soviet agent.
b. It is strangely enough true that Nixon looks like a fish.

If one ignores such surface fluctuations, (4) seems to work. Paul Neubauer has observed that such surface fluctuations do not show up if one puts the adverb outside of "it is true that" and make that the test environment instead.

(56) a. Bewilderingly, it is true that Spiro is a Soviet agent.
b. Strangely, it is true that Nixon looks like a fish.

Appendix: Notes on "willingly"

Consider the following sentences.

(57) a. Willingly, Sue was examined by Dr. Caligari.
 b. Sue willingly was examined by Dr. Caligari.
 c. Sue was willingly examined by Dr. Caligari.
 d. Sue was examined willingly by Dr. Caligari.
 e. Sue was examined by Dr. Caligari willingly.

In my speech, a, b, and e have only the "Sue is willing" reading, while c and d are ambiguous, having the "Dr. Caligari is willing" reading in addition. (I have also found speakers for whom e is ambiguous.) These facts indicate that the possible pairings of surface structures containing "willingly" and the corresponding logical structures is limited in part by the surface position of "willingly". In other words, the global constraint of (27) is further limited by surface position of "willingly". As a tentative refinement of (27), I would suggest the following (for the facts of my speech).

(58) The subject of the predicate to be lowered into surface adverb position must be an instance of the same variable as the subject of the embedded predicate at the end of the first cycle applying to the embedded predicate or to the underlying subject of the embedded predicate if the predicate to be lowered is adjacent to the embedded predicate in surface structure.

(58) is somewhat complex when stated in English, but is considerably neater when stated formally as a derivational constraint.

In (58) it is stated that the relevant level of derived structure is the end of the first cycle on the embedded predicate. This is a considerably more restrictive condition than just permitting a subject anywhere to do, and so far as I can see, it works. It should be noted that the notion of subject is crucial in the stating of (58). For the purposes of logical structure, the only constraint we can place on the occurrence of the variable in the embedded sentence which is identical to the subject of "willing" is simply that it be somewhere or other in the embedded sentence. However, there are grammatical restrictions involving the notion "subject". Consider the following cases.

(59) a. Max willingly gave a slave girl to Harry.
b. A slave girl was willingly given to Harry by Max.
c. Harry was willingly given a slave girl by Max.

In (59a), Max is both underlying and derived subject, and the sentence has only a "Max was willing" reading. In (59b), "a slave girl" is derived subject and "Max" is underlying subject, and the sentence has both the "Max was willing" and "the slave girl was willing" reading. It cannot have a "Harry was willing" reading since "Harry" is not a subject at any point in the derivation. That reading shows up, however, in (59c), where "Harry" is derived subject. However, in (59c) we do not get the "the slave girl was willing" reading, since "the slave girl" is not a subject at any point in the derivation of (59c).

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