Title
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THE ROLE OF DEDUCTION IN GRAMMAR*

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In G. Lakoff (1970d) I showed that for many sentences it makes no sense to ask whether or not they are grammatical in any absolute sense, but only to ask whether they are grammatical relative to certain presuppositions. For example, in reciprocal contrastive stress constructions:

(1) Jóhn insulted Máry and then shé insulted hím.

(2) *Jóhn praised Máry and then shé insulted hím.

(3) Jóhn called Máry a virgin and then shé insulted hím.

The pronouns on the right can be stressed in (3) only if it is presupposed that to call someone a virgin is to insult that person. (2) is judged ungrammatical since by the definition of *praise*, praising someone cannot be an insult, at least not in our culture.

Let us now ask what are the regular conditions under which reciprocal contrastive stress occurs. The simplest case occurs in (1), where no special presupposition is required. If one has two conjoined sentences of the form:

(4) $[_{S_1} \ldots [_{NP}a] \ldots [_{NP}b] \ldots _{S_1}]$ and $[_{S_2} \ldots [_{NP}b] \ldots [_{NP}a] \ldots _{S_2}]$

where S_1 is identical to S_2 in meaning, except that wherever S_1 mentions a, S_2 mentions b, and vice versa, then a and b get stressed. For convenience we will refer to S_1 and S_2 as f(a,b) and f(b,a) respectively, where f stands for a phrase-marker minus the elements a and b. Thus the simple rule is that in sentences of the form:

(5) f(a,b) and f(b,a)

stress a and b.[1]

Now consider the more complicated cases like (3) where a sentence with reciprocal contrastive stress can only be grammatical relative to a certain presupposition. Take (3). Let 'x called y a virgin' be g(x,y) and 'x insulted y' be f(x,y). (3) is of the form:

(6) g(a,b) and f(b,a)
     where: $a = John$
            $b = Mary$

[1] Actually, the condition is more general than this. The rule applies not only in conjunctions, but whenever disjoint clauses of this form occur in a sentence. For example:

The fact that John insulted Mary indicated that shé would soon insult him.

Note that the time adverb *soon* must be considered semantically external to its clause if one is to state the identity condition uniformly.

As we noted, (3) is grammatical only relative to the presupposition that calling someone a virgin is an insult. That is,

(7) $(x)(y) (g(x,y) \supset f(x,y))$

Thus (6) can receive reciprocal contrastive stress on a and b only if (7) is presupposed. But this is no accident or idiosyncratic peculiarity of this example. As we have seen, the general rule applies to structures of the form (5), and we would like to reduce all cases to cases of this form. It just so happens that given (7) as a presupposition, we can *deduce* from (6) a structure of the form (5).

(8) a. g(a,b) and f(b,a)   (the sentence of (6))
     b. g(a,b)   (by simplification of a)
     c. $(x)(y) (g(x,y) \supset f(x,y))$ (presupposed as in (7))
     d. g(a,b) $\supset$ f(a,b)   (instantiation)
     e. f(a,b)   (modus ponens, from steps b and d)
     f. f(b,a)   (by simplification of a)
     g. f(a,b) and f(b,a)   (conjunction)

The general principle here seems to be that a structure of the form (6) may receive reciprocal contrastive stress only if the sentence makes one or more presuppositions such that from (6) and those presuppositions, a structure of the form (5) can be deduced.

Let us now consider another example. Georgia Green (1968, 1969) has discussed with great insight the occurrence of *too* and *either*, and the basic facts discussed below are due to her observations. There are two basic cases where *too* occurs.

(9) a. John is honest and Bill is honest too.
     b. John is a Republican and John is honest too.
(10) a. f(a) and f(b)
         where: $a = John$
                $b = Bill$
     b. g(a) and f(a)
         where: $g = is\ a\ Republican$
                $f = is\ honest$

In (10)a the f's are the same; in (10)b the a's are the same. Thus, given a sentence of either the form (9)a or (9)b with no special presuppositions, we can get a *too* inserted. These are the simple cases.

Now consider a complex case.

(11) The mayor is a Republican and the used-car dealer is honest too.

(11) has two readings which can be differentiated by stress as in (11)a and (11)b.

(11) a. The mãyor is a Repŭblican and the used-cãr dealer is hŏnest tóo.

      b. The mãyor is a Repŭblican and the used-cãr dealer is hónest tóo.

In (11)a *honest* is unstressed and refers anaphorically back to *is a Republican. The mayor* and *the used-car dealer* are both stressed and so the latter cannot have anaphoric reference to the former; thus, they are not presupposed to be the same individual. In (11)b, however, *the mayor* and *the used-car dealer* are unstressed and so the latter does have anaphoric reference to the former; thus, they are presupposed to be coreferential.

(11)a and (11)b both require presuppositions to be considered grammatical—and they are different presuppositions. (11)a requires the presupposition that Republicans are honest. (11)b requires the presupposition that *the mayor* and *the used-car dealer* are the same person. These are given in (12)a and (12)b respectively.

(12) a. $(x) (g(x) \supset f(x))$ (all Republicans are honest)
      b. a = b   (the mayor is the used-car dealer)

(11) has the form of (13):

(13) g(a) and f(b) *too.*
      where: $g = is\ a\ Republican$
             $f = is\ honest$

Again, it is no accident that a sentence of the form (13) happens to be grammatical only given presuppositions of the form (12)a and (12)b. The reason is that from just these presuppositions we can deduce structures of the form of (10)a and (10)b—the simple cases where *too* can be inserted.

(14) a. g(a) and f(b)   (sentence as in (13))
      b. $(x) (g(x) \supset f(x))$ (presupposition of (12)a)
      c. g(a) $\supset$ f(a)   (instantiation)
      d. g(a)   (simplification of a)
      e. f(a)   (modus ponens from d and c)
      f. f(b)   (simplification of a)
      g. f(a) and f(b)   (conjunction)

(14)g is of the form of (10)a and corresponds to the reading of (11)a, where *honest* is unstressed and is understood as being anaphoric. What *honest* is

anaphoric to turns out not to be in the first half of the sentence of (11)a, but rather in what can be *deduced* from that first half given the presupposition of (12)a. Thus anaphora seems to depend on deductions.

Let us now consider the reading of (13) where (12)b is presupposed.

(15) a. g(a) and f(b)   (sentence as in (13))
     b. a = b   (presupposition of (12)b)
     c. g(a)   (simplification of a)
     d. g(b)   (substitute identicals for identicals)
     e. f(b)   (simplification of a)
     f. g(b) and f(b)   (conjunction)

(15)f is of the form of (10)b. Thus, with *too*, the generalization seems to be that a sentence can take *too* if one of the forms (10)a or (10)b can be deduced from the sentence and from the presupposition relative to which it is grammatical. The simplest case is where the presuppositions are null as in (9)a and (9)b.

Let us now consider the even more complicated use of *but*. What follows is based on the insightful observations of Robin Lakoff (1971), who has begun to make sense of the regularities involved in the use of *but*. I will consider only one of the senses of *but*, that which involves a statement contrary to one's expectations. Consider, for example,

(16) It is June, but it is snowing.

(16) asserts that it is June and it is snowing, and it presupposes that one would not expect it to be snowing in June. That is, (16) has the form:

(17) Assertion: S_1 and S_2
     Presupposition: $Exp(S_1 \supset \sim S_2)^2$
     where: $S_1 = it is June$
            $S_2 = it is snowing$

This, I think, is the basic form of this sense of *but*; it differs from *too* and reciprocal contrastive stress in that even in its most basic form, it requires

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[2] Richard Thomason has pointed out to me that 'expectation' isn't exactly the right concept for expressing the meaning of *but*, although it is close in most cases. He suggests instead that the appropriate concept would be something closer to 'a belief on the part of the speaker that, according to some general rule, S_1 should entail $\sim S_2$'. In those cases where the speaker has no special information which would lead him to believe that the rule should not hold, it would be rational for him to expect S_1 to entail $\sim S_2$. I accept Thomason's observation, and I would not be surprised if the appropriate concept were to be even more complex. In the absence of a more thorough understanding of these matters, I will use the notation "Exp" to stand for whatever the appropriate concept should be, whether expectation, belief as to general rules, differential probabilities, and so forth. Since the differences among these alternatives is not relevant to the main issue under consideration, I will continue to speak in terms of expectations, for the sake of simplicity of exposition.

a presupposition. Thus, the basic rule is that *but* replaces *and* in an assertion like that of (17) when the corresponding presupposition is as given there.

There are, however, more complicated examples of *but* in this sense. Consider (18).

(18) John is a Republican, but he is honest (too).

(18) is grammatical relative to the general presupposition that one would expect Republicans not to be honest. Thus, (18) has the form:

(18) Assertion: f(a) and g(a)
     Presupposition: $(x) Exp(f(x) \supset \sim g(x))$
     where: $f = is a Republican$
            $g = is honest$
            $a = John$
            $f(a) = S_1$
            $g(a) = S_2$

(18) does not have the form of (17); however, there is a trivial deduction from the presupposition of (18) to a structure that will correspond to (17).

(19) a. $(x) Exp(f(x) \supset \sim g(x))$ (presupposition of (18))
     b. $Exp(f(a) \supset \sim g(a))$ (instantiation)

Recalling that $f(a) = S_1$ and $g(a) = S_2$, we see that (19)b has the form $Exp(S_1 \supset \sim S_2)$. Thus, the general principle for the occurrence of *but* is that when S_1 *and* S_2 is asserted and there are one or more presuppositions from which $Exp(S_1 \supset \sim S_2)$ can be deduced, then *but* can replace *and* and the sentence will be grammatical only relative to those presuppositions.

Now consider a slightly more complex example.

(20) John's father belongs to the Republican party, but John belongs to the Republican party too.

(20) is grammatical relative to a number of presuppositions; one of the most interesting for our discussion is 'one would expect a son not to belong to the same party has his father'. We can represent (20) with this presupposition as (21).

(21) Assertion: B(F(a),r) and B(a,r)
     Presupposition: $(x)(y) Exp(B(F(x),y) \supset \sim (B(x,y)))$
     where: $B(x,y) = x belongs to the y party$
            $F(x) = x's father$
            $r = Republican$
            $a = John$

(21) also does not have the form of (17), but again there is a simple deduction that will yield the appropriate form.

(22)   a. $(x)(y) \, Exp(B(F(x),y) \supset \sim (B(x,y)))$ (presupposition of (21))

      b. $(x) \, Exp(B(F(x),r) \supset \sim (B(x,r)))$ (by instantiation of r for y)

      c. $Exp(B(F(a),r) \supset \sim (B(a,r)))$ (by instantiation of a for x)

Letting $B(F(a),r) = S_1$ and $(B(a,r) = S_2$, we see that (22)c reads $Exp(S_1 \supset \sim S_2)$. Thus, (20) is grammatical relative to the presupposition of (21), since $Exp(S_1 \supset \sim S_2)$ can be deduced from that presupposition. Much more complicated examples than these occur in normal discourse, and they often involve many presuppositions and a long chain of deduction. Take a typical example.

(23)   Nixon was elected, but the blacks won't revolt.

(23) involves the assertion of (24), and is grammatical relative to a set of presuppositions like that given in (24).

(24)   Assertion: Nixon was elected, and the blacks won't revolt.

                         S_1 and S_2

   Presuppositions:
1. Nixon is a Republican.
2. If a Republican is elected, then social welfare programs will be cut.
3. If social welfare programs are cut, the poor will suffer.
4. Blacks are poor.
5. Blacks are discriminated against.
6. Blacks form a substantial part of the population.
7. One would expect that poor, suffering people who are discriminated against and who form a substantial proportion of the population would revolt.

I will not go through the deduction here, but it should be obvious that $Exp(S_1 \supset \sim S_2)$ can be deduced from these presuppositions. Thus, (23) will be grammatical relative to these presuppositions. Since these presuppositions do not conflict with our knowledge of the world, (23) is a perfectly normal sentence. Of course, there are innumerable other sets of presuppositions relative to which (23) would be grammatical—all of those from which $Exp(S_1 \supset \sim S_2)$ can be deduced.

It should be clear that the general principles governing the occurrence of *too*, *but*, and reciprocal contrastive stress can be stated only in terms of

presuppositions and deductions based on those presuppositions. This means that certain sentences will be grammatical only relative to certain presuppositions and deductions, that is, to certain thoughts and thought processes and the situations to which they correspond. This seems to me wholly natural.

The consequences of these observations are important for both linguistics and natural logic. Logic, as it is normally studied, involves a formal system containing axioms and rules of inference which are not constrained with respect to either form or content by empirical linguistic considerations. But these observations show that natural logic must be so constrained, at least with respect to the form of expressions. Recall that we have been using the notation f(a,b) to stand for an S containing noun phrases a and b. That is, we have been describing semantic representations of sentences and lines of deductions in the same notations, and for a good reason—the general principles determining the distribution of *but*, *too*, and reciprocal contrastive stress require that *identity* relations hold between syntactic structures and lines of deductions in natural logic. The sorts of representations needed for natural logic must be of the same form as those needed for linguistics. This should hardly be surprising, but it's nice to have a demonstration of it.

The consequences for linguistics are not too surprising either, namely, that gramaticality must be defined relative to assumptions about situational contexts and to thought processes, assuming that natural logic deductions are a first approximation to a formal representation of thought processes. In formal terms this means that a syntactic derivation must not only include a sequence of phrase-markers $P_1, \ldots, P_n$ and a semantic representation, $SR = (P_1,$ presuppositions, topic, focus, . . .), but it must also include a member of the class of deductions from those presuppositions. In this sense, the study of linguistics and the study of natural logic are inextricably bound up together.

One more point: The general question of whether a given expression in a system with the expressive power of first-order logic with identity can be deduced from some arbitrarily given set of axioms is known to be undecidable, and it is generally believed that the same is true of all logics incorporating at least this much expressive power. Though an adequate natural logic is nowhere near completion, it does seem clear that any adequate natural logic will have to have at least the expressive power of first-order predicate calculus. As we saw, the question of whether a sentence with *but* is grammatical relative to a given set of presuppositions depends on the question of whether $Exp(S_1 \supset \sim S_2)$ can be deduced from these presuppositions. If this is undecidable in natural logic, as would be a good bet, the question of whether a given sentence containing *but* is grammatical relative to a given set of presuppositions would be undecidable in natural logic. In general, the notion of grammaticality relative to some set of presuppositions would then be an undecidable property of sentences. This

should give some second thoughts to investigators working in the field of discourse analysis, since it means that given a sentence and given some formal description of a context and given a completely adequate grammar of the language in question, there would still be no general solution to the question of whether that sentence was appropriate to that context. But this should not be surprising.

If the arguments in this paper are correct, we can conclude the following:

1. The general principles governing when certain sentences are grammatical relative to certain presuppositions can only be stated in terms of deductions from those presuppositions.

2. An anaphoric expression may have as its antecedent an expression which is not in the sentence itself, nor in the presuppositions of the sentence, but in some line of a deduction based on those of presuppositions. (See the discussion of (11)a.)

3. In order to determine whether a sentence containing the contrary-to-expectations sense of *but* will be grammatical relative to a set of presuppositions, it is necessary that a line of deduction be *identical* to some S in a linguistic representation of the sentence. Consequently, logical form must match up with linguistic form, at least for natural logic.

4. The question as to whether an arbitrary sentence is well formed relative to an arbitrary set of presuppositions seems to be in general undecidable.

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