8 Syntactic and Semantic Constraints on Quantifier Movement

That quantifying DPs are (sometimes or always) interpreted in positions that are different from their argument positions and related to them by movement is an idea that has a long tradition in generative syntax. Carden[1] (working in a framework where surface structure was transformationally derived *from* the input to semantic interpretation) proposed a rule of Quantifier Lowering, and an analogous raising rule was assumed by Chomsky[2] to affect quantifiers in the derivation from Surface Structure to Logical Form. At each step in the evolution of syntactic theory, syntacticians have sought to describe quantifier movement within a general theory of movement and to deduce as many of its properties as possible from basic principles of syntax. An up-to-date overview and assessment of this enterprise would be way beyond the scope of this book. Our purpose here is merely to clarify some of the respects in which certain questions that have been asked about the syntax of quantifiers depend on assumptions about their semantics.

From the perspective which we are taking in this book, we expect quantifier movement to be constrained from two independent directions: by interpretability and by the laws of syntax. Ideally, we expect to find that every observation about where quantifiers move can be fully explained by the assumptions that (i) every derivation must terminate in an interpretable structure and (ii) quantifier movement is subject to exactly the same syntactic laws as every other kind of movement. Which structures are interpretable depends, of course, on our semantic analysis. Specifically, it depends on our inventory of composition rules and lexical type-shifting rules. We will adopt as a working hypothesis the most restrictive theory in this regard. Our composition rules are only Functional Application, Predicate Modification, and Predicate Abstraction, and there are no type-shifting rules at all. This means that fewer potential structures will be interpretable than on alternative assumptions.

Let us consider in this light some of the questions that appear in the syntactic literature on quantifier movement. Many of these were discussed by May,[3] in the first extensive study of quantifiers within a framework similar to contemporary transformational syntax. While May's particular answers in that work have mostly been revised or replaced by now, the questions themselves are still pertinent.

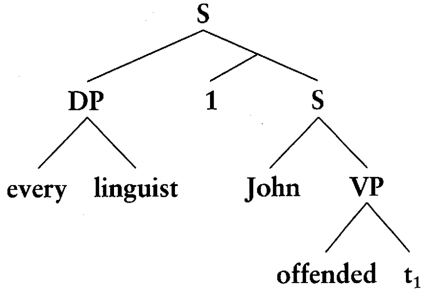
8.1 Which DPs may move, and which ones must?

May posited a special rule of Quantifier Raising (QR), formulated as follows:[4]

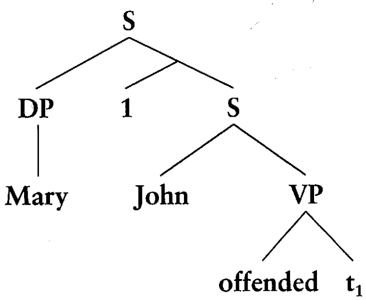
(1) Adjoin Q (to S).

"Q" stands for "quantifier", so this rule explicitly targeted quantificational DPs, and the question of it applying to, say, a proper name or a pronoun did not even arise. Soon after May's writing, however, syntacticians questioned the existence of specific rules like (1) and began to explore a theory of grammar in which there is only a completely general rule "Move α". From this perspective, all DPs should be equally movable, and if adjunction to S is an option for any of them, it should in principle be as available for those which do not contain a quantificational determiner as for those that do. So if the syntax generates a structure like (2), why wouldn't it also generate (3)?

(2)



(3)



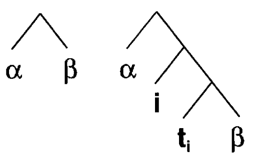
There is no problem with interpretability. As you can easily verify, (3) has well-defined truth-conditions, equivalent to those of "John offended Mary" with "Mary" left *in situ*. Given this equivalence, it is difficult to see how we could have direct empirical evidence for or against the hypothesis that DPs of type e can undergo all the same movements as those of type $<<e,t>,t>$. The simplest assumption, then, is that they *can*, and this is what we will assume henceforth.[5]

As regards quantificational DPs, May assumed that his rule (1) was, like all transformational rules, in principle optional, but that constraints on the output of LF derivations made its application effectively obligatory. One of the constraints he posited was essentially the version of the Θ-Criterion that we discussed in section 3.4.[6] As we noted there, this Θ-Criterion requires every function-denoting node to be sister to something that can be interpreted as its argument. Specifically, it requires every phrase of a type <e,t> to have a sister of type e. In this regard, it is stronger than our Interpretability Principle, which allows phrases of type <e,t> to take sisters of type e, type <e,t>,[7] or type <et,t>. In cases like (2), the Θ-Criterion and Interpretability both force movement, because two nodes with types <e,et> and <et,t> respectively cannot be sisters under either constraint. But the same does not hold for all quantifiers in argument positions. We have seen that quantifying DPs in subject position are interpretable *in situ*, and this holds more generally for whatever position realizes the highest (outermost) argument of a predicate. For instance, if unaccusative verbs like "arrive" take their only argument as an object, then there are structures in which quantifying DPs are straightforwardly interpretable *in situ* in object position. The stronger Θ-Criterion adopted by May, by contrast, forces *all* quantifiers to vacate their base positions by LF, even those that are sisters to nodes of type <e,t> to begin with.

It would be interesting to obtain some empirical evidence that distinguishes between these two predictions, but this may be difficult, perhaps even impossible. Leaving a quantifier *in situ* never gives rise to truth-conditions which could not also be obtained by subjecting it to (short) movement. So the two theories are indistinguishable in their immediate semantic predictions. If they can be teased apart at all, it will require some imaginative use of indirect evidence. We are not aware that any arguments have been presented one way or the other, and we will leave the matter open.[8]

Exercise

Let α and β be constituents with denotations of type <et,t> and type <e,t> respectively, and let $i \in \mathbb{N}$ be such that β contains no free occurrences of variables indexed i. Then the following two trees have the same denotation under every assignment.

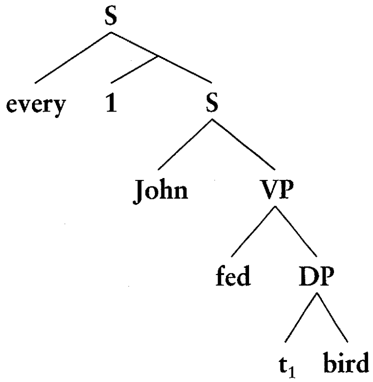


Prove this.

8.2 How much moves along? And how far can you move?

The "Q" in May's QR rule was meant to stand for a feature that characterizes lexical items like "every", "some", "no", etcetera. As formulated in (1), this rule therefore could in principle apply by moving just a quantificational determiner by itself, leaving the rest of the DP stranded, as in the derivation below:

(1) John fed every bird.
⇒ LF:



May offered a syntactic explanation for the unavailability of this LF.[9] But from our point of view, such an explanation is redundant, because we are not dealing with an interpretable structure here in the first place. The trace's type e meaning combines with the noun's type <e,t> meaning to yield a truth-value (!) as the meaning of the DP "t_1 bird". This cannot be composed with the type <e,et> meaning of the verb, and thus the VP and all higher nodes are uninterpretable.

Exercise

The argument we just gave took for granted that traces are always interpreted as variables of type e. This is the only interpretation for traces that our semantics so far has made available, and thus we have indeed shown that structure (1) is not interpretable under our current theory. But our current theory, of course, is quite preliminary, and it might well turn out that we must eventually revise it in some way that has the side effect of making structures like (1) interpretable after all. Indeed, it has been proposed that traces can in principle receive interpretations of any semantic type, not just e. Motivation for this assumption comes from the analysis of structures in which, for example, APs, predicative PPs, VPs, or Vs have been moved.[10] Consider the following topicalization structures:

(i) $[_{DP}$ Brahms$]_1$, I adore $[_{DP}$ $t_1]$.

(ii) $[_{PP}$ on the porch$]_1$, she isn't $[_{PP}$ $t_1]$.

(iii) $[_{AP}$ hard-working$]_1$, he is $[_{AP}$ $t_1]$.

(iv) . . . and $[_{VP}$ buy the couch$]_1$ I did $[_{VP}$ $t_1]$.

How can we interpret these structures? One answer might be: not at all – they are uninterpretable, and therefore the moved phrases must be lowered back into their base positions before the semantic component applies. But another response would be to generalize our rules for traces and abstraction so that they can handle these structures as they stand. Here is how we might go about this. Let's assume that an index is not just a number, but a pair of a number and a semantic type. We correspondingly need a revised definition of "assignment".

(v) A *variable assignment* is a partial function a from the set of indices to the set of all denotations, such that, for every $<i,\tau> \in$ dom(a), $a(i,\tau) \in D_\tau$.

The semantic rules stay essentially the same, except that the formulations of Pronouns and Traces and of Predicate Abstraction need trivial adjustments to fit the more complicated notion of an index:

(vi) If α is a trace or pronoun, and i and τ are a number and a type respectively, then, for any assignment a, $[\![\alpha_{<i,\tau>}]\!]^a = a(i,\tau)$.

(vii) If α is a branching node with daughters β and γ, where β (apart from vacuous material) dominates only an index $<i,\tau>$, then, for any assignment a: $[\![\alpha]\!]^a = \lambda x \in D_\tau \,.\, [\![\gamma]\!]^{a^{x/<i,\tau>}}$.

(a) Show how this proposal applies to examples (i)–(iv). (Choose one of (ii)–(iv) to illustrate.) Also show briefly that it subsumes our previous treatment of relative clauses and quantifier movement structures.

(b) What does this proposal predict regarding the potential structure (1) that we considered above?

If there is a movement operation like QR, we expect it to be subject to the very same locality constraints that are obeyed by other, better-known movement operations. Many authors have noted a close parallel between constraints on *wh*-movement and constraints on quantifier scope, for example.[11] The constraints needed are unlikely to be derivable from Interpretability. Structures with quantifiers that have been moved too far are perfectly interpretable. An unconstrained rule of QR would allow us to derive two distinct *interpretable* LFs for sentence (2), for example, as you will find out when you do the exercise below.

(2) Most accidents that nobody reported were minor.

Exercise

(a) Display both LFs for (2). Give informal, but unambiguous paraphrases of the readings represented by each, and describe a situation in which their truth-values differ.

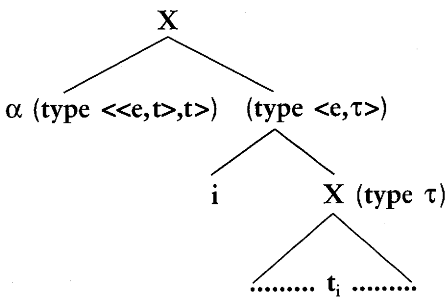
(b) Do the readings predicted coincide with those that are actually available for (2)? If not, what sort of remedy is appropriate to improve the empirical adequacy of our theory? Think of suitable syntactic constraints you may be familiar with.

8.3 What are potential landing sites for moving quantifiers?

Built into May's formulation of QR was a stipulation that quantifiers always adjoin to nodes of the category S. Again, we consider the question whether the effects of this stipulation can be reduced (in part or in whole) to the requirement of Interpretability.

Look at the following schematic representation of a structure that is derived by adjoining a quantifying DP α to a node of some category X:

(1)



"τ" stands for the type of X here, whatever it may be. The node dominating X and the adjoined index is subject to the Predicate Abstraction Rule, which assigns it a meaning of type $<e,\tau>$.[12] Up to this point, the structure is interpretable regardless of what type τ is. (Notice that our formulation of PA places no condition on the type of γ.) However, at the next node up (the higher X-node), we obtain a value *only if* $\tau = t$. Any other choice for τ would make it impossible to apply α (type $<<e,t>,t>$) to its sister (type $<e,\tau>$) (and any other ways to compose these two nodes by our rules are unavailable to begin with). It follows thus that quantifier movement can only target adjunction sites whose semantic type is t.[13]

How does this prediction relate to May's assumption that QR can only adjoin to the category S? The two are clearly not equivalent. They might coincide in practice, however, if independent factors conspire to make S (= IP) the only syntactic category with denotations of type t. In the majority of examples we have analyzed so far, this happened to be the case.[14] But we have no good reason to be sure it will hold up when we consider more refined syntactic analyses and/or a wider range of constructions. There may well be non-S categories with meanings of type t (for instance, small clauses, or VPs with internal subjects), and if there are, we expect quantifier movement to be able to adjoin to them.

The assumption that QR always adjoins to S was never uncontroversial. Montague had already proposed (the equivalent of) quantifier adjunction to VP and NP,[15] and the syntactic literature soon converged on a consensus that at least these two additional options were indeed needed, and probably adjunction to DP as well.[16] Let us review some of the evidence that was presented in this literature and assess it from our current perspective.

8.4 Quantifying into VP[17]

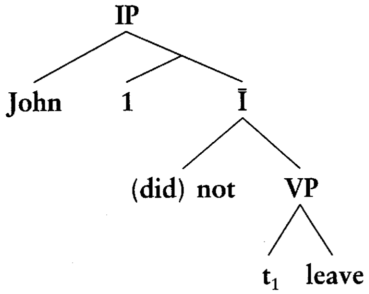
8.4.1 Quantifiers taking narrow scope with respect to auxiliary negation

One fairly straightforward argument for quantifier adjunction to VP can be constructed if we combine our current general assumptions with certain particular ones about the syntax and semantics of negation. Concretely, let's assume that auxiliary negation in English occupies an I(nflectional)-node, at LF as well as on the surface. And let's furthermore assume that it has the familiar denotation of type $<t,t>$:

(1) $[\![\textbf{not}]\!] = \begin{bmatrix} 1 \rightarrow 0 \\ 0 \rightarrow 1 \end{bmatrix}$

Such a syntax and semantics of negation imply that the VP in the LF of a sentence like "John didn't leave" must have a denotation of type t. A natural way to ensure this is to generate the subject "John" inside the VP and let it leave a trace there when it moves to its surface subject position:

(2)



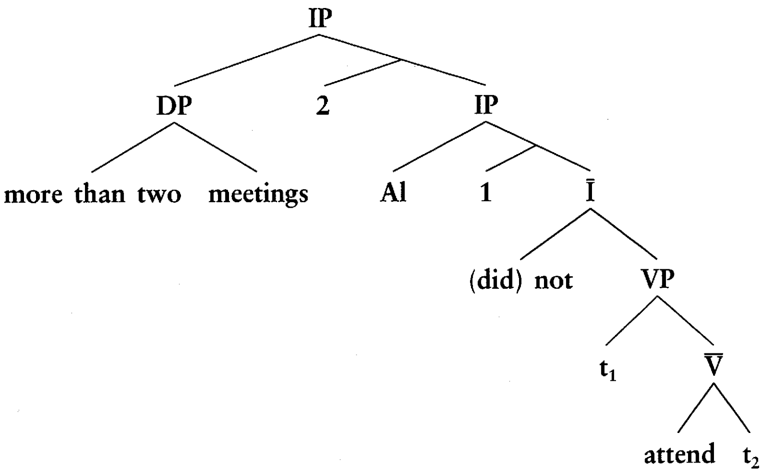
The interpretation of (2) is straightforward ("do", we take it, is vacuous). Consider now (3) and (4).

(3) Joe didn't invite a professor.

(4) Al didn't attend more than two meetings.

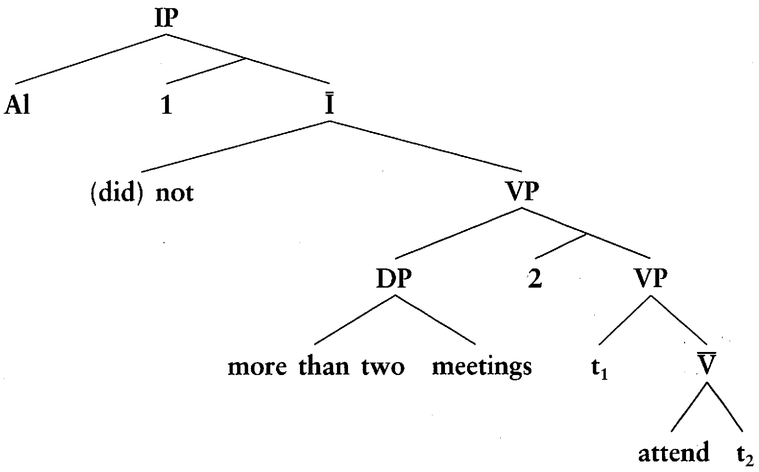
These examples are judged to be ambiguous. (3) can either mean that Joe didn't invite any professor. Or else it can mean that there was some professor that he failed to invite. Similarly, (4) can mean that Al attended no more than two meetings; or else that there were more than two meetings from which he was absent. The second reading in each case is the one that we generate if we adjoin the object DP to IP:

(4a)



To obtain the first-mentioned reading, we must adjoin instead to VP:

(4b)



The LF in (4b) could not have been generated with a QR rule that allows only adjunction to IP (= S). But the reading it represents is available (in fact, even preferred) in sentence (4). If our background assumptions are correct, we therefore have a straightforward empirical argument for quantifier adjunction to VP. The most reasonable general hypothesis at this point is that quantifiers can adjoin freely to any syntactic category, as long as the output of the derivation is interpretable.

8.4.2 Quantifying into VP, VP-internal subjects, and flexible types

In our effort to show that quantifiers do sometimes adjoin to VP, we have so far been presupposing our working hypothesis that there are no flexible types (or other devices for *in situ* interpretation). We have also taken for granted that VPs (at least in the cases we have been looking at) contain a subject position, and therefore are semantically of type t. Neither of these two assumptions is taken for granted, however, in most of the literature that deals with the issue of possible adjunction sites for QR. This must be borne in mind when one reads that literature and tries to assess the internal logic and the current relevance of its arguments. There is actually a rather intricate relation among one's answers on these three questions: (i) whether quantifiers can adjoin to VP, (ii) whether VPs are of type t or of type <e,t>, and (iii) whether flexible types are available. The three questions are logically independent of each other, but not all possible sets of answers to them are equally defensible.

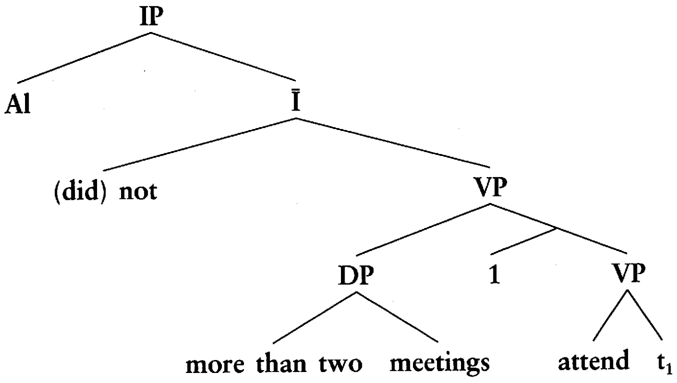
In much of the early 1980s literature on the syntax of quantifier movement, the idea of VP-internal subjects was not even entertained, and it was implicitly taken for granted that VP meanings were of type <e,t>. On that assumption, how compelling is the putative evidence for VP adjunction that we have reviewed in this section? Let's look again at the case of quantifier scope below auxiliary negation, as in (4).

(4) Al didn't attend more than two meetings.

Assuming (as before) that the scope of negation is fixed in some I(nflectional) position, what does the ambiguity of (4) tell us about possible adjunction sites for QR?

To get any interpretable LF out of (4) at all, we must now assume that "not" has a type-shifted meaning of type <et,et>. Then, if "more than two meetings" adjoins to IP, we derive the reading on which there are more than two meetings from which Al was absent. How about the other reading? Can we still argue that we need adjunction to VP to generate that reading? Let us see what adjunction to VP would give us here:

(4c)



Is this even interpretable? Yes, but only if we employ flexible types for quantifiers, in this case, a meaning of type <<e,et>,et> for "more than two meetings"! If we do that, we can calculate as follows:

$\llbracket$**more-than-two$_2$ meetings 1[attend t$_1$]**$\rrbracket$
$=$ $\llbracket$**more-than-two$_2$**$\rrbracket$($\llbracket$**meetings**$\rrbracket$)($\llbracket$**1[attend t$_1$]**$\rrbracket$)
$=^{[1]}$ $\lambda x \in D$. $\llbracket$**more-than-two$_1$**$\rrbracket$($\llbracket$**meetings**$\rrbracket$)($\lambda y \in D$. $\llbracket$**1[attend t$_1$]**$\rrbracket$(y)(x))
$=$ $\lambda x \in D$. there are more than two $y \in D$ such that $\llbracket$**meeting**$\rrbracket$(y) = 1 and $\llbracket$**1[attend t$_1$]**$\rrbracket$(y)(x) = 1
$=$ $\lambda x \in D$. there are more than two meetings y such that $\llbracket$**1[attend t$_1$]**$\rrbracket$(y)(x) = 1

$=^{[2]}$ $\lambda x \in D$. there are more than two meetings y such that $[\![\textbf{attend t}_1]\!]^{[1\to y]}(x) = 1$

$=$ $\lambda x \in D$. there are more than two meetings y such that $[\![\textbf{attend}]\!]([\![\textbf{t}_1]\!]^{[1\to y]})(x) = 1$

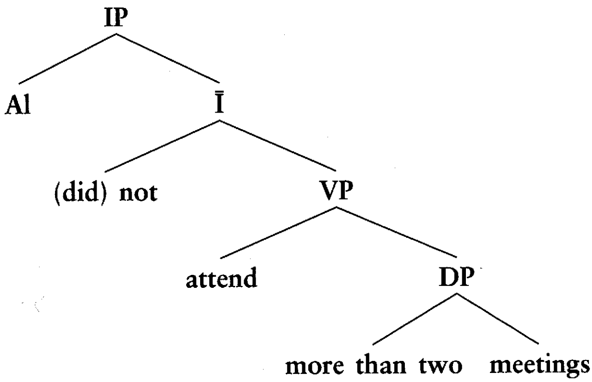
$=$ $\lambda x \in D$. there are more than two meetings y such that x attended y

$=$ $\lambda x \in D$. x attended more than two meetings

In checking this calculation, pay attention especially to the steps marked by superscripts on the "=". Step [1] eliminates **more-than-two**$_2$ (of type <<et>,<<e,et>,et>>) in favor of its basic homonym **more-than-two**$_1$ (of type <<et>,<<et>,t>>, whose lexical entry is then used in the following step). Step [2] is licensed by the Predicate Abstraction Rule, which tells us that $[\![\textbf{1[attend t}_1\textbf{]}]\!]^{\varnothing}(y) = [\![\textbf{attend t}_1]\!]^{\varnothing^{y/1}}$. (It also exploits the fact that $[\![\alpha]\!] = [\![\alpha]\!]^{\varnothing}$ and that $\varnothing^{y/1} = [1 \to y]$.)

Given the denotation we have just calculated for the higher VP in (4e), it can be further shown that (4c) as a whole does indeed represent the desired reading of (4) (that is, that it is equivalent to (4b).) But it would be premature to conclude from this that quantifiers must be able to adjoin to VP. Since we needed flexible types for the interpretation of (4c) anyway, we might as well have left the quantifier *in situ*:

(4d)



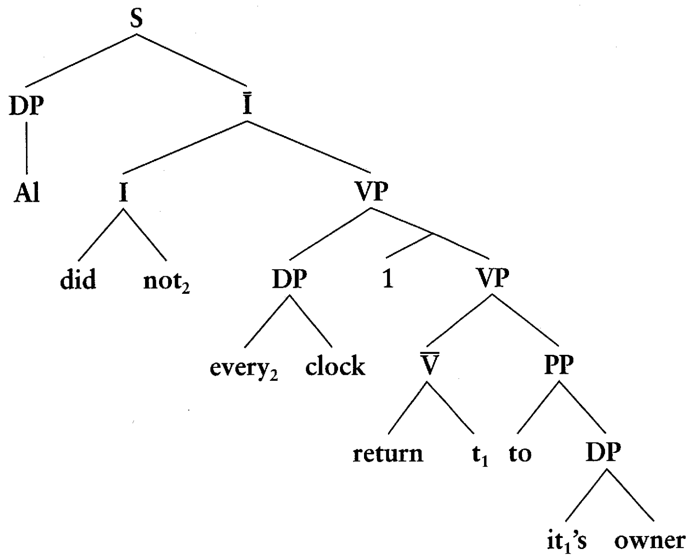
(4d) is just as interpretable as (4c), and receives exactly the same truth conditions! (*Exercise*: Show this.)

So it looks at this point as if we cannot make a case for quantifying into VP unless we take a stand against flexible types, which in turn commits us to VP-internal subjects. If we want to show that VP adjunction is needed *even if we allow flexible types*, we must come up with more complicated examples. One way to do this is to bring in bound-variable pronouns. Consider the following variant of (4):

(5) Al didn't return every clock to its owner.

(5) has a reading where the direct object **every clock** has narrower scope than the negation, but at the same time is the antecedent of the bound-variable pronoun **it**. What is the LF for this reading? As we saw earlier, if the pronoun is to be bound, it must be inside a PA configuration and co-indexed with a trace. So **every clock** cannot have stayed *in situ* in this LF; rather, it must have adjoined to a node which is high enough to dominate both its own trace and the pronoun. The only such nodes in (5) are VP, $\bar{I}$, and IP. But since the scope of **every clock** also is narrower than that of the negation in the intended reading, it cannot have raised as high as $\bar{I}$ or IP. This leaves adjunction to VP as the only possibility. In other words, (5) has a reading that is expressed by the LF in (5), *but not by any LF derivable without adjoining to VP.*

(5′)



Exercise

Another way to show that flexible types are not sufficient to do away with quantifying into VP is to construct examples with *two* quantifiers in the VP. Spell out this argument.

In sum, then, the need for quantifier adjunction to VP can be established even if we remain neutral on the availability of flexible types (or other methods of *in situ* interpretation) – provided, of course, that we accept the background assumptions that we have made here about negation, as well as the background assumptions that we needed earlier to argue for quantifier movement in the first place.

8.5 Quantifying into PP, AP, and NP

In our earlier discussion of so-called inversely linked readings we considered the sentence "One apple in every basket is rotten" and showed how its salient reading could be derived by adjoining the embedded quantifier "every basket" to IP. We noted in passing that this sentence might also have another reading, under which it asserted the existence of a rotten apple that is simultaneously inside every basket. The pragmatic oddity of this meaning makes it difficult to decide whether we actually want our grammar to generate it. But if we look at other examples with an analogous structure, it is quite clear that analogous readings are perfectly grammatical, and therefore we have to make sure our grammar predicts them.

8.5.1 A problem of undergeneration

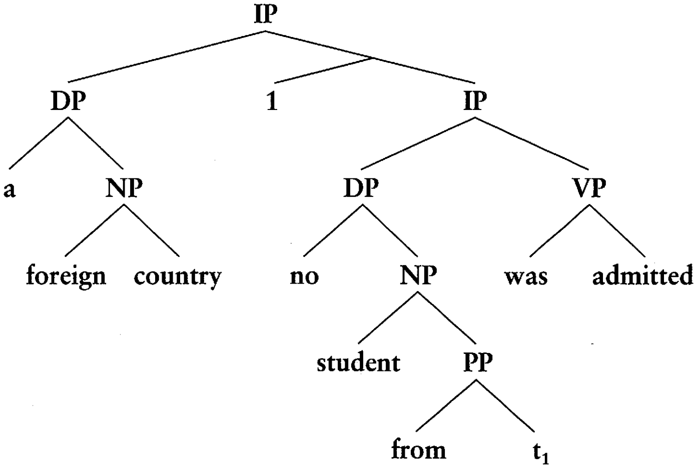
Consider:

(1) No student from a foreign country was admitted.

(1) is naturally understood as asserting that no student from any foreign country was admitted.

Let us first convince ourselves that this is *not* the inversely linked reading, and that in fact it cannot be represented by *any* LF in which quantifiers only adjoin to S. Here is what we get if we adjoin the more embedded DP (here, "a foreign country") to IP.[18]

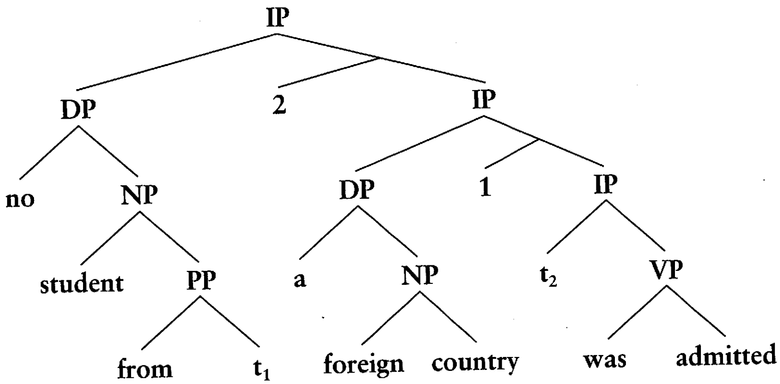
(2)



(2) is an interpretable LF, but it does not represent the meaning of (1) that we are interested in. For (2) to be true, there needs to be only one foreign country from which no students were admitted. So (2) might be true even when there are many students from foreign countries who were admitted. The reading of (1) that we described above, by contrast, is false as soon as there is even one student who is from a foreign country and is admitted.[19]

Is there a better candidate than (2) for the LF of this intended reading? If only type t nodes are available adjunction sites for quantifier movement, there is little else we can do. Raising the "no" DP above the "a" DP, as in (3), won't help.

(3)



(3) violates both the prohibition against vacuous binding (the variable binder "1" binds nothing!) and the prohibition against unbound traces ("t_1" is free!).[20] The types all fit together fine, but the truth-conditions of (3) turn out to be dependent on the assignment. Calculate them, and you will see that they don't even bear a remote resemblance to the ones we are after.

Exercise 1

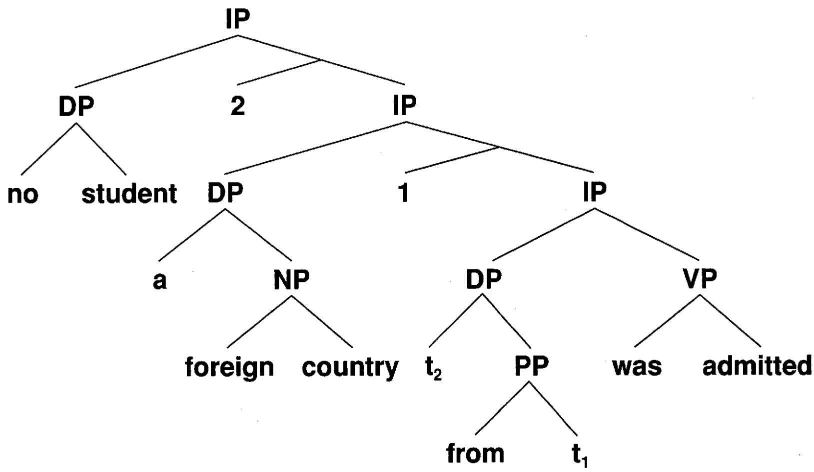
Prove the following two claims about (3):

(i) For any assignment a, (3) is not in the domain of $[\![\ ]\!]^a$ unless the domain of a includes 1.

(ii) For any assignment a such that (3) is in the domain of $[\![\ ]\!]^a$, $[\![(3)]\!]^a = 1$ iff there are either no foreign countries, or no student from a(1) was admitted (or both).

Exercise 2

It may seem that the problems with the unbound trace and vacuous binder in (3) could have been avoided if we had allowed a different constituent structure for the subject DP of (3): namely, [$_{DP}$ [$_{DP}$ **no student**] [$_{PP}$ **from a foreign country**]] instead of [$_{DP}$ **no** [$_{NP}$ **student** [$_{PP}$ **from a foreign country**]]]. Then we could have QR'd the **no** DP above the **a** DP without creating unbound traces or vacuous binders:



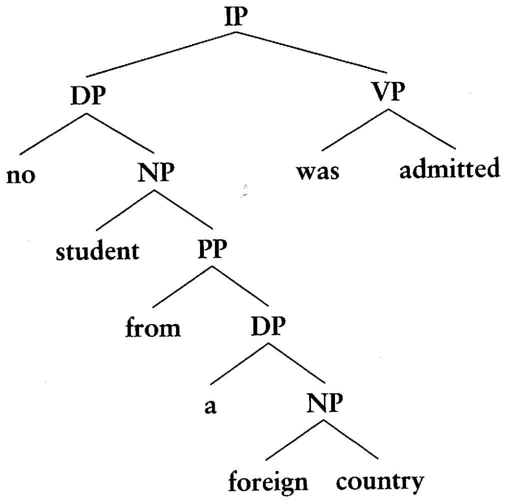
Show that this is not a solution to our problem.

We have seen that, once we have QR'd "a foreign country" out of the containing DP "no student from t", we cannot QR the latter any higher than the former. We can then at best QR it to adjoin to its immediately dominating IP-node, but that, of course, gives us no meaning distinct from leaving it *in situ*.

So if we want to find an interpretable LF for (1) that's truth-conditionally distinct from (2) yet interpretable, it seems that we will have to avoid QR'ing "a foreign country" out of its containing DP. But where could we adjoin it *within* that DP? The PP- and NP-nodes have meanings of type <e,t>, and the containing DP itself has a meaning of type <et,t>. So these are all excluded as adjunction sites by the Interpretability principle. We have thus exhausted all the possible LF derivations, and have not found any one suited for the natural reading of (1) that we described at the beginning of this section.

This conclusion, of course, depends on our tacit assumption that we don't have the option of flexible types. If we do allow those, the picture changes completely. Then, all we need to do to obtain the desired interpretation is to leave everything *in situ*:

(4)



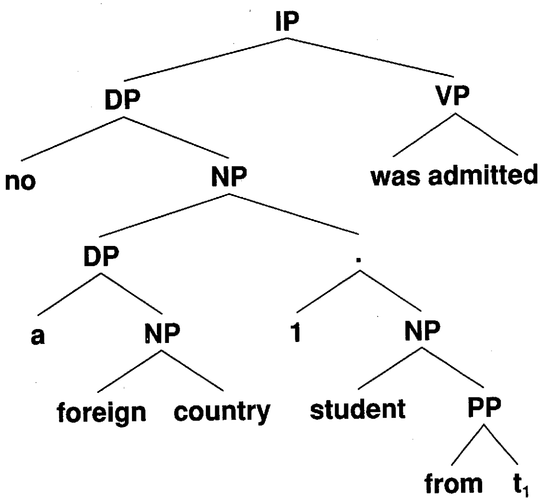
Exercise 1

Identify the type-shifted meaning for "a" that we need to interpret (4), and show that the predicted meaning is the one we want.

Exercise 2

Huang, following Fiengo and Higginbotham (see n. 16), proposed that the intended reading of (1) could be generated by adjoining the smaller DP to the NP containing it:

(i)



(a) Show that (i) is equivalent to (4), provided that we use a type-shifted meaning for "a".
(b) Show that adjunction of "a foreign country" to PP would yield yet another LF with the same meaning as (4) and (i).
(c) Can you think of examples that show that QR *must* be allowed to adjoin to PP or NP, even if flexible types (and hence *in situ* interpretation) are also available? (*Hint*: Recall what we have said about the analogous question regarding adjunction to VP.)

8.5.2 *PP-internal subjects*

May was aware that examples like (1) were a problem for his hypothesis that QR always adjoined to S, and he proposed a solution. He hypothesized that in the derivation from S structure to the input of the semantic component, PP modifiers were sometimes allowed to rewrite as clausal structures. If this operation were applied to the PP "from a foreign country" in (1), it would turn it into something essentially isomorphic to the relative clause "who is from a foreign country". Now this relative clause, of course, contains an S-node, and hence an adjunction site for QR.

Exercise

Show that sentence (i) has a straightforwardly interpretable LF which represents exactly the reading that we are trying to generate for (1).

(i) No student who is from a foreign country was admitted.

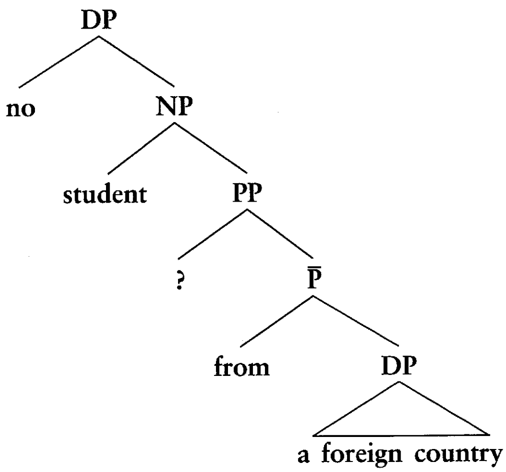
(By "straightforwardly interpretable", we mean, of course, interpretable without the use of flexible types.)

May's idea, then, was to account for the reading that (1) shares with (i) by adding enough internal structure within the DP "no student from a foreign country" so that it, too, would contain an internal IP-node for QR to adjoin to. The attractiveness of this idea does not depend on any commitment to a syntactic characterization of the possible landing sites for QR. We can equally appreciate it from our present perspective, where the decisive factor is semantic interpretability, and quantifiers must therefore adjoin to nodes with meanings of type t. From this perspective, we don't need an S-node between the embedded and the containing DP; but we do need something with type t, hence something more, it seems, than the superficially present PP and NP, whose types are <e,t>.

We are reminded at this point of the assumption of VP-internal subjects that made it possible to have an additional site for quantifier scope without any syntactic structure building. It is natural to ask, then, whether it would serve our present purposes to posit subject positions in other categories, such as PP or NP, as well. Indeed, there are arguments for such covert subject positions in the syntactic literature.[21] So let's explore this possibility.

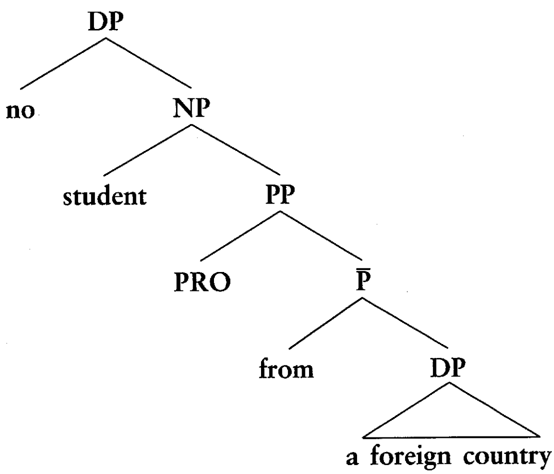
Suppose, for instance, there is a subject position within the PP headed by "from" in example (1):

(5)



What occupies this subject position? On the surface, it is evidently an empty category. Could it be a trace? Then something would have had to move from there, but it's hard to see what that would be. Let's assume, rather, that it is a base-generated empty category: that is, an empty pronoun usually referred to as "PRO":

(5′)

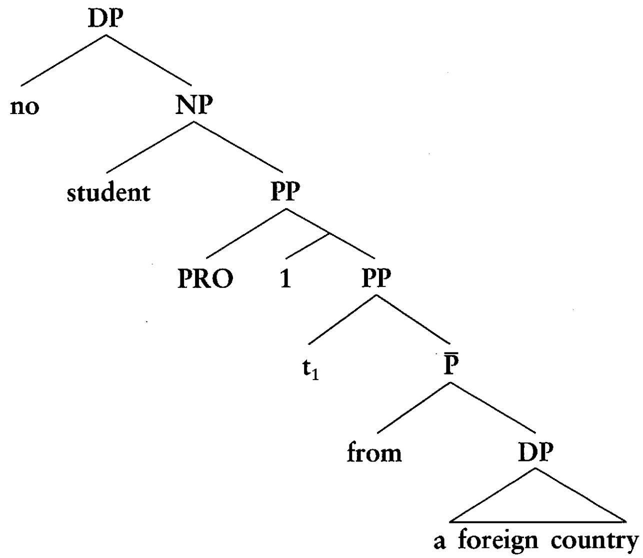


How are we going to interpret the empty pronoun? An empty pronoun presumably gets the same semantic interpretation as an overt one; in particular, it can be a variable. This, at any rate, would seem to be the most promising hypothesis for us here; it would imply that the PP has a subject of semantic type e, hence that the PP's type is t, which makes it a good adjunction site for the quantifier "a foreign country".

So far, so good; but there remains a big hole in this analysis: If the PRO is a variable, it needs a binder. The meaning of sentence (1) as a whole is clearly independent of a variable assignment, so its LF cannot contain any free variables. What could possibly be binding this PRO, though? It is not contained within a predicate abstraction configuration, and there is no obvious way to create one around it by performing some suitable movement.

Here is a possible solution. Suppose that PRO is not, after all, a variable (like overt pronouns), but rather is semantically vacuous. Now this assumption looks at first like a step in the wrong direction. If PRO is vacuous, it doesn't provide an argument for ⟦**from**⟧, and hence the PP won't get a meaning of type t. We might as well have left it out altogether then, it seems. – But that's not quite right. There *is* a difference between generating no subject position at all and generating one that is semantically vacuous. Such an item is still visible to the syntax, hence can be subjected to movement. Look what happens then:

(6)

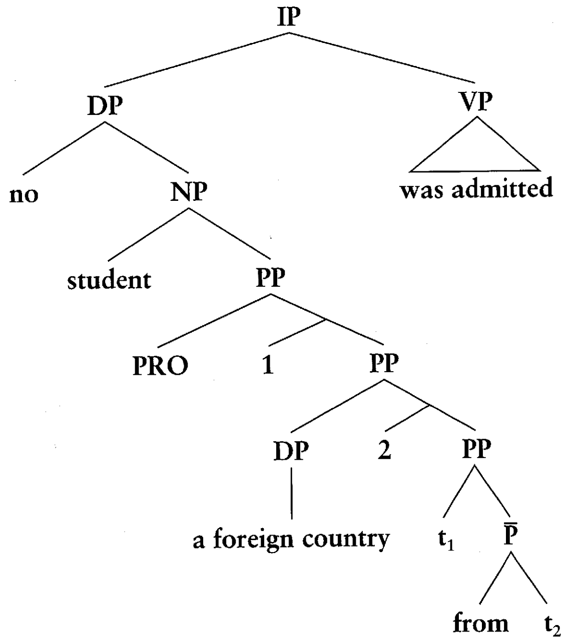


(6) is derived from (5′) by short movement of the PRO: PRO has adjoined to its immediately dominating PP, leaving an indexed trace in its previous site and giving rise to the insertion of a co-indexed variable binder at the adjunction site. (This is just how movement always operates, on our assumptions.) As a result of this movement, the lower PP now has a *nonvacuous* subject, the indexed

trace. It also has a binder for this subject. There are no unbound variables in (6): the trace has a binder, and the PRO, being semantically vacuous, is not a variable in need of a binder in the first place.

Now all that we have left to do to make this structure interpretable is QR "a foreign country". The lower PP provides a suitable adjunction site, and the LF we thus obtain for the whole sentence (1) is (7):

(7)



We leave it to the reader to calculate the interpretation of (7), and thereby verify that it captures the intended reading of (1) – without committing us to flexible types.

In sum, we saw how positing an underlying subject position in PP may help us account for the NP-internal scope readings of DPs embedded within other DPs, while still maintaining the smallest possible inventory of composition principles and lexical meanings for quantifiers. This analysis did not have to stipulate anything apart from lexical properties of PRO: PRO was taken to be a DP that is visible to the syntax, but not to the semantics. Interpretability did the rest. Being a DP, PRO *could* undergo QR, just like any other DP. In order for the whole structure to be interpretable, PRO *had to* undergo QR.

8.5.3 *Subjects in all lexically headed XPs?*

Once we entertain a subject position not only in VP but also in PP, it is natural to do the same for the remaining categories that were traditionally analyzed as

1-place predicates: namely, APs and NPs. Regarding APs, it is easy to construct examples analogous to our (1), except with an AP modifier instead of the PP modifier:

(8) No student $[_{AP}$ interested in more than one topic] showed up.

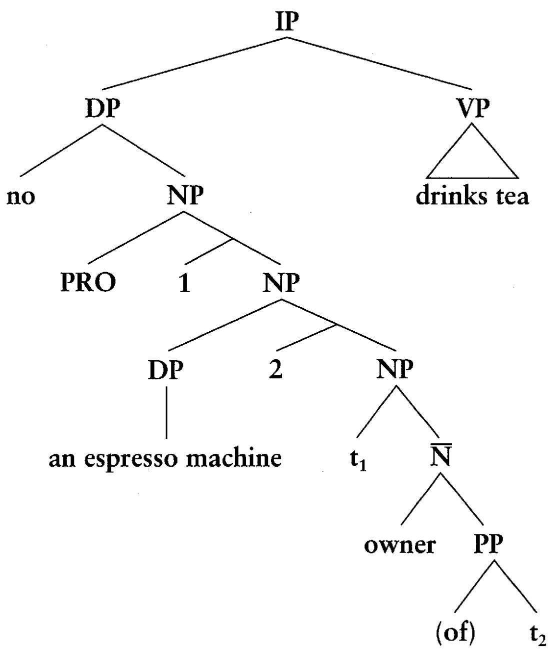
(8) has a natural reading paraphrasable as "no student who was interested in more than one topic showed up". We can generate this reading by giving the AP a PRO subject and then adjoining both this PRO and the quantifier "more than one topic" to the AP. This analysis is exactly parallel to the one we just applied to (1), so we need not elaborate further.

Are there examples which require a subject in NP?[22] (9) looks like a case in point.

(9) No owner of an espresso machine drinks tea.

This example differs from (1) in that the PP here is presumably an *argument* of the noun, not a modifier. In other words, the "of" in (9) (unlike the "from" in (1)) is semantically vacuous, and the meaning of "owner" is of type <e,et>. Positing a subject in PP here would not be helpful: due to the vacuity of "of," there is no chance of getting a type t meaning for the PP anyway. How, then, do we generate the meaning of (9) (paraphrasable as "no one who owns an espresso machine drinks tea")? A PRO subject in the NP seems the obvious solution. The LF then looks as in (9′), and you are invited to show that this means what it should.

(9′)



Exercise 1

Examples (1) and (8) do not really show that we need subjects in PP or AP as well.

(a) Show that the relevant readings of (1) and (8) can also be accounted for if NPs have subjects, but PPs and APs don't.
(b) Can you think of examples that establish the need for a PP- or AP-internal subject, even if NP-internal subjects are also available?

Exercise 2

Show how the assumption of empty subjects in PPs and APs helps with the interpretation of pronouns in DPs of the following kind:

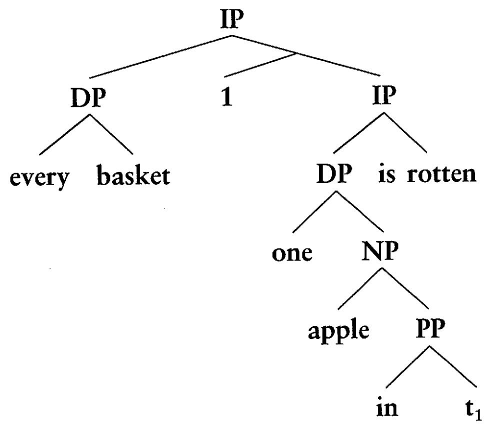
(i) No woman in her (own) office. . . .
(ii) No man attentive to his (own) needs. . . .

8.6 Quantifying into DP

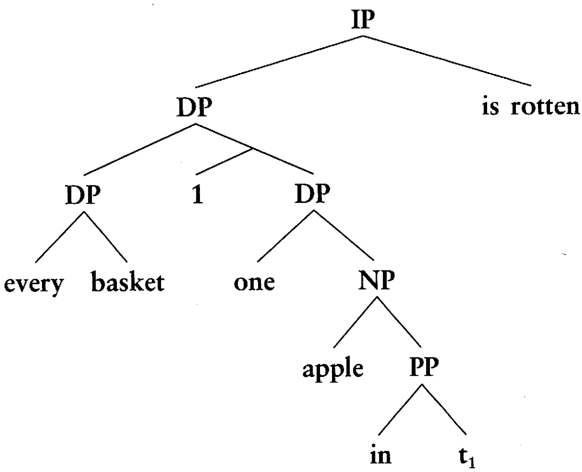
May[23] criticized his earlier analysis of inversely linked readings and proposed an alternative, on which the embedded quantifier was not adjoined to S but to the larger DP. For instance, instead of the LF structure (2) that he had assumed for the (most natural) reading of (1),[24] he posits the one in (3).

(1) One apple in every basket is rotten.

(2)



(3)



Before we turn to the reasons why May (and others) thought that (3) might be preferable to (2), let us first see whether (3) is interpretable at all and expresses (as May assumes) the same truth-conditions as (2).

It is evident that (3) is *not* interpretable on the most restrictive assumptions that we have been trying to maintain up to now: The DP **one apple in t_1** has a meaning of type <et,t>. The node above it that includes the variable binder **1**, then, gets a meaning of type <e,<et,t>>. (This follows as usual from the semantics of Predicate Abstraction.) This cannot combine with the standard type <et,t> meaning of **every basket**. So we need flexible types. Specifically, we need here a meaning for **every basket** that is of type <<e,<et,t>>, <et,t>>. Let's define such a meaning which not only has the desired type but also gives rise to the intended truth-conditions for (3):[25]

(4) $[\![\textbf{every basket}]\!] = \lambda f \in D_{<e,<et,t>>} \,.\, [\lambda g \in D_{<e,t>} \,.\, \text{for every basket } x,\ f(x)(g) = 1]$

Exercise

Apply (4) in the interpretation of (3) and thereby convince yourself that (3) is equivalent to (2).

Having shown that (3) is in principle viable as an alternative to (2), we turn to the question of whether there is any evidence for such LFs.

8.6.1 *Readings that can only be represented by DP adjunction?*

When we argued for quantifier adjunction to VP, PP, etcetera, we based our arguments on the existence of readings which could not be generated without these adjunction options. Can we come up with analogous positive evidence for adjunction to DP? This is not easy. The fact that (3) represents an attested reading of (1), for instance, shows nothing, because (3) has an equivalent counterpart involving only S adjunction (namely (2)). Is it possible in principle to construct DP adjunction LFs that do *not* have such equivalent IP adjunction alternatives?

The following example provides a possible candidate:[26]

(5) John met neither a student from every class nor a professor.

We take it that (5) can mean that neither (i) nor (ii) are true (that is, that both are false):

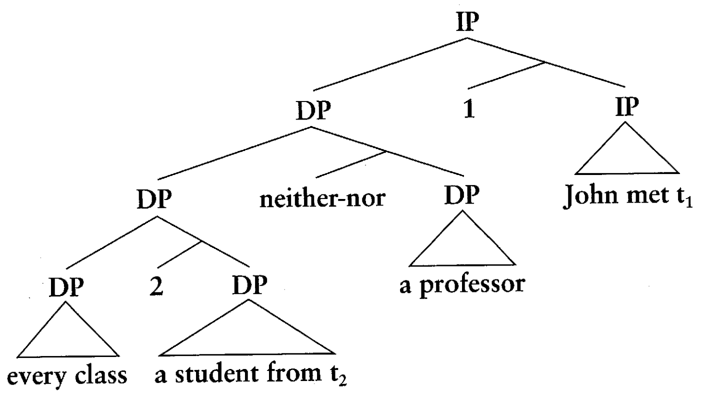
(i) For every class x, John met a student from x.
(ii) John met a professor.

The connective **neither ... nor** here conjoins two quantificational DPs, so it seems to have a meaning of type <<et,t>,<<et,t>,<et,t>>>, as follows:[27]

(6) $[\![\textbf{neither ... nor}]\!] = \lambda f \in D_{<et,t>} \,.\, \lambda g \in D_{<et,t>} \,.\, \lambda h \in D_{<e,t>} \,.\, f(g) = f(h) = 0.$

Indeed, with (6) and (an analog of) (4) at our disposal, we can show that the following LF has precisely the meaning we just described for (5):

(5′)

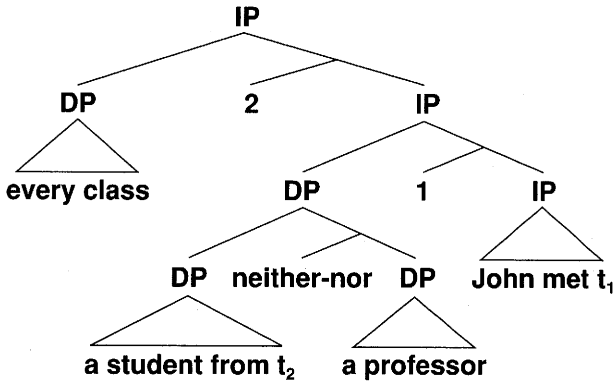


(*Exercise*: Prove this.) But – and this is the point of the example – there is no equivalent alternative in which **every class** adjoins to an IP-node instead.

Exercise

Show that (i) does not have the same truth-conditions as (5′).

(i)



8.6.2 *Indirect evidence for DP adjunction: a problem with free IP adjunction?*

The starting point for May's reanalysis of inverse linking readings was a syntactic consideration: We know from the study of movement in general that extraction out of a subject DP leads to ungrammaticality. For instance, *wh*-movement as in (7) is impossible:

(7) *the basket which one apple in t is rotten . . .

It is *prima facie* implausible, therefore, that the essentially parallel configuration in (2) above should be syntactically well-formed. The assumption that it is leads to unattractive complications in the syntactic theory of movement, and this motivates us to look for an alternative representation of the meaning that (2) expresses. (3) is a more attractive candidate in this regard, because it does not involve extraction *out* of the subject DP, as do (2) and (7).

This consideration by itself is not decisive in favor of allowing (3) and excluding (2). All it does is alert us to a trade-off: if we want the simplest syntax, we must complicate the semantics, and vice versa. But May did not stop here. He, and later Larson, argued that there is empirical evidence for locality constraints on QR which allow a DP-internal quantifier to move only as far as the edge of the containing DP (hence licensing (3) but not (2)).[28]

Consider a sentence with three quantifiers such as Larson's (8).

(8) Two politicians spy on someone from every city.

(8) has a number of possible readings, but Larson reports that it can*not* mean "for every city x, there are two politicians who spy on someone from x". Larson's generalization is that sentences of this form do not allow readings where a third, separate DP takes scope *in between* the two nested DPs. Here is a summary of possible and impossible scope orders that Larson observes:[29]

(a) $^{\text{OK}}$every city$_x$ [[someone from x]$_y$ [two politicians$_z$ [z spies on y]]]
(b) $^{\text{OK}}$two politicians$_z$ [every city$_x$ [someone from x]$_y$ [[z spies on y]]]
(c) *every city$_x$ [two politicians$_z$ [[someone from x]$_y$ [z spies on y]]]

To get an intuitive grasp of what the missing reading (c) amounts to, imagine a situation in which it would be true, but (a) and (b) false. Let there be two cities, LA and NY. Each has two natives, l_1 and l_2 for LA, n_1 and n_2 for NY. There are four politicians $p_1, \ldots, p_4$, each of whom spies on exactly one person: p_1 on l_1, p_2 on l_2, p_3 on n_1, and p_4 on n_2. (c) is true here. (a) is false, because not every city (in fact, neither) has a native on whom two politicians spy. (b) is false, because there aren't two politicians (in fact, not even one) who spy on natives of every city.

The point about the example now is this: If a quantifier embedded inside another DP were allowed to move out of the containing DP and adjoin to the IP above it, then all three of (a)–(c) could be generated. If, on the other hand, such a quantifier can move at most as far as the edge of its containing DP, then (a) and (b) can be generated, but (c) cannot be. (Draw the relevant structures and calculate their meanings to convince yourself of this claim.)

So the unavailablity of reading (c) for (8) yields an indirect argument for the existence of quantifier adjunction to DP. Once we make adjunction to IP unavailable for DP-contained quantifiers – which is a good move if we want to exclude (c) – then adjunction to DP seems to be the only way to represent those inverse-linking readings that are grammatical.

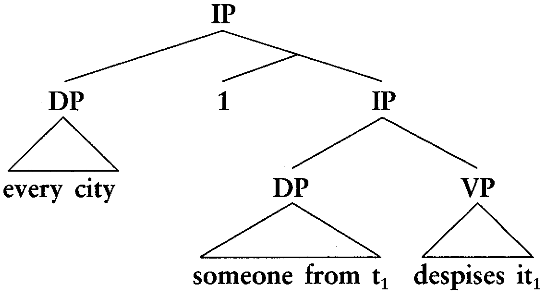
8.6.3 Summary

The argument we have just presented is sound and important, but the conclusion to which it has led May and Larson is nevertheless rather unattractive. Not only does it force us to admit type flexibility after all; it also raises – as May and Larson were well aware – a serious problem with bound pronouns. Consider an example from May's book:[30]

(9) **Someone from every city despises it.**

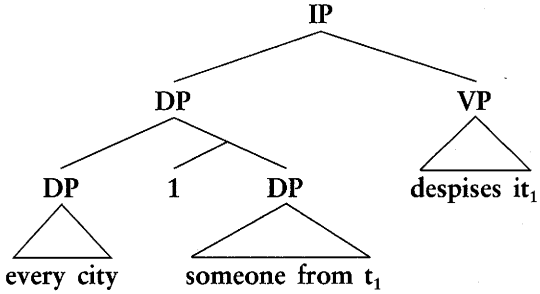
(9) shows that the embedded quantifier in an inverse-linking sentence can be the antecedent of a bound-variable pronoun which is outside the containing DP. The intended reading of (9) is straightforwardly predicted if **every city** is allowed to adjoin to S:

(9′)



But in a DP adjunction structure like (9″) the pronoun is free:

(9″)



In the response to this problem, May and Larson propose far-reaching revisions of the theory of pronominal anaphora. We are not prepared to discuss these at this point, and therefore we must withhold judgment as to whether their overall proposals can ultimately justify the price we have to pay for them.[31]

Notes

1 G. Carden, "English Quantifiers" (MA thesis, Harvard, 1968); also *idem*, *English Quantifiers: Logical Structure and Linguistic Variation* (New York, Academic Press, 1973). Related work in the tradition of generative semantics includes E. Bach, "Nouns and Noun Phrases," in E. Bach and R. T. Harms, *Universals in Linguistic Theory* (New York, Holt, Rinehart & Winston, 1968), pp. 90–122; G. Lakoff, "On Generative Semantics," in D. D. Steinberg and L. A. Jakobovits (eds), *Semantics* (Cambridge, Cambridge University Press, 1971), pp. 232–96; J. D. McCawley, "Where Do Noun Phrases Come From?," in A. R. Jacobs and P. S. Rosenbaum (eds), *Readings in English Transformational Grammar* (Waltham, Mass., Ginn & Co., 1970), pp. 166–83.

2 N. Chomsky, "Conditions on Rules of Grammar," *Linguistic Analysis*, 2 (1976), pp. 303–51.
3 R. May, "The Grammar of Quantification" (Ph.D. dissertation, MIT, 1977).
4 Ibid., p. 18.
5 In her analysis of ellipsis constructions and sloppy identity, Tanya Reinhart gives an independent argument for it. See T. Reinhart, *Anaphora and Semantic Interpretation* (London, Croom Helm, 1983). See chapters 9 and 10 below.
6 May called it the "Predication Condition" ("Grammar of Quantification," p. 22).
7 The type <e,t> option is due to the existence of Predicate Modification and not directly relevant to the present discussion. Both e and <<et>,t> are possible because we have Functional Application.
8 It may well be that there are syntactic reasons (e.g., Case Theory) that force the outermost argument of each predicate to move anyway, independently of the Θ-Criterion or Interpretability. See N. Hornstein, *Logical Form. From GB to Minimalism* (Oxford, Basil Blackwell, 1995).
9 May's explanation relied on his "Condition on Analyzability", which said that a transformation whose structural description mentions a specifier must affect the minimal DP containing that specifier which isn't immediately dominated by another DP. Independent motivation for this condition came from facts about pied-piping in *wh*-movement. See May, "Grammar of Quantification," for details.
10 A. von Stechow, "Syntax und Semantik," in A. von Stechow and D. Wunderlich (eds), *Semantik/Semantics. An International Handbook of Contemporary Research* (Berlin and New York, Walter de Gruyter, 1991), pp. 90–148; M. Bittner, "Cross-linguistic Semantics," *Linguistics and Philosophy*, 17 (1994), pp. 53–108; H. Rullmann, "Maximality in the Semantics of Wh-Constructions" (Ph.D. dissertation, University of Massachusetts, Amherst, 1995); D. Cresti, "Extraction and Reconstruction," *Natural Language Semantics*, 3/1 (1995), pp. 79–122.
11 P. Postal, "On Certain Ambiguities," *Linguistic Inquiry*, 5 (1974), pp. 367–424; G. Fauconnier, "Pragmatic Scales and Logical Structure," *Linguistic Inquiry*, 6 (1975), pp. 353–76; R. Rodman, "Scope Phenomena, Movement Transformations, and Relative Clauses," in B. H. Partee (ed.), *Montague Grammar* (New York, Academic Press, 1976), pp. 165–76; May, "Grammar of Quantification".
12 We are *not* adopting the revision that was tentatively entertained in the exercise in section 8.2.
13 More accurately, this restriction holds for the *final* landing site of a moved quantifier. Intermediate landing sites are not so constrained, for the same reason for which movement of DPs of type e is not. *Exercise*: Show that Interpretability considerations place no constraints at all on the type of the adjunction site for a moved name or an intermediate trace of a moved quantifier.
14 One exception (but perhaps not an interesting one) results from our decision to treat the complementizers (in relative clauses) as semantically vacuous. This implies that $\bar{C}$ constituents have meanings of type t as well.
15 See R. Montague, "The Proper Treatment of Quantification in Ordinary English" (1971), in R. Thomason (ed.), *Formal Philosophy* (New York, Academic Press, 1974), pp. 247–70. We say "the equivalent of", because Montague worked in a framework of syntax which did not have transformational rules in a literal sense. His syntactic category labels were also different: our VP corresponds to his IV ("intransitive verb"), and our NP to his CN ("common noun").
16 That QR needs to be able to adjoin to VP was argued by (among others) E. Williams, "Discourse and Logical Form," *Linguistic Inquiry*, 8 (1997), pp. 101–39;

H. Koopman and D. Sportiche, "Variables and the Bijection Principle," *Linguistic Review*, 2 (1982/3), pp. 139–60; and R. May, *Logical Form* (Cambridge, Mass., MIT Press, 1985). For arguments in favor of adjunction to NP (then called N-bar), see R. Fiengo and J. Higginbotham, "Opacity in NP," *Linguistic Analysis*, 7 (1981), pp. 395–421, and C.-T. J. Huang, "Logical Relations in Chinese and the Theory of Grammar" (Ph.D. dissertation, MIT, 1982).

Adjunction to DP was defended by R. May, *Logical Form: Its Structure and Derivation* (Cambridge, Mass., MIT Press, 1985), as well as by M. Rooth, "Association with Focus" (Ph.D. dissertation, University of Massachusetts, Amherst, 1985); and R. Larson, "Quantifying into NP" (unpubl. MS, 1987). (For these authors, "NP" corresponds to our "DP".)

17 The locution "quantifying into" comes from the philosophical literature, and came into linguistics through Montague's papers. Montague employed something more like a Quantifier Lowering rule in his syntactic derivations. But we use his terminology here in an extended sense. For us, "quantifying into category X" means adjoining a quantifier to X.

18 In (2) and below, we disregard the VP-internal subject position and the movement of the subject from there. This simplification does not affect any points in this section.

19 Whether sentence (1) also has the reading represented by (2) is not relevant to our discussion here. If that reading is altogether absent (and not just less prominent), that is problematic for our overall theory. But let us set *this* potential problem aside here. What we are concerned with in this section is how to predict the other reading we have described, which is no doubt available.

20 See chapter 5, where we introduced these conditions.

21 See, e.g., T. Stowell, "Subjects across categories," *Linguistic Review*, 2 (1983), pp. 285–312.

22 See P. Jacobson's "i-within-i Effects in a Variable-Free Semantics and a Categorial Syntax," in P. Dekker and M. Stokhof (eds), *Proceedings of the Ninth Amsterdam Colloquium* (Amsterdam, University of Amsterdam Institute for Logic, Language, and Computation, 1994), pp. 349–68, for an interesting study of pronoun binding within DP. Jacobson's evidence actually supports the view that NPs (in contrast to APs and PPs) do *not* have subjects, and therefore there might be a problem with our analysis of (9).

23 May, *Logical Form*, p. 69.

24 May, "Grammar of Quantification," p. 63.

25 Once we have (4), it is a routine exercise (which we leave to the reader) to define an appropriate meaning for the determiner **every** itself which combines with the standard meaning of **basket** to yield (4).

26 This argument does not appear in the literature, as far as we know. Only Rooth, "Association with Focus," and Larson, "Quantifying into NP," have tried to show that there are possible readings of English sentences which can only be generated by quantifying into DP, and their examples involve DPs in the object position of intensional verbs like **need**, **want**, and **look for**. Their argument relies on Montague's analysis for these verbs, which is beyond the scope of this book.

27 We are distorting the syntax of **neither . . . nor** here, by treating it as a unit which appears between the two phrases it coordinates (see LF (5′)). A better analysis would probably treat it as negation affixed to **either . . . or**. These refinements shouldn't affect our present point.

28 See Huang, "Logical Relations in Chinese"; May, *Logical Form*; J. Hobbs and S. Shieber, "An Algorithm for Generating Quantifier Scopings," *Computational*

Linguistics, 13 (1987), pp. 47–63; and Larson, "Quantifying into NP." We present Larson's examples here.

29 We are disregarding any readings on which **every city** takes scope *internal* to the NP **person from every city**. We are also disregarding any readings on which **from every city** is an argument or modifier of the verb **spy** rather than a part of the **some** DP (as in **I spied on him from the window**).

30 May, "Logical Form," p. 68.

31 Huang, "Logical Relations in Chinese," pp. 228–35, drew from examples similar to (8) a very different conclusion. He hypothesized that relative scope always had to be disambiguated at *S structure*. More precisely, he claimed that if one DP c-commanded another at SS, it also had to c-command it at LF. At first sight, this principle appears to be violated by the existence of wide-scope object readings in sentences like (i).

(i) Two politicians spy on every citizen.

(i) can mean that for every citizen there are two politicians who spy on him/her. In the LF of this reading, **every citizen** is not c-commanded by **two politcians**, but at SS, it apparently is. Huang explained away this apparent counterexample to his principle by maintaining that (i) had (at least) two different SSs, including one in which the DP **every citizen** was extraposed, i.e., right-adjoined to S. He proposed that this SS was the one that went with to the wide-scope object reading.

We cannot discuss the merits of this general proposal here, but Huang's application to examples like (8) is interesting. If nothing extraposes at SS in (8), Huang predicts the reading in (a). (Note that the **some** DP and the **every** DP do not stand in a c-command relation one way or the other, so their relative scopes with respect to each other are unaffected by Huang's principle.) If the object of **spy on** extraposes (as in (i)), we get an SS in which the **some** DP c-commands the subject, so this forces reading (b). For (c) to be generated, we would have to extrapose the DP **every city** outside the c-command domain of the subject, without at the same time extraposing the containing **some** DP so high that it c-commands the subject.