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Logical Form and LF (1993)*

[This paper was originally published in *Noam Chomsky: Critical Assessments*, edited by C. Otero, London: Routledge and Kegan Paul, 1993, pp. 788–838. It was intended to be accessible to both linguists and philosophers, and its aim was to encourage the idea that talk of *logical form* in much of philosophy and linguistics can be construed as converging on a single notion of importance to both fields. Today I am considerably more skeptical about the possibility of Davidsonian truth theories serving as theories of meaning than much of the present paper suggests I was when I wrote it. The reasons for this increased skepticism are given in Ch. 3. Of *Facing Facts*.]

1. Introduction

A feature common to the work of Russell, Chomsky, and Davidson is the idea that the superficial *grammatical form* of a sentence is distinct from, but systematically related to, its *logical form*. But what does it mean to say that a sentence has such-and-such a *logical form*? To some extent, the character of any philosophical answer to this question will be determined by one's primary interest: inference, ontology, or the relationship between semantics and syntax. It is the last of these that I am primarily concerned with here (though for reasons that will occasionally surface, I doubt that questions about the nature of logical form can be divorced entirely from questions about ontology or inference).

Philosophers and linguists who assign a central rôle to some notion of logical form in their semantical theories (or semantical inquiries) are sometimes charged with not doing semantics at all, a complaint that seems often to hinge on the assumption that a theory of logical form concerns formal

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inference templates and has no part to play in an account of the relationship between language and the world.[1] At the same time, some of those linguists who give a leading rôle to logical form in their syntactical theories (or syntactical inquiries) see themselves as doing semantics simply by virtue of providing a mapping from representations of surface syntax to unambiguous "conceptual" representations or unambiguous representations at another level of syntax, a view apparently based on the assumption that such a mapping obviates the need to explicate the relationship between language and the world.[2]

In my view, the acceptance of one or other of these assumptions has had a detrimental effect on much research in semantics and in the philosophy of language more generally. Philosophers who scoff at the semantical utility of logical form because they accept the first assumption, and linguists who tout a shift from logical to "conceptual" (or "psycho-logical") semantics because they accept the second, are both guilty of misunderstanding the original philosophical motivation for logical form and its rôle in semantical explanation. In this paper, I want to present in a favorable light a version of the view that there is a notion of logical form that plays a central, unifying rôle in syntax and semantics. To be more precise, I want to set out, defend, and develop in certain ways the view that there is a level of syntactical representation—LF ("Logical Form") in Chomskyan grammar—that instantiates the properties that many philosophers have traditionally ascribed to logical form.[3] In my view, a strong case can be made for the view that certain recent advances in logic, the philosophy of language, and grammatical theory are mutually illuminating and hold out the prospect of a much better understanding of structure, reference, quantification, variable-binding, and anaphora, notions that are central in different ways to philosophy and linguistics. Indeed, I am of the opinion that we are fast approaching the time when a substantial unification of grammatical theory and philosophical logic can take place. I shall comment on this toward the end of the paper.

2. Logical Form and Truth Definition

Many philosophers and linguists are attracted to the view that if we succeed in explicating the logical forms of the sentences of a natural language *L* we will

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1 See, for example, Carlson (1983), Barwise (1989).

2 See, for example, Hornstein (1985), Jackendoff (1983).

3 See (e.g.) Davidson (1967, 1975), Harman (1972, 1975), Higginbotham (1980, 1983, 1987), Lycan (1984), Platts (1979), Wiggins (1980), Russell (1905).

be making some sort of contribution to the project of constructing a systematic semantical theory for L: to specify the logical form of a sentence S is to specify its structure in a way transparently related to its meaning, transparently related to the proposition S expresses in a given context, transparently related to the world. I have no quarrel with this claim; indeed it needs to be developed considerably if it is to be subjected to any sort of philosophical scrutiny. One way of developing the claim would be to pursue the idea that the logical form of a sentence S belonging to a language L is the structure imposed upon S in the course of providing a systematic and principled mapping from sentences of L (as determined by the best syntactical theory for L) to the propositions (or perhaps proposition types) those sentences express. Alternatively, one might develop a view one finds in the work of many philosophers influenced by Davidson: the logical form of a sentence S belonging to a language L is the structure imposed upon S in the course of providing a systematic and principled truth definition for L.[4] I suspect that ontological considerations of a rather abstract nature will have to be invoked if these two conceptions of logical form are not to collapse into one. For concreteness and ease of exposition, I shall adopt the Davidsonian conception.

Very often, when a philosopher characterizes the logical form of a quantified English sentence, a formula in some version of the first-order predicate calculus is used. From the point of view of capturing certain inferences, this certainly makes good sense. But from the point of view of providing a systematic semantics for English, the procedure has clear limitations.[5] In the calculus, in order to characterize the "logical forms" of sentences like (1) and (2), sentential connectives as well as quantifiers must be introduced, as in their translations (1′) and (2′):

(1) Some humans are mortal
(1′) $(\exists x_1)(\text{humans}(x_1)\ \&\ \text{mortal}(x_1))$
(2) All humans are mortal
(2′) $(\forall x_1)(\text{human}(x_1) \supset \text{mortal}(x_1))$.

Thus a sizeable gap opens up between surface syntax and logical form. And, if we follow Russell, the logical form of (3) will be given by (3′), which contains two quantifiers and two connectives, making the relationship between surface syntax and logical form even more obscure:

(3) The president is mortal
(3′) $(\exists x_1)((\forall x_2)(\text{president}(x_2) \equiv x_2 = x_1)\ \&\ \text{mortal}\ x_1))$.

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4 Davidson (1967); Harman (1972, 1975); Platts (1979); Wiggins (1980).

5 Hintikka (1974); Evans (1977); Barwise (1979); Wiggins (1980); Barwise and Cooper (1981); Heim (1988).

So the prospects of providing a rigorous and straightforward procedure for converting sentences of English into sentences of the standard calculus do not look terribly good.[6]

Once plurality-quantifiers such as 'most' or 'many' are introduced, the picture darkens; for there are syntactically simple sentences containing such quantifiers that cannot be handled within the calculus. Consider (4):

(4) Most humans are mortal.

This cannot be represented in the calculus because 'most' is not definable in first-order logic, even if the domain of quantification is kept finite.[7]

One familiar solution to this problem is to view natural language quantification as *restricted*. A simple modification of the predicate calculus will serve our purposes. Call the resulting language *RQ*. In *RQ,* a determiner such as 'every', 'some', 'all', or 'most' is an expression that combines with a formula to create a restricted quantifier phrase.[8] For example, 'all_1' combines with, say, 'humans x_1' to create the restricted quantifier phrase '$[\text{all}_1 \text{ humans } x_1]_1$'. And this expression may combine with a second formula such as 'mortal x_1' to form a formula as in (5):

(5) $[\text{all}_1 \text{ humans } x_1]_1 (\text{mortal } x_1)$.

A truth definition for *RQ* is then constructed in such a way that (5) comes out equivalent to (2′). Before saying something about the truth definition for *RQ*, let's specify its syntax by modifying the formation rules of a standard first-order language. We can replace the rules specifying that if ϕ is a well-formed formula then so are $(\forall x_k)\phi$ and $(\exists x_k)\phi$ with the following (for any $k \geq 1$):

(Q1) If ϕ is a well-formed formula and D is one of (e.g.) 'every', 'all', 'each', 'a', 'no', 'some', 'most', then $[D_k\ \phi]_k$ is a well-formed restricted quantifier phrase.

(Q2) If ψ is a well-formed formula and $[D_k\ \phi]_k$ is a well-formed restricted quantifier phrase, then $[D_k\ \phi]_k\psi$ is a well-formed formula.

Next, we specify conditions on binding and scope in *RQ*. There are two types of variable-binding operator to deal with: determiners and restricted quantifiers. A determiner-variable complex D_k is really an unrestricted quantifier that binds any free occurrences of x_k in the formula ϕ with which it combines to form a restricted quantifier. And a restricted quantifier $[D_k\ \phi]_k$

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6 Montague, Kalish, and Mar (1980); Hintikka (1989); Hintikka and Sandu (1991).

7 Rescher (1962); Kaplan (1966); and Barwise and Cooper (1981).

8 Barwise and Cooper (1981); Higginbotham and May (1981); Higginbotham (1987); McCawley (1981); May (1985); Neale (1990).

binds any free occurrences of x_k in the formula ψ with which it combines to form a formula. The scope of a variable-binding operator (or any other expression) is just the smallest expression properly containing it, a generalization of Russell's notion of scope for the first-order predicate calculus.

We can now provide a truth definition for *RQ* by making a few slight modifications to a Tarski-style truth definition for an ordinary first-order language. First, we need axioms for the referring expressions or singular terms. I shall take proper names and variables (under assignments) as paradigm singular terms.[9] (Interestingly, both philosophers and linguists have found themselves wanting to treat names and variables as forming a natural class of expressions (for certain purposes). Philosophers influenced by Kripke (1972) and Kaplan (1977) often find themselves looking at names and variables together because they are *rigid* referring expressions (a term refers rigidly to X if, and only if, it refers to X in every possible world in which X exists). And linguists influenced by Chomsky (1981) often find themselves treating names and variables together as *R-expressions* (an R-expression is "not subject to the binding conditions for traces and other anaphors"). In my view, it is no accident that philosophical and syntactical considerations have independently led to grouping names and variables together. In section 9, I shall suggest a unification of these philosophical and syntactical considerations. Until then, the similarity between names and variables will reside in the (for now) superficial fact that they fall under the same sorts of axioms. Very roughly, for each proper name there will be an axiom similar to the following:

(i) Ref('Chomsky', s) = Chomsky.

This just says that the referent of 'Chomsky' with respect to an arbitrary sequence (or assignment) s is Chomsky. (For ease of exposition, I shall ignore many details; for example, universal quantification over sequences, terms, and formulae throughout will be suppressed throughout). For individual variables x_k, we will have the following axiom schema:

(ii) $\mathrm{Ref}(x_k, s) = s_k$

which says that the referent of x_k with respect to a sequence s is the k-th element of s.

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[9] Definite descriptions are to be treated not as singular terms but as quantifier phrases for more or less the reasons given by Russell. For a detailed defense of this position, see Neale (1990). I shall ignore demonstratives because they bring up difficult problems involving such things as context-sensitivity that are not pertinent to my main theme. For truth-theoretic treatments of demonstratives, see (e.g.) Weinstein (1974) and Taylor (1980).

For each one-place predicate there will be an axiom similar to the following axiom for 'procrastinate'

(iii) s satisfies α *procrastinates* iff Ref(α, s) procrastinates

where t is a singular term (i.e., a name or a variable). For each two-place predicate, there will be an axiom similar to the following axiom for 'respect'

(iv) s satisfies t *respects* u iff Ref(t, s) respects Ref(u, s)

where t and u are singular terms.

For each binary connective there will be an axiom similar to the following axiom for 'and'

(v) s satisfies ϕ *and* ψ iff s satisfies ϕ and s satisfies ψ where ϕ and ψ are wffs.

Finally, we replace the unrestricted quantifier axioms of a Tarski-style truth definition by axioms appropriate for dealing with restricted quantifiers. For each unary determiner there will be an axiom similar to the following axioms for 'every' and 'most':

(vi) s satisfies $[every_k\ \phi]_k\ \psi$ iff every sequence satisfying ϕ and differing from s at most in the k-th place also satisfies ψ.

(vii) s satisfies $[\mathrm{most}_k\ \phi]_k\ \psi$ iff most sequences satisfying ϕ and differing from s at most in the k-th place also satisfy ψ.

As usual, a sentence is true just in case it is satisfied by all sequences.

In a standard first-order language, no increase in expressive power is obtained, of course, by introducing the existential quantifier as a primitive quantifier when the language already contains the universal quantifier and negation. Similarly, the expressive power of RQ is not increased by introducing a new determiner 'some' along with the following axiom to supplement (vi) and (vii):

(viii) s satisfies $[\mathrm{some}_k\ \phi]_k\ \psi$ iff at least one sequence satisfying ϕ and differing from s at most in the k-th place also satisfies ψ.

But introducing axiom (viii) would of course simplify the translation of sentences of English into formulae of RQ; for this reason and another more important reason that will emerge, I suggest we adopt it along with further axioms for 'each', 'no', 'any', and 'a'. Let's say that sentences of RQ "give the logical forms" of the English sentences with which they are paired. By my own lights this involves something of a liberty because I am subscribing to the view that the logical form of a sentence S of a language L is the structure imposed upon S in the course of providing a systematic and principled truth definition for L. So an account is still needed of how, for example, (5) can be viewed as the structure imposed upon (2) in the course of meeting this obligation. Before any of this, however, I want to say something about the expressive power of RQ and about definite descriptions.

RQ can be used perspicuously, systematically, and unambiguously to reveal the "logical forms" of sentences with more than one operator. For example, the negation sign '~' can be prefixed either to the entire sentence, as in (6_1), or to the open sentence that contains the predicate, as in (6_2):

(6) $\sim$ [some$_1$ human x_1]$_1$ (mortal x_1)
(6′) [some$_1$ human x_1]$_1$ $\sim$ (mortal x_1).

Sentences containing quantifier phrases in non-subject positions and sentences containing more than one quantifier phrase can also be represented in RQ. For example, the scope ambiguity perceived in 'Every philosopher respects some linguist' is captured as follows:

(7) [every$_1$ philosopher x_1]$_1$ ([some$_2$ linguist x_2]$_2$ (x_1 respects x_2))
(7′) [some$_2$ linguist x_2]$_2$ ([every$_1$ philosopher x_1]$_1$ (x_1 respects x_2)).[10]

In these formulae a quantifier combines with an open sentence that is itself the product of combining a quantifier with an open sentence.

From a syntactical perspective, the definite article is another determiner, like 'every' and 'some', that combines with a nominal expression to form an NP. This was something that Russell saw and he went on to argue very successfully that 'the' is also semantically like 'every' and 'some' in that it introduces quantification. According to Russell, the truth conditions of a simple sentence of the form the *F* is *G* are given by (8):

(8) $(\exists x_1)((\forall x_2)(Fx_2 \equiv x_2 = x_1) \supset Gx_1)$.

On this account, then, 'the *F* is *G*' is true iff (i) all *F*s are *G*s and (ii) there is exactly one *F*. No great effort is involved in implementing Russell's proposal in RQ. Since the word 'the' is just another one-place quantificational determiner, in RQ we can treat the_k as combining with a formula ϕ to form a restricted quantifier $[the_k\ \phi]_k$.[11] On such an account, a sentence of the form 'the *F* is *G*' can be represented as '$[the_1\ Fx_1]_1(Gx_1)$', and the following axiom

[10] It is sometimes claimed that 'Every philosopher admires some linguist' is unambiguous on the grounds that (7′) entails (7). Proponents of this view usually claim that the weaker reading (7) provides the correct truth conditions but in certain conversational contexts it is clear that the speaker is seeking to *convey* something stronger than what he or she literally says. Presumably people who argue this way see some sort of analogy with Grice's defence of a truth-functional analysis of 'and'. I am certainly much moved by Gricean considerations that serve to explain away apparent ambiguities; but in the present example the case for a genuine truth-conditional ambiguity seems to me overwhelming.

[11] Grice (1969); Evans (1982); Wiggins (1980); Barwise and Cooper (1981); Higginbotham and May (1981); Neale (1990).

for *the* (when it takes singular complements) can be added to the truth definition for RQ:

(ix) s satisfies $[the_k\ \phi]_k\ \psi$ iff the sequence satisfying ϕ and differing from s at most in the k-th position also satisfies ψ.[12]

The right-hand side of (ix) is to be understood as equivalent to "there is exactly one sequence satisfying ϕ and differing from s at most in the k-th position and every sequence satisfying ϕ and differing from s at most in the k-th position also satisfies ψ." In order to make (ix) congruent with the axioms for the other determiners, I have used the determiner 'the' in the metalanguage.

Chomsky (1977) points out that, on a Russellian account, the relationship between singular and plural descriptions can be specified very neatly. Whereas 'the F is G' is true if, and only if, every F is G and there is *exactly one F*, on its non-collective reading 'the Fs are Gs' is true if, and only if, every F is G and there is *more than one F*. We can capture Chomsky's observation by adding the following axiom for 'the' when it takes plural complements:

(x) s satisfies $[\text{the}_k\ \phi]_k\psi$ iff the sequences satisfying ϕ and differing from s at most in the k-th position also satisfy ψ.

Here, the right-hand side is to be understood as equivalent to "there is more than one sequence satisfying ϕ and differing from s at most in the k-th

[12] It might be thought that by presenting a formal language (RQ) in which descriptions are treated as restricted quantifiers, although I have succeeded in presenting an account of descriptions that might find a place within a general compositional semantical theory, I have achieved this only by presenting an account of definite descriptions that is inconsistent with Russell's own account: for in RQ, definite descriptions are complete "logical units," but on Russell's account, as presented in *Principia Mathematica*, they are "incomplete symbols" that "disappear on analysis." (This complaint is registered by Linsky (1992) in his review of *Descriptions.*) I do not think there is much that is legitimate here. Of course, Russell did not have the resources of generalized quantifier theory at his disposal; but on reflection an RQ account of descriptions is really just Russell's theory stated in a way that will ultimately allow us to see the relationship between surface syntax and logical form more clearly. By virtue of being Russellians about definite descriptions, we are not committed to the view that the only way of representing the logical form of a sentence containing such a phrase is to translate the sentence in question into a formula of the language of *Principia Mathematica* (or a similar language). As far as explicating the logical structure of sentences containing descriptions is concerned, treating them as restricted quantifiers results not in a falling out with Russell but in an explanation of where the Theory of Descriptions fits into a more general theory of natural language quantification, a theory in which determiners like 'every', 'some', 'all', 'most', 'a', 'the', and so on, are treated as members of a unified syntactical and semantical category. Although Russell's theory is often put forward as the paradigm case of a theory that invokes a distinction between *grammatical form* and *logical form*, ironically there is a sense in which it preserves symmetry: the gap between grammatical form and logical form in the case of 'the F is G' is no wider than it is in the case of 'every F is G' or 'some F is G' because 'the' is of the same syntactical and semantical category as 'every' and 'some'. On this account a description (or any other quantified NP) is still an *incomplete* symbol: a *complete* symbol stands for some entity and contributes that entity to the propositions expressed by (or to specifications of the truth conditions of) utterances of sentences containing that symbol. But of course quantified noun phrases do not do this, *not even in RQ*. For discussion see my 'Logical Form, Grammatical Form, and Incomplete Symbols.'

position, and every sequence satisfying ϕ and differing from s at most in the k-th position also satisfies ψ."

3. Logical Form, LF, and Evacuation

Although we now have a formal language in which quantified NPs are treated as restricted quantifiers, by the definition of logical form I took up at the beginning of the paper, we do not yet have a theory of the logical forms of sentences of English: we lack a mechanism capable of delivering formulae of RQ as structures imposed on sentences of English in the course of providing a truth definition.

I think there is good reason to think this situation can be remedied by appealing to the work of Chomsky.[13] In the 1970's, Chomsky and others explored the view that *wh*-phrases such as 'who', 'which man' and 'whose party' are quasi-quantifiers that bind variables in the sentences in which they occur. To anyone who has been exposed to the devices of introductory logic, there is certainly an intuitive (albeit loose) sense in which the "logical form" of the English sentence (9)

(9) which linguist married Fred?

can be thought of as given by the quasi-English sentence (9′):

(9′) which linguist x is such that x married Fred?

On independent syntactical grounds that need not detain us, Chomsky argued that something very similar to the quantifier-variable structure in (9′) is actually present in the syntactical structure of the English sentence (9). And out of this idea and detailed work on *wh*-phrases, quantified NPs, and anaphoric pronouns, there emerged a level of syntactical representation called "LF," a level distinct from "surface structure" and "deep structure," but with some affinity to the conception of "deep structure" championed by Harman, Lakoff, McCawley, Ross and others in the late 1960s and early 1970s.[14]

The label "LF" is supposed to connote "logical form" and it is of interest to the theorist of logical form because it can be construed—and by some Chomskyans *is* construed—as the syntactical level at which scope assignments are made explicit and, consequently, the syntactical level relevant to semantical interpretation.[15] For concreteness, let us assume a two-tiered Chomskyan

[13] Chomsky (1975, 1977, 1980, 1981, 1986).

[14] See, e.g., Harman (1972, 1975), Lakoff (1971, 1972), McCawley (1968, 1970, 1972), and Ross (1974).

[15] Chomsky (1977, 1981, 1986); Higginbotham (1980, 1983, 1987); Higginbotham and May (1981).

syntax comprising SF (Surface Form), and LF, and take a sentence to be an ordered pair ⟨SF, LF⟩. A purported sentence is grammatical just in case it has a well-formed SF and a well-formed LF (When talking about *Wh*-phrases, I shall also assume the existence of D-Structure, construed as the level where lexical insertion takes place. Technically, then, a sentence would be an ordered triple ⟨DS, SF, LF⟩, though ultimately, D-Structure ought to be dispensable.[16])

In my opinion, a reasonable case can be made for the view that the distinction between SF and LF provides an independently motivated way of capturing what Russell and Davidson are after when they appeal (in their own ways) to a distinction between *grammatical form* and *logical form*. Consider (10), the RQ rendering of which is (10_1):

(10) all philosophers procrastinate

(10_1) [all_3 philosophers x_3]$_3$ (x_3 procrastinate).

Following Chomsky and others, I shall assume that something very like (10_1) is the LF representation for (10).[17] It is now standard to assume that SF representations are mapped onto LF representations by an elementary syntactical operation sometimes known as "Quantifier Raising." With the aims of (a) focussing on the *phenomenon* rather than any rule of grammar (thereby preparing the ground for section 9), (b) avoiding any sort of commitment to particular implementations found in the literature, (b) allowing for the possibility of "lowering" as well as raising quantifiers, let us say that QNPs are *evacuated* rather than *raised* (QNPs must be forced out of the matrix sentence at LF). The SF (10_2) is mapped onto the LF representation (10_3) by the evacuation of 'all philosophers':

(10_2) [$_S$ [$_{NP}$ all philosophers]$_3$ [$_{VP}$ procrastinate]]

(10_3) [$_S$ [$_{NP}$ all philosophers]$_3$ [$_S$ e_3 [$_{VP}$ procrastinate]]].

Here, QNP-evacuation creates an S node immediately dominating the original S node: at LF, the evacuated QNP is an immediate constituent of the new S node and a sister to the original S node, i.e., the QNP has been Chomsky-adjoined to the original S node. The trace 'e_3' left by the evacuated quantifier functions as a variable bound by that quantifier. (In effect, then, QNP-evacuation might be viewed as the product of a "transformational" operation

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[16] My own inclination is to see LF as the most basic level with surface structure representations as projections of LF representations. For discussion, see section 10. Although I talk of Surface Form, Chomsky has pointed out to me that ultimately what I have in mind is arguably better thought of as his PF ("Phonetic Form").

[17] Chomsky (1977, 1981, 1986); Higginbotham (1980, 1983); Higginbotham and May (1981); May (1987).

in the sense familiar from early generative grammar. In current versions of the Extended Standard Theory, it can be viewed as an instance (along with, e.g., *wh*-movement ("*wh*-evacuation")) of the more general schema "move α." This matter is discussed below.[18]

Although the syntactical details of this type of mapping between SF and LF are familiar enough to linguists, both linguists and philosophers might wonder at this point how the notion of LF in Chomsky's theory can be of use to the philosopher or logician interested in logical form in the Davidsonian sense I advocated earlier. Puzzlement may be dispelled by reflecting on the following points. (i) The semantical properties of a sentence are to some extent determined by its syntactical properties. (ii) If sentences have syntactical representations with the properties that LFs are supposed to possess, the vitally important semantical notion of the *scope* of an expression in natural language may well admit of a syntactical characterization: for the *scope* (in exactly the standard sense of Whitehead and Russell) of the evacuated QNP can be identified with the S node to which it has been Chomsky-adjoined. (iii) The mapping from LF representations to sentences of RQ looks to be trivial and the truth definition for RQ is straightforward.

I suggest, then, that an independently motivated syntactical theory that delivers an SF representation and an LF representation for each sentence of a fragment of a given language ought to be of considerable interest to philosophers and linguists who take the logical form of a sentence *S* belonging to a language *L* to be the structure imposed upon *S* in the course of providing a systematic and principled semantics for *L*. Arguably, we can make some serious progress by exploring the view that a fully worked out theory of LF will be a fully worked out theory of logical form. (It is sometimes claimed that theories of LF or logical form cannot be contributions to *semantics* because they are theories about representations and inferential relations rather than about the relationship between language and the world (see, e.g. Carlson [1983] and Barwise [1989]). However, it should be perfectly clear that anyone who (a) views a fully worked out theory of LF as a fully worked out theory of logical form and (b) takes the logical form of a sentence to be the structure imposed upon it in the course of providing a truth definition cannot be accused of failing to hook up language and the world.[19])

[18] For detailed discussion, see Chomsky (1981, 1986). Arguably, QNPs may be adjoined to categories other than S, for example NP or VP. For the primarily conceptual concerns of the present paper, I shall assume that QNPs adjoin only to S nodes, though doubtless some of the discussion might profit from abandoning this restriction.

[19] By saying this, I hope it is clear that I am distancing myself from certain ways of viewing LF that have appeared in the literature. For the record, I wish to explicitly distance myself from the LF theory proposed by Hornstein (1984) and the account of definite descriptions proposed therein. For important work on LF in the tradition to which I see the present paper as belonging, see Higginbotham (1980, 1983, 1987), Higginbotham and May (1981), and May

On the assumption that the relationship between (10_1) and (10_3) is transparent, and on the further assumption that the objects of semantical interpretation are LFs rather than SFs, we can, in effect use the truth definition for RQ as a truth definition for a quantified fragment of English. This idea becomes less offensive once more is said about scope and variable-binding. As I said above, the scope of a quantified NP is just the S node to which it has been Chomsky-adjoined at LF. This can be viewed as a consequence of a general characterization of scope that emerged from interactions in the late 1960s between linguists and philosophers interested in the relationship between "deep structure" and "logical form." First, we need to introduce a notion that has become a central component of syntactical theory through the work of (e.g.) Reinhart [1978]:

(A) An expression α c-commands an expression β if and only if the first branching node dominating α dominates β (and neither α nor β dominates the other).

If we think tree-theoretically about the usual sorts of formation rules and truth definitions for the propositional calculus, the first-order predicate calculus, RQ, and standard modal extensions of each of these, we see straight away that an expression β is within the *scope* of an expression α iff α c-commands β. For example, The scope of a unary connective such as ~ or ◊ is just the wff(s) it c-commands; the scope of a binary sentential connective such as '&' or '⊃' consists of the two wffs it c-commands; and the scope of a quantifier such as $(\forall x_k)$ or $[every_k\ \alpha]_k$ is the wff it c-commands. This is a trivial consequence of the way these languages are constructed and interpreted.

In the late 1960s and early 1970s, Bach, Harman, Lakoff, McCawley, and others suggested that the same is true of natural language; more precisely, they suggested that the scope of an expression in natural language is its c-command domain at the syntactical level relevant to semantical interpretation.[20] Thus we reach the following, which is in fact accepted by many linguists working within Chomsky's Extended Standard Theory:

(1987). Criticisms of some conceptions of LF can be found in Carlson (1983), Hintikka (1989) and Hintikka and Sandu (1990).

20 Bach (1968), Harman (1972), Lakoff (1971, 1972), McCawley (1968, 1970, 1972). This principle is stated explicitly in Harman's paper, though he does not use the *term* "c-command," which is due to Reinhart (1976). For Harman *et al.*, the level of linguistic representation relevant to semantical interpretation was Deep Structure, but a Deep Structure with much more affinity to LF than current D-Structure. The relevance of c-command to the interpretation of certain anaphoric pronouns as variables bound by QNPs was noticed by, *inter alia*, Evans (1977) and Reinhart (1978). With the benefit of hindsight, it is clear that the relevance of the notion of c-command to bound pronouns is a trivial consequence of the truth of the Bach-Harman-Lakoff-McCawley Thesis.

(B) The scope of an expression α is everything α c-commands at LF.

On the assumption that a trace left by QNP-evacuation is understood as a variable and thereby falls under an instance of the axiom schema

(ii) $\text{Ref}(s, x_k) = s_k$

we get exactly the right truth conditions for (10) as the occurrence of 'e_3' in that sentence is bound by the fronted quantifier '[all_3 philosophers]$_3$' by virtue of lying within its scope at LF.

For all intents and purposes, (10_1) and (10_3) can be viewed as notational variants. In a more fully worked out theory, I should want to provide a truth definition for a fragment of English by modifying the axioms of the truth definition for RQ in such a way that it can be applied to LF representations directly; but such a task lies well beyond the aims of the present paper.[21] For present purposes I shall continue using the truth definition for RQ, trading on the transparency of the relationship between an LF and the sentence of RQ with which it is paired. Although we have examined only one simple example, it will become clear as we proceed that the aforementioned transparency is preserved even in considerably more complex cases. I see no harm, then, in using formulae of RQ to stand for LFs unless there is some specific syntactical reason for using LF representations.

I want to conclude this section by looking at one philosophically important feature of natural language that the LF proposal may help to illuminate: the matter of ambiguity involving quantifier scope. It is a commonplace of philosophy and linguistics that many sentences containing two or more quantifiers admit of distinct readings, i.e. readings with distinct truth conditions. Typically, the readings in question are captured in terms of relative scope; thus (11) is given the readings (11_1) and (11_2):

(11) Every philosopher respects some linguist

(11_1) [every_1 philosopher x_1]$_1$ ([some_2 linguist x_2]$_2$ (x_1 respects x_2))

(11_2) [some_2 linguist x_2]$_2$ ([every_1 philosopher x_1]$_1$ (x_1 respects x_2)).

And of course by the truth definition for RQ, (11_1) and (11_2) are not equivalent. This suggests very strongly that if we want to pursue the idea that LF representations are representations of the logical forms of sentences in the Davidsonian sense given earlier, we need to associate two distinct LFs with the surface string (11), one corresponding to (11_1) the other to (11_2):

(11_3) $[_S$ [every philosopher]$_1$ $[_S$ [some linguist]$_2$ $[_S$ e_1 respects e_2]]]

[21] I understand that a detailed axiomatization of this sort is to appear in *Knowledge of Meaning*, a textbook being written by Richard Larson and Gabriel Segal for the MIT Press.

(11_4) [$_S$ [some linguist]$_2$ [$_S$ [every philosopher]$_1$ [$_S$ e_1 respects e_2]]].

Since the identity of a sentence is determined by an SF representation and an LF representation, rather than saying that (11) is an ambiguous sentence, we must say that (11) is the surface representation of two distinct sentences—viz. ⟨(11), (11_3)⟩ and ⟨(11), (11_4)⟩—that share an SF representation and in fact look and sound alike (for convenience we might still want to say, loosely of course, that the "string" (11) is ambiguous).[22]

There are several ways one might structure the theory in order to obtain the two distinct LF representations (11_3) and (11_4). For reasons that will emerge, I suggest we view evacuation as the Chomsky-adjunction of any quantified NP in an argument position to any superior S-node. Evacuation is a phenomenon rather than a rule of grammar; it is the product of two very natural constraints on the well-formedness of representations at the syntactical level relevant to semantical interpretation, viz. LF: (i) only referential NPs (e.g., names, variables, and NPs anaphoric on referential NPs) may occupy argument positions; (ii) no variables may remain free. I will say more about these conditions later; for immediate purposes it will be enough to note that one consequence of such constraints is that every quantified NP will vacate its SF position for a position that c-commands the "original" position at LF. On this account, we can derive (11_4) in one of two ways. (i) A first evacuation Chomsky-adjoins 'every philosopher' to the S node of the original SF representation to produce the "intermediate" representation (11_5):

(11_5) [$_S$ [every philosopher]$_1$ [$_S$ e_1 respects [some linguist]$_2$]].

A second evacuation Chomsky-adjoins 'some linguist' to the higher S node of (11_5) to produce the LF representation (11_4). (ii) Alternatively, a first evacuation Chomsky-adjoins 'some linguist' to the S node of the original SF representation to produce the intermediate representation (11_6):

(11_6) [$_S$ [some linguist]$_2$ [$_S$ [every philosopher]$_1$ respects e_2]].

And a second evacuation Chomsky-adjoins 'every philosopher' to the *lower* S node of the intermediate representation (11_6) to produce the LF representation (11_4).

A general point about redundancy should be taken up here. I am assuming that exactly one quantifier is evacuated at a time. For any sentence ⟨SS, LF⟩,

[22] Higginbotham (1987). In principle, we might also find two sentences that differ in respect of SF representation but not in respect of LF representation. Examples might be (i) and (ii), where each is construed as the sentence on which 'someone' has small scope:

(i) Someone is certain to win the lottery

(ii) It is certain someone will win the lottery.

For further discussion of such constructions, see note 64.

let us say that the sentence has one or more *LF Histories*: an LF History is a sequence of representations $\langle R_1,\ldots, R_n\rangle$, where R_1 is SS, R_n (for $n > 1$) is LF, and each R_k results from R_{k-1} after at most one evacuation. Let us now say that for any $k > 1$, a representation R_k in an LF History is a *candidate-LF* representation. Finally, let us say that if a candidate-LF representation satisfies the conditions on well-formedness for LF representations, it is an LF representation (we can now eliminate talk of "intermediate" representations).

The sentence $\langle(11), (11_4)\rangle$ has two distinct LF Histories: $\langle(11), (11_5), (11_4)\rangle$ and $\langle(11), (11_6), (11_4)\rangle$. (Similarly, $\langle(11), (11_3)\rangle$ has two distinct LF Histories.) Now it might be thought that the theory ought to be tightened up so as to eliminate unnecessary redundancy. So it might be suggested that a sentence $\langle$SS, LF$\rangle$ should have exactly one LF History, and that a theory with this desirable consequence will result if evacuated QNPs adjoin only to the *topmost* S node of the relevant representation. Whatever the aesthetic merits of such a proposal, it is known to be empirically deficient. The following strings containing verbs of propositional attitude make the point very clearly:

(12) Bill thinks that someone downstairs is following him
(13) Bill thinks that the person upstairs is ignoring him.

Each of these strings is ambiguous between a *de re* and a *de dicto* reading. Following Russell, it is usual to account for this ambiguity in terms of the scopes of the quantified NPs ('someone' and 'the person who lives upstairs', respectively). Take (12). This is ambiguous between (12_1) and (12_2):

(13_1) Bill_2 thinks that ([the_1 man upstairs $x_1]_1$ (x_1 is ignoring him_2))
(13_2) [the_1 man upstairs $x_1]_1$ (Bill thinks that (x_1 is ignoring him_2)).[23]

While the LF associated with (13_2) can be derived from SF by Chomsky-adjoining the quantifier to the higher *S* node, in order to derive the LF associated with (13_1) the quantifier must be adjoined to the *lower* S node. To

[23] I hope this point is clear despite the fact that I make no attempt to provide the additional axioms necessary to provide a truth definition for an extension of RQ containing verbs of propositional attitude! As is well known, there are tremendous philosophical and technical problems involved in attempting to provide such axioms. Suffice to say they will have to comport with the fact that (13) is the surface manifestation of (at least) two sentences that do not entail one another. (For interesting attempts to overcome the main problems, see Davidson (1968) and Larson and Ludlow (forthcoming).)

As pointed out by Smullyan (1948), the same sort of ambiguity is found in constructions containing modal operators and descriptions:

(i) The first person to climb Kilimanjaro might have been American
(ii) The number of planets is necessarily odd.

By comparison with attitude verbs, modal adverbs do not create very much difficulty when it comes to formulating axioms that bring them within the purview of a truth definition (see Peacocke (1978) and Davies (1981)). As pointed out by Kripke (1977), the ambiguities of scope in attitude and modal constructions predicted by Russell's theory cannot be replaced by some sort of ambiguity in the definite article.

my mind this demonstrates conclusively that if we are to follow Russell in capturing *de re-de dicto* ambiguities in terms of scope permutations (and I think we must), an adequate theory of LF, as currently understood, must allow evacuated QNPs to adjoin to S nodes other than the topmost S node. (there are also examples involving anaphora that demonstrate the same point (see below), but I do not want rely on facts involving anaphora before saying something about anaphoric matters more generally).[24] For the present, then, I shall maintain that evacuated QNPs may adjoin to any superior *S* node.[25]

The original motivation in logic for wanting to allow quantifier permutation within a "sentence" was of course the desire to capture readings with distinct truth conditions. But as is well known, permuting quantifiers does not always result in a difference in truth conditions. For example, the truth conditions of neither (14) nor (15) are sensitive to which quantifier has larger scope:

(14) Every philosopher respects every linguist
(15) Some linguist respects some philosopher.

Of course, the version of the LF theory I am advocating declares that each of (14) and (15) is the surface manifestation of two distinct but logically equivalent sentences. This might strike some people as introducing yet another unnecessary redundancy; but again I think this is illusory. First, as theorists we should be striving after the most general and aesthetically satisfying theory, and the fact that no truth-conditional differences result from scope permutations in *some* simple sentences is of no great importance by itself. It should be noted that, contrary to what some people have claimed, in order to produce such examples, it is neither necessary nor sufficient to use the same determiner twice. That it is not necessary was observed in *Principia Mathematica* by Whitehead and Russell who pointed out that scope interactions involving definite descriptions and some other quantifiers are truth-conditionally inert. For example, (16) is the surface form of two distinct sentences, the LFs of which are (16_1) and (16_2):

(16) The man upstairs owns a bicycle
(16_1) [the_1 man upstairs x_1]$_1$ ([a_2 bicycle x_2]$_2$ (x_1 owns x_2))
(16_2) [a_2 bicycle x_2]$_2$ ([the_1 man upstairs x_1]$_1$ (x_1 owns x_2)).

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24 Other ways have been suggested for capturing such ambiguities but they have not met with much success. For discussion, see Kripke (1977), Neale (1990), and Ludlow and Neale (1991).

25 A question that naturally arises at this point is whether evacuated QNPs can adjoin only to S nodes. There may well be reasons for holding that evacuees may adjoin to *any* superior node (or any superior node of specified types (e.g. maximal projections), or for that matter *any node at all*, superior or not). This is not a matter for *a priori* stipulation, it is a question for empirical research. For discussion, see May (1985).

Yet (16_1) and (16_2) are logically equivalent. Similarly (17):

(17) Every bandit talked to the sheriff.

That it is not sufficient follows from the fact that (e.g.) 'most' is not self commutative.

In my view, the real moral that emerges from reflecting on examples like (14)-(17) is that they reinforce the working assumption that a theory of logical form is rather more than a theory that associates a sentence of a well-behaved formal language with each sentence of a natural language. If the best syntax and semantics we have both say (or jointly entail) that there are two distinct logical forms associated with some particular string, then it would be absurd to claim that the string in question is not the surface form of two distinct sentences just because the two purported LFs are logically equivalent. My point here is not the familiar point that truth conditions are not fine-grained enough to serve as propositions or meanings. This matter is irrelevant to the point at hand—but notice that although, say, (16_1) and (16_2) are truth-conditionally equivalent, the axioms of the truth definition will apply in a different order, and to that extent there may still be room for the truth-conditional semanticist to say that the sentences differ *semantically*. My point is much simpler. We all accept that the string "Visiting professors can be a nuisance" is the surface manifestation of two distinct sentences with distinct truth conditions, and we don't mind saying this even though the two sentences are written and sound alike. Equally, we all accept that "Bill sold Mary a car" and "Mary bought a car from Bill" are the surface manifestations of two distinct sentences with the same truth conditions. So neither the "surface sameness" of two purported sentences nor the "truth-conditional sameness" of two purported sentences is sufficient to demonstrate that a single sentence is actually under scrutiny. And as far as I can see, there is no compelling reason to think that the combination of surface sameness and truth-conditional sameness demonstrates this either. So there is no compelling reason to reject the view that each of (14)-(17) is the surface manifestation of a pair of sentences. At times we must let the theory decide. If the best syntax and semantics we have say there are two distinct sentences corresponding to a single string, so be it.[26]

[26] In response to all this, it might be countered that the absence of a difference in truth conditions for (16_1) and (16_2) lends support to the view that descriptions are *not* regular QNPs that admit of various scope assignments (This appears to be the view of Hornstein (1984), who uses examples similar to (16) and (17) to motivate his view that descriptions are always interpreted as if they took wide interpretive scope, something he sees as explicable on the assumption that descriptions are more like referring expressions than quantifiers that undergo QNP-evacuation. As argued in detail by Soames (1987) and Neale (1990), Hornstein's view is fraught with philosophical and technical problems.) However, there is plenty of evidence against this approach, much of which involves truth-conditionally active scope permutations. For example, as Russell observed, scope matters in (i) just as much as it does in (ii):

I want now to turn to those anaphoric pronouns that function as bound variables.

4. BOUND-VARIABLE ANAPHORA

The study of anaphora brings up a variety of interesting questions about the relationship between semantics and syntax; and as many linguists working within Chomsky's Extended Standard Theory have argued, the syntactical level LF seems to cast a lot of light in this domain. For concreteness, let us say (provisionally) that

(C) An expression α is *anaphoric* on an expression β if and only if (i) the semantical value of α is determined, at least in part, by the semantical value of β, and (ii) β is not a constituent of α.

Where α is anaphoric on β, let's say (again, provisionally) that β is the *antecedent* of α.

Any adequate grammatical theory must provide an account of when a pronoun can be understood as anaphoric on some other NP (a name, a demonstrative, a restricted quantifier, another pronoun, or even an empty NP such as PRO or trace). In addition, for every sentence *S* containing a pronoun *P* that is understood as anaphoric on some other NP, an adequate semantical theory must provide an account of the contribution that *P* makes to the truth conditions of *S*. Where the antecedent is a referring expression such as a name, it is plausible to suppose that the pronoun refers to the same thing as its antecedent and that this effectively answers any truth-conditional questions we might have about *P*.[27] The axioms of the truth theory for RQ ensure that a referring expression in a sentence S contributes just its bearer to a specification of the truth conditions of *S*. For example, the axiom

(i) Ref('Chomsky', *s*) = Chomsky

(i) Fred thinks that the person who lives upstairs is a spy

(ii) Fred thinks that someone who lives upstairs is a spy.

And as Russell also pointed out, even within the relative safety of extensional constructions, the scope of a description is important. Russell makes the point with the sentence 'the king of France is not bald', which he claims has two readings according as the description or the negation has larger scope. Within the framework we have in place, we can bolster Russell's point by considering sentences that contain a description together with a quantifier that is monotone decreasing:

(iii) Few women have met the king of France.

[27] See Soames (1990) for examples that suggest this may be too simplistic a picture.

ensures that 'Chomsky' contributes Chomsky to a specification of the truth conditions of a sentence containing 'Chomsky'.[28] Intuitively, a pronoun anaphoric on 'Chomsky' ought to do exactly the same.

It will be instructive to say a little more about how this can be effected before we examine the semantics of pronouns anaphoric on quantifiers. There are several ways one might proceed here and I shall select one that seems to me not wholly without merit. Consider (18) on the reading upon which 'he' is understood as anaphoric on 'Chomsky':[29]

(18) Chomsky$_2$ likes the book he$_2$ bought.

As is customary, I have indicated the anaphoric connection by "coindexing" the NPs 'Chomsky' and 'he', i.e. by giving them matching numerical subscripts. Coindexing noun phrases in this way is more than just a way of indicating anaphoric connections to other linguists. Typically, indices are taken to be elements of syntax that are semantically relevant. If α is anaphoric on β then α is coindexed with β. However, it would be a mistake to equate "α is coindexed with β" and "α is anaphoric on β": (i) *being coindexed with* is a symmetric relation whereas *being anaphoric on* is an asymmetric relation; (ii) *being coindexed with* is syntactical relation whereas *being anaphoric on* is a semantical relation.

For concreteness, let us say (provisionally) that

(D) A pronoun P_k that is anaphoric on a referring expression R_k is understood as R_k.

(The matter of the precise status of (D) vis-a-vis LF and truth definitions will be taken up later.) In effect, then, the LF (18$_1$) will be understood as (18$_2$):

(18$_1$) [the$_1$ book he$_2$ bought]$_1$ [$_S$ Chomsky$_2$ likes e_1]

(18$_2$) [the$_1$ book x_1 & Chomsky bought x_1]$_1$
(Chomsky likes x_1).

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28 I am suppressing the difficulties raised by occurrences of names in the referentially opaque contexts created by verbs of propositional attitude. Contrary to what some people have thought, modal contexts are not referentially opaque (see *Descriptions* ch 4), so I am suppressing no difficulty raised by names in modal contexts.

29 Not everyone posits a grammatically specified anaphoric link here. For example, according to Lasnik (1976) pronouns refer to salient objects; in the right setting, the referent of 'Chomsky' is one such object, and since Lasnik's rule of noncoreference does not preclude 'Chomsky' and 'he' from being coreferential in (18), one possible way of understanding the sentence has 'he' referring to Chomsky. This approach is criticized by Evans (1980).

I should add that my main point in this section concerns pronouns anaphoric on quantifiers not pronouns anaphoric on referring expressions. Adopting the view that there is a distinct reading of (18) upon which 'he' is anaphoric on 'Chomsky' leads more easily into the discussion of pronouns anaphoric on quantifiers, but no substantial point turns on it. In the light of Evans' paper, it seems clear to me that there is a distinct anaphoric reading of (18) and that Lasnik's theory has serious problems because it is built on a rule of noncoreference.

And this gets the right truth conditions. I suspect that something like this is tacitly assumed by many linguists who are sensitive to matters of truth conditions (though there are, of course, other ways one might proceed that may ultimately turn out to be technically superior).

When it comes to pronouns anaphoric on quantified noun phrases, notoriously matters are more complex. Coindexing the pronoun with its antecedent so as to indicate an anaphoric connection is a start; but then we need to know which axiom of the truth definition to apply to the pronoun. Consider the following:

(19) [Every linguist]$_2$ likes the book he$_2$ bought

(20) [Some linguists]$_3$ dislike philosophers who engage them$_3$

(21) [The president]$_1$ loves his$_1$ wife

(22) [Most linguists]$_1$ admire themselves$_1$

(23) [Few students]$_2$ enjoy their$_2$ oral exams.

Clearly, it will not do to see the pronouns in these examples as subject to the same axioms as their antecedents. (For example, (20) simply does not have the same truth conditions as "some linguists dislike philosophers who engage some linguists.") The right truth conditions will be forthcoming for sentences (19)-(21) if the pronouns are understood as bound variables in the manner familiar from first-order logic, as Quine and Geach have stressed. It is a simple matter to adapt this suggestion to suit the present discussion, and thereby provide the means of handling sentences (22) and (23) as well as (19)-(21). For example, the truth conditions of (19) are given by the following sentence of RQ:

(19_1) [every$_2$ linguist x_2]$_2$ ([the$_1$ book x_1 & x_2 bought x_1]$_1$ (x_2 likes x_1)).

This suggests that we treat 'he$_2$' exactly as we would treat an occurrence of a trace 'e_2', i.e., as an occurrence of the variable 'x_2'. The pronoun will then be subject to an instance of axiom schema (ii).[30]

In general, then, we might provisionally accept the following:

(E) When a pronoun P_k is anaphoric on a c-commanding quantifier $[D_k\ \alpha]_k$, the axiom for x_k applies to P_k.

The net result of all this is that such a pronoun will always be understood as a bound variable; and this appears to deliver the right truth conditions quite generally.

[30] Notice that (19) reinforces Russell's point that the scope of a description matters even in an extensional context: the description itself contains a pronoun bound by a quantifier with larger scope.

Given the usual assumptions of standard logics, it makes no sense of course to talk of a quantifier binding a variable that is not within its scope (its c-command domain). And on the assumption that the scope of an expression in natural language is to be characterized in exactly the same way as the scope of an expression in a standard logic, it will make no sense to talk of a quantified noun phrase binding a pronoun that it does not c-command (at LF). To say all this is not, of course, to deny that a pronoun P may be *anaphoric on* a quantifier Q that does not c-command it at LF; it is just to deny that in such a case P is *bound by* Q, and to maintain that some other account is needed of the semantics of P.

Before looking at a possible semantics for pronouns anaphoric on quantifiers that do not c-command them at LF, we need to find some clear-cut examples.

5. Constraining Evacuation

It is at least arguable that the class of pronouns anaphoric on quantifiers that do not c-command them at LF is identical to the class of pronouns that Evans [1977] demonstrates are not understood as variables bound by those quantifiers. Consider the following:

(24) Jack bought [some cows]$_1$ and Jill vaccinated them$_1$

(25) [Just one man]$_1$ drank rum and he$_1$ was ill this morning.

If the pronoun 'them' in (24) were treated as a variable bound by 'some cows', the quantifier would have to be understood as taking scope over the connective 'and', and so the truth conditions of (24) would be given by (24$_1$):

(24$_1$) [some$_1$ cows x_1]$_1$ (Jack bought x_1 and Jill vaccinated x_1).

But (24$_1$) captures the truth conditions of "Jack bought some cows that Jill vaccinated" not the truth conditions of (24). Suppose Jack bought a dozen cows and Jill vaccinated only six of them. In such a situation, (24$_1$) is true but (24) is false.

Similarly, there would be trouble ahead if we attempted to treat the pronoun 'he' in (25) as a variable bound by 'just one man'. This time we would need to understand the quantifier as taking scope over 'and', and so the truth conditions of (25) would be given by (25$_1$):

(25$_1$) [just one$_1$ man x_1]$_1$ (x_1 drank rum and x_1 was ill this morning).

But (25$_1$) captures the truth conditions of "Just one man drank rum and was ill this morning," not the truth conditions of (25). Suppose two men drank rum and only one was ill this morning. In such a situation (25_1) is true but (25) is false.

Before examining a plausible semantics for the pronouns in (24), (25), and indefinitely many similar examples, I want to use (24) and (25) to raise a question that the LF theorist must confront: If (i) LF is derived from SF by a series of evacuations, and (ii) the SF representation of a conjunction 'α and β' contains two subsentences as in the structure

$[_{S0}\ [_{S1}\ \alpha\ ]$ and $[_{S2}\ \beta]]$

then some sort of constraint on evacuation appears to be required to prevent a QNP that is a constituent of S1 (or S2) in such a structure (whether or not S0 is a constituent of a larger S) from Chomsky-adjoining to S0. For without such a constraint the LFs (24_2) and (25_2) could be derived from the SFs for (24) and (25):

(24_2) $[_S$ [some cows]$_1$ $[_S$ $[_S$ [Jack bought e_1] and $[_S$ Jill vaccinated them$_1$]]]

(25_2) $[_S$ [just one man]$_1$ $[_S$ $[_S$ e_1 drank rum] and $[_S$ he$_1$ was ill this morning]]].

And in RQ notation (24_2) and (25_2) are just (24_1) and (25_1), which as we have already seen ascribe the wrong truth conditions to (24) and (25).[31]

It would not be a good idea for the LF theorist to pin any hopes on the idea that the relevant constraint on QNP-evacuation is a consequence of any sort of simplistic constraint on the "distance," number of nodes, or number of S nodes between a QNP's LF position and the position it vacates. A possible problem for this line of thought emerges when we turn to propositional attitude constructions. Consider (26):

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[31] It should be pointed out that the data involving sentential conjunction cannot be spirited away by appealing to the fact that 'α and β' is satisfied just in case the pair α, β is satisfied. One reason for this is that the general problem rears its head with binary connectives quite generally. For example, (i) is not understood as (ii):

(i) If Jack buys only one cow, then Jill will milk it

(ii) [only one$_2$ cow x_2] (If Jack buys x_2 then Jill will milk x_2).

Quite generally, then, it would seem that in an SF of the form 'α connective β' the scope of a quantifier inside α does not extend beyond α, and the scope of a quantifier inside β does not extend beyond β.

This has been contested by Hornstein (1984), who argues that quantified NPs of the form 'any *F*', 'each *F*', and 'the *F*' constitute a special class of quantifiers that insist on large scope, to the point of taking large scope in conditionals, conjunctions and the like. Although Hornstein locates his account of quantified NPs within Chomsky's Extended Standard Theory, it is not compatible with the approach I have been taking to quantified NPs, scope, and binding, or the approaches taken by many others working within Chomsky's framework. As it turns out, the data that Hornstein claims to capture by treating 'any *F*', 'each *F*', and 'the *F*' as fundamentally different from 'every *F*', 'some *F*', 'an *F*', 'most *F*s', 'no *F*s' etc. are perfectly well accounted for within a theory that treats them all as quantifiers that respect the constraint on scope given above (see *Descriptions,* chs. 4 and 6)). This is fortunate as it is easily shown that 'any *F*', 'each *F*', and 'the *F*' do not possess the properties that they need to possess in order to be treated in the way Hornstein envisages; in particular, it is simply false that they always enjoy large scope.

(26) $[_{S0}$ Watson doubts that $[_{S1}$ Holmes thinks
$[_{S2}$ [the man who lives upstairs]$_1$ is insane]]].

As pointed out by Kripke [1977], this string has three distinct readings according as the description 'the man who lives upstairs' is given large, intermediate, or small scope. So the QNP must be able to Chomsky-adjoin to S0, S1, or S2.[32] Of interest to us is the fact that on the reading in which the description has large scope, several S nodes intervene between the description and its SF position. This suggests very strongly that any apparent constraint on evacuation must reside in the nature of the mapping between SF and LF rather than in the final resting place of an evacuee. Consider the following sentence, which in crucial respects differs from (26) only in containing the *wh*-phrase 'which man' instead of the QNP 'the man who lives upstairs':

(26_1) [which man]$_1$ $[_{S0}$ (does) Watson doubt that
$[_{S1}$ Holmes thinks $[_{S2}$ e_1 is insane]]].

On the assumption that the *wh*-phrase occupies the position marked 'e_1' at D-Structure, it is clear that a simplistic constraint on the "distance," number of nodes, or number of S nodes between a *wh*-phrase's SF (or LF position) and the position it originally occupied will fail. However, there are good reasons for thinking that the *transformational process*—if we allow ourselves this anachronistic way of talking for the moment—involved in deriving (26_1) from D-Structure is subject to a constraint on the number of nodes of a certain specified type across which it may "move" an expression in one go.[33]

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[32] Kripke also points out that it is not possible to mimic the readings obtained by allowing the description to take various scopes by postulating some sort of "referential-attributive" ambiguity. Besides, such an ambiguity would have to be extended to quantifiers quite generally and also runs into serious empirical difficulties. For detailed discussion, see *Descriptions*, chs. 3 and 4.

[33] Cf. Chomsky's *Subjacency Condition.* It has been suggested to me by several linguists that something approximating Ross's Coordinate Structure Constraint (CSC)—or a more general principle from which the CSC can be deduced—needs to be appealed to constrain QNP-evacuation. Ross argues that there is a quite general prohibition on movement of phrases out of coordinate structures, i.e. structures of the form "α connective β' where α and β are of the same phrasal category (e.g., S, NP, or VP). I lack the knowledge of syntactical theory necessary to pursue this matter in any sort of detail, but it does seem to me that there are several worries with a straightforward appeal to the CSC. For one thing, it is not at all clear how something like this constraint can find a place within current theory. For another, it appears that QNPs can move out of some coordinate structures, such as coordinate NPs and coordinate VPs. For example, it is arguable that the LF of (i) is given by (ii), where the QNP has been moved out of a coordinate VP:

(i) Chomsky is reading *Othello* and watching a movie

(ii) $[_S$ $[_{NP}$ a movie]$_1$ $[_s$ $[_{NP}$ Chomsky]
$[_{VP}$ is reading *Othello* and watching e_1]]].

If the LF of (i) is indeed (ii), although the grammaticality of (i) would conflict with the CSC, it would still be consistent with a weaker constraint to the effect that no phrase may be moved out of coordinated *sentences*. Alternatively, if there are good reasons for holding onto the CSC, the grammaticality of (i) might be taken to show that (ii) is not its LF, and that evacuated QNPs may adjoin to phrases other than S, for example, VP. (Richard Larson has

6. *WH*-PHRASES AS INTERROGATIVE QUANTIFIERS

Corresponding to the simple indicative sentence "Halle is reading a play," English contains (at least) two interrogative sentences (27) and (28):

(27) Which play is Halle reading?
(28) Which linguist is reading a play?

The interesting fact about (27) and (28) concerns the interpretation of the so-called *wh*-phrases 'which play' and 'which linguist'. As Chomsky has stressed for many years, at LF *wh*-phrases function very much like quantified NPs: (27) is understood as "which play x is such that Halle is reading x?" and (28) is understood as "which linguist y is such that there is a play x such that y is reading x?"[34] Thus we might posit the following LFs:

(27_1) [[which play]$_2$ [$_S$ Halle is reading e_2]].
(28_1) [[which linguist]$_1$ [$_S$ [a play]$_2$ [$_S$ e_1 is reading e_2]]].

For immediate purposes, my interest in the interrogative determiner 'which' is syntactical rather than semantical, but the general semantical idea would be that in a suitable extension of RQ with quantificational axioms for singular and plural occurrences of 'which', these LFs are understood as (27_2) and (28_2) respectively:

(27_2) [which$_2$ play x_2]$_2$ (Halle is reading x_2).
(28_2) [which$_1$ linguist x_1]$_1$ ([a$_2$ play x_2]$_2$ (x_1 is reading x_2)).[35]

As I said, my immediate concern is syntactical. However, in the hope that QNP-evacuation and *wh*-movement can be seen as instances of the same general phenomenon (as Chomsky has suggested, of course), let me say a little about Chomsky's conception of *wh*-movement as I understand it. On Chomsky's account, whereas the evacuation of ordinary quantified NPs takes place between SF and LF, evacuation of *wh*-phrases takes place between D-Structure and SF. Thus the D-Structure representation of (28), given by (28_3), is transformed into the SF representation (28_4):

(28_3) [$_S$ [which linguist]$_1$ is reading [a play]$_2$]
(28_4) [[which linguist]$_1$ [$_S$ e_1 is reading [a play]$_2$]].

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suggested to me that there are reasons for thinking that an empirically and explanatorily superior theory will emerge if evacuees may adjoin to any maximal projection.)

34 Chomsky (1975, 1986).

35 For discussion, see Chomsky (1975, 1977), Evans (1977, 1977a), and Higginbotham and May (1981).

That is, at SF the *wh*-phrase evacuates to an operator position that c-commands the vacated position, that position now being occupied by a coindexed trace. At LF the quantified NP ‘a play’ evacuates to an operator position that c-commands the vacated position, that position now being occupied by a coindexed trace to produce the LF (28_1). No further “movement” is either necessary or possible: in accordance with earlier remarks, each trace functions as a variable bound by its antecedent. The null hypothesis is that in any natural language, at LF both *wh*-phrases and quantified noun phrases have evacuated their D-Structure positions and function as sentential operators. In English, *wh*-evacuation (typically) takes place between D-Structure and SF whereas QNP-evacuation takes place between SF and LF.[36] In principle, other languages might exploit the possibility of (e.g.) QNP-evacuation taking place between D-Structure and SF or *wh*-movement taking place between SF and LF. We have here what Chomsky takes to be a “parametric difference” between languages.[37] For example, in Chinese and Japanese *wh*-evacuation takes place between SF and LF.[38]

The upshot of this is that we can talk about the evacuation of what I shall call *Structured* NPs or SNPs (i.e., *wh*-NPs and QNPs phrases) in two different ways. For some purposes we may want to talk of *wh*-evacuation and QNP-evacuation; for other purposes we may want to talk about what we might call SF evacuation (the evacuation of SNPs between D-Structure and SF) and LF evacuation (the evacuation of SNPs between SF and LF). Later, I shall suggest that SNP-movement quite generally is the result of a general condition on the well-formedness of LF representations: (roughly) every argument position must be occupied by a name or a variable (i.e. by a rigidly referential expression subject to a single axiom of the form “Ref(α, s) = x”).

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[36] The parenthetical “typically” seems to be needed because of the possibility of questions like the following in which it is at least arguable that *wh*-evacuation takes place between SF and LF:

(i) Bill saw WHOM?
(ii) Halle and which linguist wrote *SPE*?
(iii) Who read what?

On this matter, see Pesetsky (1987).

[37] On Chomsky’s account, we should explore the view that the guts of a given language can be more or less identified with the settings of a number of parameters that characterize the most important differences between particular natural languages. I have no quarrel with this claim. Indeed, it seems to me like a perfectly reasonable idea to pursue given the power of Chomsky’s own philosophical and empirical discussions of innateness and modularity. For discussion, see Chomsky (1980, 1986).

[38] Huang (1982); Chomsky (1986); Pesetsky (1987).

7. Dispensing with LF?

A view shared by many philosophers, logicians, and linguists with otherwise disparate views about semantics is that there is little to be gained either by pairing sentences of natural language with sentences of a formal language prior to semantical interpretation or by postulating a level of syntactical representation that has the properties I have here ascribed to LF.[39] That is, there seems to be a feeling that semantical rules ought to apply directly to SF representations (or something akin to SF representations). Some semanticists of this persuasion have gestured toward Grice's [1969] work on quantifier "indexing," Cooper's [1983] work on quantifier "storage" and "retrieval," or Hintikka's [1987] work on game-theoretic semantics suggesting that mechanisms based on ideas found in such works obviate the need for LF (or for translation into a formal language).

There are many issues that one could take up here, conceptual, methodological, and empirical. For present purposes, I want to address just one issue that has both a methodological and empirical flavor. I have no doubt that it is possible to capture all of the relevant facts about quantifier scope within a theory that does not make use of LF. But I fail to see the importance of this fact by itself. This is the usual situation in any empirical inquiry: if it is possible to construct a theory $\theta 1$ that accounts for a certain range of data, it is nearly always possible to construct a distinct theory $\theta 2$ that will account for the same range of data. New data will often be of use in eliminating *some* rival theories, but the general problem of underdetermination will persist and is of no real consequence. Ultimately, aesthetic and methodological considerations will lead the way. It might be thought advantageous to do without LF on the grounds that an additional level of syntactical representation "transformationally derived" from SF just adds an unnecessary level of complexity to the grammar. But of course an additional level of syntax may allow the theorist to discard other parts of the theory or effect all sorts of simplifications elsewhere in the theory. Moreover, it may make it much easier for the grammarian to address such matters as the similarities and differences between human languages, language acquisition, and language change. The issue simply cannot be prejudged on the basis of *a priori* speculation.

39 Carlson (1983); Cooper (1983); Etchemendy (1983); Hintikka (1989); Hintikka and Sandu (1990); Reinhart (1983); Williams (1987). It should be stressed that some linguists working within Chomsky's general framework appear to be just as anxious to get rid of LF as many linguists and philosophers working in alternative frameworks.

In principle, a theory that appeals to a "hidden" level of syntax may end up explaining a range of data in a more economical and systematic fashion than a theory that does not posit such a level. The history of the study of grammar under Chomsky testifies to this. An extraordinary range of data has turned out to be amenable to systematic treatment within successive two- or three-tiered syntactical theories, data that seem to resist aesthetically satisfying treatments within approaches that dogmatically insist upon a single level of syntactical representation.

Examples such as (24) and (25) demonstrate quite conclusively that there must be some sort of constraint on when a pronoun anaphoric on a QNP is understood as a variable bound by that NP:

(24) Jack bought [some cows]$_1$ and Jill vaccinated them$_1$

(25) [Just one man]$_1$ drank rum and he$_1$ was ill this morning.

Now it might be thought that LF is more of a hindrance than a help here, that no appeal to such a level is needed to specify the relevant syntactical constraint, that it can be stated in terms of SF representations. Certainly Evans does not appeal to LF in specifying what he takes to be the right constraint (he may not have been aware of LF at the time (1977) he wrote his original paper). In effect, Evans claims that a pronoun *P* cannot be bound by a QNP *Q* unless *Q* c-commands *P* at SF.[40] So it might be thought natural for the theorist who disavows LF and handles QNP scope in some other way to maintain that it is because the QNPs c-command the pronouns at SF that the pronouns are understood as bound variables in (19)-(23):

(19) [Every linguist]$_2$ likes the book he$_2$ bought

(20) [Some linguists]$_3$ dislike philosophers who engage them$_3$

(21) [The president]$_1$ loves his$_1$ wife

(22) [Most linguists]$_1$ admire themselves$_1$

(23) [Few students]$_2$ enjoy their$_2$ oral exams.

Additionally, on such an account, the pronouns in (24) and (25) cannot be understood as variables bound by their antecedents because the QNPs do not c-command the pronouns at SF.

Although Evans's SF constraint makes the right predictions in these and many other cases, ultimately I think it fails. For as Robert May has stressed, there are sentences in which pronouns seem to be understood as bound by QNPs that do not c-command them at SF but which do c-command them at LF:[41]

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[40] See also Davies (1981).

[41] May (1987).

(29) [the father of [each girl]$_2$]$_1$ waved to her$_2$

(30) [some man from [every city]$_2$]$_1$ despises it$_2$

(31) [every linguist in [some department I know]$_2$]$_1$
would leave it$_2$ at the first opportunity.

The special feature of these examples is that in each case the subject QNP contains, as a proper part, another QNP that (a) is understood with largest scope and (b) binds a subsequent pronoun. To see exactly how the LFs of such examples are derived, let's go through May's example (30). Evacuating the subject quantifier to the top of the tree yields the intermediate representation (30$_1$):

(30$_1$) [$_S$ [some man from [every city]$_2$]$_1$ [$_S$ e_1 despises it$_2$]].

Evacuating 'every city' to the top of the intermediate tree gives us(30$_2$),

(30$_2$) [$_S$ [every city]$_2$ [$_S$ [some man from e_2]$_1$ [$_S$ e_1 despises it$_2$]]].

which in RQ notation is just (30$_3$):

(30$_3$) [every$_2$ city x_2]$_2$ ([some$_1$ man x_1 & x_1 is from x_2]$_1$ (x_1 despises x_2)).

And (30$_3$) has exactly the right truth conditions. In the LF representation (30$_2$) the pronoun 'it' is within the scope of (i.e. c-commanded by) 'every city', so by the Bach-Harman-Lakoff-McCawley (BHLM) Thesis—an expressions's scope is everything it c-commands (at LF)—the pronoun is legitimately understood as a variable bound by that QNP; and from a truth-conditional perspective this turns out to be exactly right, witness the fidelity of (30$_3$. In short, the LF theorist has a very elegant explanation of the fact that (30$_3$) gives the truth conditions of (30). Similarly with (29) and (31) (and an indefinite number of similar examples). If we were to state a descriptive generalization, it would be the following: a pronoun *P* can be understood as a variable bound by a QNP *Q* only if *Q* c-commands *P* at LF. But of course this doesn't need to be stated anywhere in the theory: it is a trivial consequence of the BHLM Thesis, which is itself a consequence of the general theory.

Of course, the foregoing cannot be construed as any sort of knock-down argument for LF. Positive proposals are to be put forward with their empirical and aesthetic merits and defects clearly on display; alternative proposals can then be compared on both fronts. Both the empirical and aesthetic merits of the LF proposal are now clear. The challenge to the theorist who wants to dispense with LF, then, is to provide a complete account of the syntax and semantics of the quantifier-pronoun relation in (30) and similar sentences such as (29) and (31). First off, the no-LF theorist must provide a syntactical characterization of when a pronoun anaphoric on a QNP is understood as a bound variable and a semantics for such pronouns. Additionally, if the syntactical characterization that is put forward rules that the anaphoric pronoun 'it' in (30) is *not* a bound variable, the no-LF theorist must provide a semantics for unbound anaphoric pronouns that ascribes to (30) the truth conditions stated by (30_3). (Of course, the no-LF theorist is not required to view (30_3) as *giving the logical form* of (30). He or she must simply produce a theory that delivers the right truth conditions for (30); and the right truth conditions are given by (30_3), which the no-LF theorist is at liberty to view as a sentence of just another formal language, rather than as a simplification of the official LF (30_2).)

The problem facing the no-LF theorist stems from the following observations: (i) examples such as (24) and (25) demonstrate very clearly that there must be a constraint on when a pronoun anaphoric on a QNP can be understood as a bound variable; (ii) the QNP 'every city_2' does not c-command the pronoun 'it_2' at SF in (30). The situation, then, is as follows: the no-LF theorist who wants to treat the pronoun in (30) as a bound variable, cannot maintain that a pronoun *P* bound by a QNP *Q* must be c-commanded by *Q* at SF; some other constraint needs to be provided; by the same token, the no-LF theorist who wants to treat the pronoun in (30) as unbound because it is not c-commanded by its antecedent at SF needs to provide an independently motivated theory of unbound anaphora that delivers a reading for (30) that is equivalent to (30_3). It is not acceptable just to dogmatically assert that the pronouns in (29)-(31) are unbound anaphors and leave matters there.[42] After all, the LF theorist's bound variable analysis does deliver the right truth conditions for each of (29)-(31). So anyone who wants to treat the pronouns in these examples as unbound anaphors is under an obligation to provide a systematic semantics that delivers the same truth conditions as those delivered by the LF theory.

8. LF AND D-TYPE ANAPHORA.

The considerations adduced thus far suggest that any finally acceptable theory of pronominal anaphora, whether or not it makes use of LF, will have to contain, in addition to the subtheory of bound anaphora, a subtheory of unbound anaphora that applies to cross-clausal anaphora of the sort exemplified in (24) and (25):

[42] Reinhart (1983).

(24) Jack bought [some cows]$_1$ and Jill vaccinated them$_1$

(25) [Just one man]$_1$ drank rum and he$_1$ was ill this morning.

Both the LF theorist and the No-LF theorist want to treat the pronouns in these examples as not bound by their antecedents.

Interestingly, the most promising approach to such pronouns is Russellian: such pronouns are *quantificational* by virtue of being equivalent to definite descriptions.[43] The singular pronoun 'he' in (25) is understood as the singular description 'the man who drank rum'; and the plural pronoun 'them' in (24) seems to be understood as the plural description 'the cows Jack bought'. That is, (24) and (25) seem to be understood as equivalent to (24$_2$) and (25$_2$) respectively:

(24$_3$) Jack bought some cows and Jill vaccinated the cows Jack bought.

(25$_3$) Just one man drank rum and the man who drank rum was ill this morning.

These results appear to be forthcoming on the Evans-inspired theory I presented in *Descriptions,* according to which a pronoun P that is anaphoric on a quantifier Q that does not c-command P at LF is understood as a definite description typically recovered from Q and everything Q c-commands at LF. Adapting that idea to the present discussion, we get the following:

(F) If a pronoun P_k is anaphoric on but not within the scope β of an SNP $[D_k\ \alpha]_k$ then P_k is understood as $[the_k\ \alpha\ \&\ \beta]_k$.[44]

But what is the precise status of (F) vis-a-vis an adequate truth definition and its role within a theory of LF? Before addressing this matter, I want to make clear the intuitive force of (F) itself. The logical form of the first conjunct of (25) is

(25$_4$) [just one$_1$ man x_1] (x_1 drank rum).

Since the pronoun 'he$_1$' in the second conjunct is not c-commanded by 'just one man' at LF, by (F), the pronoun will be understood as

(25$_5$) [the$_1$ man x_1 & x_1 drank rum].

And so (25) as a whole will be understood as

[43] Evans (1977); Davies (1981); Neale (1990). As the last two point out, although such pronouns are typically equivalent to phrases of the form 'the *F*', in certain cases the precise semantical character of the determiner may be sensitive to information derived from linguistic or nonlinguistic context. This is an unexciting fact and (contrary to some opinion) attempts to formulate rules for determining the precise mathematical character of the determiner in this or that context should be viewed as attempts at fine-tuning rather than attempts to provide anything more substantial.

[44] This is too narrow as stated, but it will suffice for present concerns.

(25_6) [just one_1 man x_1]$_1$ (x_1 drank rum) &
[the_1 man x_1 & x_1 drank rum]$_1$ (x_1 was ill this morning).

By the same process, (24) will be understood as

(24_4) [some_1 cows x_1]$_1$ (Jack bought x_1) &
[the_1 cows x_1 & Jack bought x_1]$_1$ (Jill vaccinated x_1).

And (24_4) and (25_6) correctly characterize the truth conditions of (24) and (25).

Similarly, where the antecedent is a *wh*-phrase as in (32):

(32) [which man]$_1$ drank rum and which waitress served him_1?

The logical form of the first conjunct of (32) is

(32_1) [which_1 man x_1] (x_1 drank rum).

Since the pronoun 'him_1' in the second conjunct is not c-commanded by 'which man' at LF, by (F), the pronoun will be understood as (32_2) [= (25_4)]:

(32_2) [the_1 man x_1 & x_1 drank rum].

And so (32) as a whole will be understood as

(32_3) [which_1 man x_1]$_1$ (x_1 drank rum) & [which_2 waitress x_2]$_2$
([the_1 man x_1 & x_1 drank rum]$_1$ (x_2 served x_1)).

We can call any pronoun that is understood as equivalent to a definite description a *D-type* pronoun. (The label "D-type" (borrowed loosely from Sommers [1982]), is meant to conjure up both the similarities and differences between D-type pronouns and Evans' [1977, 1980] *E-type* pronouns. The differences, which are crucial, are discussed below.)

In the light of the LF theorist's success with examples (29)-(31) from the previous section, the LF theorist who endorses a D-type account of pronouns anaphoric on QNPs that do not c-command them at LF looks to be in a very attractive position. In conjunction with the axioms for the various determiners, the axiom schema for variables provides a plausible semantics for pronouns anaphoric on c-commanding quantifiers. And in conjunction with Principle (F) the axioms for 'the'—axioms (ix) and (x) from section 2—seem to provide a plausible semantics for pronouns anaphoric on non-c-commanding quantifiers.

But there is still plenty of work to be done if the D-type theory of unbound anaphora is to form part of a general theory that appeals to LF as I am construing it. Since I discussed the general merits of D-type theories of unbound anaphora in *Descriptions*, I will not dwell on the matter here, except to say that the general picture can be spelled out in many ways; and with sufficient care it is possible to spell out versions that cope rather well with a number of interesting problems, such as those created by "donkey anaphora" and "crossing."[45] The question I am interested in right now is one I did not take up earlier: On the assumption that a theory of D-type anaphora presents the LF theorist with a plausible semantics for unbound anaphoric pronouns (with quantified antecedents), what is the most profitable way of viewing the relationship between the SF and LF representations of sentences containing D-type pronouns? At the time I was writing *Descriptions*, I was not particularly interested in this question because it did not impinge upon my general thesis. Having thought more about LF itself in the course of writing the present paper, this question now seems to me like rather an interesting and important one.

In order that we do not set off on the wrong foot, let me begin by stressing that a D-type interpretation of unbound anaphoric pronouns is most definitely not the same thing as an Evansian E-type interpretation. It has been my impression that some people are not particularly inclined to keep these notions apart. For the philosophical grammarian the distinction is absolutely crucial: as Russell pointed out, serious error is the inevitable result of confusing referring expressions and quantifiers in philosophical argumentation. I think it is not too difficult to show that linguists who want to appeal to LF must also pay attention to the distinction. On Evans's account, (i) a pronoun *P* anaphoric on a QNP *Q* is an E-type pronoun if and only if *P* is not c-commanded by *Q* at SF. Furthermore, Evans is explicit that (ii) E-type pronouns are referring expressions whose references are fixed rigidly by description (in the sense of Kripke [1972]). It should be clear, then, that the LF/D-type theorist's Principle (F) does not provide E-type interpretations. (F) is stated in terms of the axioms for 'the'—viz. axioms (ix) and (x) from section 2—and as such any pronouns falling under it are QNPs. This is a syntactically and semantically significant fact: QNPs undergo evacuation and the axioms of the truth definition operate on LF.

On the assumption that (F) is a correct generalization, the indexed pronouns in each of the following examples will be understood as definite descriptions, and hence as QNPs:[46]

(25) [Just one man]$_1$ drank rum and he$_1$ was ill this morning.

(33) [A man]$_1$ has murdered Smith. The police have reason to think he$_1$ injured himself in the process

(34) Next year [a man from Texas]$_1$ will be in charge of the economy and I'm sure he$_1$'ll help the oil business.

[45] Neale (1990, 1990a).

[46] Davies (1981); Soames (1989).

It is important to see that although the pronoun 'he' in (25) is understood as 'the man who drank rum', it does not have its reference fixed by this description, and hence it would be a mistake to think of it is an E-type pronoun. If this occurrence of 'he' had its reference fixed by description, it would refer to the man who actually drank rum—call him 'Gideon'—and so what is expressed by (25) would be true at any circumstance of evaluation in which just one man drank rum and Gideon was ill this morning. But this is clearly wrong, so the occurrence of 'he' in (25) does not receive an E-type interpretation.[47]

Although Evans states explicitly that E-type pronouns are rigid referring expressions, in his formalism they end up being treated as equivalent to Russellian descriptions that insist on large scope.[48] But as many people have observed, even this modified notion of an E-type interpretation will not do because of examples such as (33) and (34). In each case, it is clear that the description 'he' is can be understood with small scope. It is clear, then, that at least some unbound anaphoric pronouns receive D-type rather than (modified) E-type interpretations.

Up to now, the examples of pronouns anaphoric on non-c-commanding QNPs we have examined have all been in structures of the form

$$[_{S0}\ [_{S1} \ldots Q \ldots] \text{ connective } [_{S2} \ldots P \ldots]]$$

where the QNP Q is a constituent S1 and the pronoun P is a constituent of S2. But, notoriously, there is at least one more type of structure—the so-called "donkey" structure—in which it is possible to have a pronoun anaphoric on a non-c-commanding QNP. Let us assume (counterfactually, but harmlessly for immediate concerns) that relative pronouns in restricted relative clauses are bound variables. Thus (35) and (36) are understood as (35_1) and (36_1) respectively:

(35) the linguist who loves Mary is happy
(35_1) [the$_1$ linguist x_1 & (x_1 loves Mary)]$_1$ (x_1 is happy)
(36) the linguist whom Mary loves is happy
(36_1) [the$_1$ linguist x_1 & (Mary loves x_1)]$_1$ (x_1 is happy).[49]

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47 This type of argument against Evans's theory was first presented by Soames (1989).

48 Soames (1989).

49 Following Quine (1960) and Evans (1977), it is customary to think of relative pronouns (as they occur in restrictive relative clauses) as devices of predicate abstraction rather than as variables. On such an account, the logical forms of (35) and (36) are given by (35_2) and (36_2), respectively:

(35_2) [the$_1$ linguist x_1 & $[\lambda x_2](x_2$ loves Mary$)x_1]_1$ (x_1 is happy)
(36_2) [the$_1$ linguist x_1 & $[\lambda x_2]($Mary loves $x_2)x_1]_1$ (x_1 is happy).

However, for simplicity the relative pronouns in (35) and (36) are often thought of as variables bound by determiners since (35_1) and (36_1) are equivalent (by lambda-elimination)

Now consider the following examples:

(37) [which man who bought [a cow]$_2$]$_1$ vaccinated it$_2$?

(38) [every man who bought [some cows]$_2$]$_1$ vaccinated them$_2$.

The interesting feature of (37) and (38) is that even if they admit of readings upon which the embedded QNPs (‘a cow’ and ‘some cows’) have large scope—just as in examples (29)–(31) discussed earlier—it is clear that they have perfectly natural readings upon which the QNPs in question have small scope. But upon such readings the pronouns cannot function as variables bound by the QNPs upon which they are anaphoric as they do not lie within their scopes (the pronouns are not c-commanded by the QNPs):

(37_1) [which$_1$ man x_1 & [a$_2$ cow x_2]$_2$ (x_1 bought x_2)]$_1$ (x_1 vaccinated x_2)

(38_1) [every$_1$ man x_1 & [some$_2$ cows x_2]$_2$ (x_1 bought x_2)]$_1$ (x_1 vaccinated x_2).

In each formula, the final occurrence of ‘x_2’ (corresponding to ‘it’ in (37) and ‘them’ in (38)) fails to be bound by its antecedent. And this corresponds to the fact that on the readings in question, the embedded QNP evacuates only as far as the embedded S node (relative clause).

By (F) above, the pronouns in (37) and (38) receive D-type interpretations. Take (37). The quantifier □‘[D_k α]$_k$’ upon which ‘it’ is anaphoric is ‘[a$_2$ cow x_2]$_2$’ and its scope is ‘(x_1 bought x_2)’. Thus k is ‘2’, α is ‘cow x_2’ and β is ‘(x_1 bought x_2)’. Consequently the description ‘[the$_k$ α & β]$_k$’ that the pronoun ‘it’ is understood as ‘[the$_2$ ‘cow x_2 & (x_1 bought x_2)]$_2$, which contains a free occurrence of x_1. Thus (37) ought to be interpretable as either (37_2) or (37_3), according as the subject quantifier or the D-type pronoun has larger scope:

(37_2) [which$_1$ man x_1 & [a$_2$ cow x_2]$_2$ (x_1 bought x_2)]$_1$
([the$_2$ cow x_2 & (x_1 bought x_2)]$_2$ (x_1 vaccinated x_2))

(37_3) [the$_2$ cow x_2 & (x_1 bought x_2)]$_2$
([which$_1$ man x_1 & [a$_2$ cow x_2]$_2$ (x_1 bought x_2)]$_1$
(x_1 vaccinated x_2)).

(37_3) is not of much use because it contains a free occurrence of ‘x_2’. But (37_2) is fine: it also represents the English sentence (39)

(39) [which man who bought a donkey]$_1$ vaccinated the donkey he$_1$ bought

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to (35_1) and (36_1). In the context of the present paper, one reason for preferring the semantical structures in (35_2) and (36_2) is that they fit well with the view that at LF (and in English at SF) relative pronouns occupy nonargument positions and as such are naturally treated as variable-binding operators. For syntactical considerations that lend support for such a view, see Chomsky [1986), ch 2.

on the reading in which the pronoun 'he' is understood as a variable bound by the subject NP 'which man who bought a donkey', which c-commands it as required. Examples (37) and (38) seem to provide additional evidence, then, that D-type pronouns are not forced in some *ad hoc* way to take large scope.

Taken together, examples (24), (25), (33), (34), (37), and (38) suggest very strongly that a general theory of unbound anaphora can be founded on D-type interpretations. And as I said in *Descriptions*, in the absence of evidence for the existence of (modified) E-type interpretations, I am tempted to suggest that natural languages are simply not the sorts of languages that may contain E-type pronouns. To say this is not to say that the notion of an E-type pronoun is incoherent. On the contrary, it is a simple matter to construct an intelligible artificial language containing such expressions. My claim is an empirical one: such a language would indeed be *artificial*; natural languages are of such a nature that they do not contain E-type pronouns. The difference between E-type and D-type interpretations is, then, very marked. (All the more so if there are, as I shall maintain in section 9, correlated syntactical, semantical and structural differences between referential and quantificational NPs.)

The question facing the LF/*D*-type theorist should now be clear: (i) What is the LF of a sentence containing a *D*-type pronoun? And (ii) how is its LF related to its SF? The SF of (25) is presumably just

(25_7) [$_S$ [$_{NP}$ Just one man]$_1$ drank rum] and [$_S$ he$_1$ was ill this morning].

But what is its LF? Putting aside the way (F) is worded (which is irrelevant to the real issue), three candidates present themselves:

(25_8) [$_S$ [$_{NP}$ Just one man]$_1$ [$_S$ [e_1 drank rum]] and
[$_S$ he$_1$ was ill this morning]]

(25_9) [$_S$ [$_{NP}$ Just one man]$_1$ [$_S$ [e_1 drank rum]] and
[$_S$ [$_{NP}$ he]$_1$ [$_S$ e_1 was ill this morning]]]

(25_{10})[$_S$ [$_{NP}$ Just one man]$_1$ [$_S$ [e_1 drank rum]] and
[$_S$ [$_{NP}$ the man who drank rum]$_1$ [$_S$ e_1 was ill this morning]]].

Let us call the description a particular *D*-type pronoun is understood as equivalent to its *p-description*. The proposed LF (25_8) has the *D*-type pronoun occupying its SF position (an argument position) at LF. By contrast, the proposed LF (25_9) has a variable in that position bound by the *D*-type pronoun (the pronoun having been evacuated as if it were an ordinary QNP). Finally, the proposed LF (25_{10}) contains the *D*-type pronoun's proposed *p*-description, rather than the pronoun itself, in a position of the sort created by QNP-evacuation.

As things stand right now, there are worries about each candidate. In the case of (25_8) and (25_{10}), the worries seem to amount to fatal objections. If we are to continue working with anything remotely resembling a Chomskyan notion of LF, there is a decisive objection to (25_{10}). LF is a level of syntax and the introduction of lexical material in the mapping from one level to another—even if the material can be culled from the rest of the tree and reordered in a systematic way—involves a radical revision of the syntactical theory in question. To say this is not to say that (25) is not *understood as equivalent to* (25_{10}): it is. It's just to say that the *p*-description cannot appear in the LF representation if we are to continue viewing LF as a level of syntactical representation derived from SF in the usual way.

The initial worry with (25_8) and (25_9) is that, without further ado, they are quite useless as far as the truth definition is concerned. The only axiom we have for "he_1" at this point is the following, which can be seen as an instance of axiom schema (ii), adapted for LF rather than RQ representations:

$$\text{Ref}(\text{"he}_1\text{"}, s) = s_1.$$

This axiom is fine for dealing with instances of "he_1" that are anaphoric on c-commanding quantifiers; but it is a hindrance rather than a help with instances of 'he_1' anaphoric on referring expressions or non-c-commanding quantifiers. The generalizations we want to capture are the following:

(D) A pronoun P_k that is anaphoric on a referring expression is understood as R_k.

(F) A pronoun P_k that is anaphoric on but not within the scope β of an SNP $[D_k\ \alpha]_k$ is understood as $[\text{the}_k\ \alpha \bullet \beta]_k$.

But how are these results to be obtained? With respect to (D), there is some temptation to augment the theory (somewhere) with a rule that ensures that such a pronoun falls under the axiom for R_k. This would involve some engineering problems, but doubtless they could be solved without making too much of a mess.

When it comes to capturing (F), however, matters are considerably more complicated. Even if we could augment the theory (somewhere) with a rule that ensures that a pronoun P_k that is anaphoric on but not within the scope β of an SNP $[D_k\ \alpha]_k$ falls under "the axioms for" $[\text{the}_k\ \alpha \bullet \beta]_k$, this would not help with the proposed LF (25_8) because the *D*-type pronoun occupies an argument position in that representation, i.e. a position that "the axioms for" $[\text{the}_1 \text{ man } x_1 \bullet x_1 \text{ drank rum}]_1$ do not apply to directly. This effectively rules out (25_8) as the LF of (25). The proposed LF (25_9) still seems to be in the running, however, because at LF the argument position is occupied by a variable e_1 that is within the scope of the *D*-type pronoun, and the pronoun itself occupies a position that “the axioms for” [the$_1$ man x_1 & x_1 drank rum]$_1$ do indeed apply to.

We are left, then, with (25_9) as the only plausible candidate if we plan to continue in the way expected. But a nontrivial question remains to be answered concerning (25_9): how is the truth definition, so to speak, “tipped off”? We need an account of how the right axioms of the truth definition can be applied to this representation (we know which axioms are the right ones). Vague talk of “a rule” that ensures a *D*-type interpretation will not do. What is this rule? And where does it reside? I will return to this matter after some remarks on the relationship between structure and reference.

9. Philosophical Grammar: Reference, Structure, and Evacuation

I want now to say something more speculative about the relationship between the sorts of issues involved in spelling out a theory of LF and certain other issues in the philosophy of language and logic. Although everything I say in this section should be taken as provisional, I stand by the view that underpins the discussion: when things are going well, work in philosophical logic and work in theoretical syntax will be mutually illuminating.

In a moment, I want to entertain a possible constraint on the well-formedness of LF representations. Rather than stating the constraint right now, I prefer to sneak up on it. One consequence of the constraint is going to be that only names, simple demonstrative and indexical NPs, variables, and devices anaphoric on such expressions occupy argument positions at LF. The reason I want to entertain a constraint with this feature is that I believe it is of philosophical importance to explore the view (found in Russell and Wittgenstein as I read them) that there is a fundamental connection between reference and structure: only a semantically unstructured expression can function as a device of reference. The logico-metaphysical picture that informs this view need not detain us here; but I will say that the idea of a *complex* referring expression has always struck me as, if not incoherent, at least very difficult to understand. Of course, many philosophers treat certain expressions as referring to things in virtue of the meanings of their parts; but I am very dubious about this business. For present concerns, the main semantical point is that, on the account I think we ought to explore, if an NP has any internal semantical structure whatsoever, then it is not referential. On such an account, we are precluded from following Frege, Davidson, and many others in treating expressions such as ‘3 x 4’, ‘√49’, ‘*S*(*S*(0))’, ‘*f*(*a*)’, ‘the successor of zero’, ‘Bill’s father’, ‘the father of Bill’s wife’, and ‘that man talking to Henry’ as complex referring expressions. (For anyone suspicious about complex referring expressions, there is great comfort in Russell's Theory of Descriptions: it provides a means—an independently motivated means—of avoiding any sort of commitment to the view that the complex expressions just mentioned are semantically structured referring expressions. Certainly the projects of *The Philosophy of Logical Atomism* and the *Tractatus* could not have been seriously contemplated without the Theory of Descriptions, or some similar method of contextual definition.)

Now if the connection between philosophical logic and theoretical syntax is as close as I am suggesting, it ought to be profitable for both philosophy and linguistics to explore the view that only semantically unstructured NPs occupy argument positions in logical form (LF). Before saying something about the syntactical side of this proposal, let me try to motivate the general picture in another way. The discussion will have to be rather compressed and otherwise truncated, but not, I hope, to the point of unintelligibility.

It is by now a commonplace of philosophy that names, simple indexical and demonstrative NPs, and variables (under assignments, i.e. relative to sequences) are rigid referring expressions (in the sense of Kripke [1972]). Kripke has demonstrated convincingly that ordinary proper names are rigid, and that there is no prospect of viewing names as equivalent to, or as having their references fixed rigidly by, definite descriptions (even descriptions that insist on maximum scope or descriptions that are "actualized" (or "rigidified" in some other way[50])). And arguably Kaplan has shown that the simple indexical and demonstrative NPs 'I', 'you', 'this', and 'that' (as well as demonstrative occurrences of 'he' and 'she') are also rigid referring expressions. Finally, it is clear a variable under an assignment is a rigid designator.

In *Descriptions*, I argued at length the Russellian point that phrases of the form "the *F*' should not be grouped with these phrases.[51] Rather, they belong

[50] Following Kripke (1972), the phrase 'rigid description' has gained some currency in application to descriptions such as 'the successor of zero', 'the positive square root of 9', 'the actual number of planets', 'the atomic number of gold', and (possibly) 'Nixon's father'. Take 'the positive square root of 9'; it is certainly true that this description is satisfied by the same entity in every possible world. But there is a danger of interpretation involved in classifying the description as "rigid" on the basis of this fact. The danger is that one might thereby be taken to hold that the description is (or even has to be) a referential rather than a quantified NP. And this is not so. The interesting feature of a "rigid" description "the *F*' is not that it *refers* (rigidly) but that the same single object satisfies the *predicate F* in every possible world (as we might put it, the contained predicate has a *rigid extension*). But this fact is *completely irrelevant* as far as the semantics of descriptions is concerned (many predicates have rigid extensions, whether or not they are combined with 'the', 'no', 'most', or any other determiner). It should be stressed that Kripke himself is certainly not guilty of assuming that "rigid" descriptions are referential rather than quantificational; indeed Kripke's leanings are explicitly Russellian for descriptions, whether or not they happen to contain predicates with rigid extensions (see Kripke (1977)). In view of these considerations, it is difficult to lend a sympathetic ear to criticisms of Kripke that see "rigid" descriptions as creating problems for the connections between naming and necessity that he uncovers.

[51] Of course, Russell finally convinced himself that he had to redraw the line between referring expressions and quantified noun phrases ("denoting phrases") in such a way that

with their syntactical siblings ‘every *F*‘, ‘no *F*‘, ‘an *F*‘, and so on: they are quantificational rather than referential. Putting this point together with the points made by Kripke and Kaplan, certain results in modal logic, and the strengths of a D-type (i.e. quantificational) account of unbound anaphora, I succumbed to the tremendous temptation to claim that there are exactly two classes of meaningful NPs in natural language, viz. (i) a finite class of (rigid) referring expressions (names, demonstratives, and variables), and (2) an infinite class of QNPs (a class that includes definite and indefinite descriptions and D-type pronouns of course).

For the philosopher who has succumbed to this temptation as well as the temptation to think of logical form in terms of the structure required for truth definition, and the temptation to view LF as providing the required structure, it is the shortest of steps to the position that only names, simple indexical and demonstrative NPs, variables, and their anaphors occupy argument positions at LF, a position that, if sustainable, might hold out the hope of a substantial syntactico-philosophical unification. Of course the fact that a philosopher might blunder into this position by reflections of this sort is no endorsement in and of itself; but the idea certainly warrants at least a cursory examination.

I propose two (provisional) terminological stipulations:

(G) An NP is *Referential* (capital ‘R’) iff it has exactly one syntactical constituent.
(H) An NP is *Structured* (capital ‘S’) iff it is not Referential.

Henceforth, the expressions ‘RNP’ and ‘SNP’ are to be understood as abbreviations of ‘Referential NP’ and ‘Structured NP’ respectively. Consider now the following constraint on well-formedness:

(J) At LF, every RNP occupies an argument position and every SNP occupies an operator (nonargument) position.

The basic idea, then, is that *wh*-evacuation and QNP-evacuation are instances of a more general phenomenon (SNP-evacuation) which, given standard assumptions about the placing of NPs at D-Structure, is mandated by the well-formedness condition (J).

If (J) were true, it would certainly make life easy as far as one part of the truth definition is concerned: On the assumption that the semantical value (truth-theoretic contribution) of a node is determined by and only by the semantical values of its constituents and their syntactical organization, in

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ordinary proper names would not qualify as referring expressions. There is no need for anyone who endorses the Theory of Descriptions as a theory of *descriptions* to follow Russell down this ruinous path (see Kripke (1972), Neale (1990)). However, I should confess that considerations very similar to those that drove Russell to such lengths have played a significant rôle part in shaping my own general view of the relationship between reference and structure.

effect an RNP '$[_{NP}\, \phi]$' will be an NP whose semantical value is exhausted by a simple axiom of the form

$$\text{Ref}(\phi, s) = x.$$

Thus the semantical value of anything in an argument position at LF would be completely determined by such an axiom, just as in the simplest first-order languages (i.e. those that do not contain complex terms of the form '$f(x)$' where f is a functional expression). In a nutshell: a phrase can occupy an argument position at LF only if its semantical value is wholly determined by a single axiom, i.e. only if it is semantically *atomic*.[52]

There are certainly *prima facie* obstacles to this view. I cannot go into detail here, but it should be noted that anyone who endorses (J) seems to be committed to the view that the following NPs are quantificational and undergo evacuation 'Bill's mother', 'that man', 'Chomsky and Halle', and 'Mary and two journalists'.[53] The case is more plausible for some of these than it is for others. It is certainly reasonable to maintain that NPs of the form NP's *F* are definite descriptions (or at least semantically equivalent to definite descriptions).[54] On such an account, the surface string 'Bill's mother bought two cars' is associated with the following LFs:

(40) $[_S[_{NP}$ Bill's mother$]_1$ $[_S[_{NP}$ two cars$]_2$ $[_S\, e_1$ bought $e_2]]]$
(41) $[_S[_{NP}$ two cars$]_2$ $[_S[_{NP}$ Bill's mother$]_1$ $[_S\, e_1$ bought $e_2]]]$.

Notoriously, complex demonstratives (demonstrative descriptions) such as 'that man' create a number of semantical problems. On the face of it, such expressions look like hybrids, being both semantically structured and referential. I am not aware of any satisfactory hybrid semantics for such phrases, and it may well be that a satisfactory semantics will emerge by taking (J) seriously. Two avenues seem to be worth exploring. First, in view of Kaplan's discussions of demonstrations and directing intentions,[55] complex demonstratives might be viewed as semantically unstructured RNPs, the descriptive material in such a phrase functioning only as an *aside* that makes no contribution to truth conditions. Such a view will, however, require replacing (G) by something more like the following:

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[52] This would effectively take any sting out of Etchemendy's (1983) statement that a theory of logical form deserving the name has to assign ". . . distinct forms or structures to sentences displaying, from all appearances, the same grammatical form, simply on the basis of a difference in the logical properties of the sentences" (p. 319).

[53] For the moment, I am leaving NP-trace out of the picture. The reason for this will emerge in the next section. For suggestions about NP-trace and PRO, see note 58.

[54] Russell (1905), Higginbotham (1983).

[55] Kaplan (1977, 1989).

(G') An NP is *Referential* (capital 'R') iff its semantical value (truth-theoretic contribution) is exhausted by the semantical value of exactly one of its syntactical constituents.

Second, in the light of work on the logic of 'actually', complex demonstratives might be viewed as equivalent to actualized descriptions (that insist on largest scope?) and hence as semantically structured restricted quantifiers. To be sure, in their crudest forms such proposals have their problems, but it is does not appear unreasonable to suppose that work on non-hybrid accounts of the semantics of complex demonstratives will be fruitful.

Consider also complex NPs of the forms "RNP and SNP", and "RNP and RNP" as they occur in (42) and (43) (for simplicity, assume distributive readings only):

(42) Mary and two journalists are tailing Hamilton

(43) Mary and Fred are tailing Hamilton.

If (J) is taken as it stands, the NPs in these examples are SNPs and so they must evacuate. I cannot go into the complex issues raised by such examples here, but they may support the view that evacuees may adjoin to NP nodes as well as S nodes. That is, it is at least arguable that the LF for (42) is not (42_1) but (42_2):

(42_1) $[_S[_{NP}$ two journalists$]_2$ $[_S[_{NP}$ Mary and $e_2]_1$ $[_S$ e_1 are tailing Hamilton$]]]$

(42_2) $[_S[_{NP}[_{NP}$ two journalists$]_2$ $[_{NP}$ Mary and $e_2]_1]_1$ $[_S$ e_1 are tailing Hamilton$]]$.

10. LF AND "DEEP STRUCTURE"

An important feature of the earliest work in generative grammar was a distinction between the "deep structure" and "surface structure" of a sentence, a distinction postulated, in part, to account for a variety of syntactical and semantical facts. In a sense, Chomsky and those he influenced held a view not entirely unconnected to Russell's view that the superficial grammatical form of a sentence does not reveal its underlying logical structure. One important difference, of course, is that from the outset Chomsky was in the business of providing a rigorous account of the syntax of his underlying structures (in terms of a set of phrase structure rules) and a rigorous account of the relationship between underlying structures and surface structures (in terms of a set of transformational rules).

In the mid-to-late 1960s, accounts of the relationship between deep structure and surface structure were increasingly shaped by semantical concerns. At the the hands of people like Bach, Lakoff, McCawley, and Ross, at a certain point deep structure representations began to look a lot like formulae of first-order logic or formulae of RQ. As this conception of deep structure became increasingly "abstract" (i.e. as the transformational gap between surface structure and deep structure widened) it encountered stiffer resistance from many generative grammarians (including Chomsky) and finally "Generative Semantics" broke off and became a rival to Chomsky's Standard Theory. In the light of work such as Chomsky's "Remarks on Nominalization," it gradually became clear that if generative grammar was to continue as an empirical investigation into the structure of natural language, many of the more abstract conceptions of deep structure could not be taken seriously. As the reins were tightened on both deep structure and transformational rules, it was argued that surface structure was at least as relevant to matters of semantical interpretation as deep structure, and by the early 1970s the idea of a single underlying level of logical or semantical representation had begun to fade.

In the late 1970s, Chomsky's Extended Standard Theory received a tremendous boost when it became clear that a host of apparently disparate facts about *wh*-movement and the interpretation of *wh*-phrases, quantifier scope, bound anaphora, empty categories, and important differences between different languages could be accounted for in a systematic way by playing down the role of sets of phrase structure rules and focussing more on sets of general principles constraining well-formedness at three (rather than two) levels of syntactical representation: D-Structure, SF, and LF. If LF is to be understood in the way I have suggested here, certain versions of the Extended Standard Theory restore the hope of viewing logical structure as revealed at a level of underlying syntax.

One interesting feature of LF representations is that since they look very much like the well understood formulae of RQ, they are also look a lot like the deep structure representations used in some of the more conservative versions of Generative Semantics. One interesting question I have found myself asking for some time is whether it might not be possible, without any loss of explanatory power, to dispense with D-Structure altogether, or in some sense collapse old D-Structure and LF into a single level LF.[56] This is not a question for *a priori* stipulation one way or the other. The act of raising this question may well open old wounds, but the question is an empirical one and ought to be treated as such rather than as a question whose answer is to be determined by past or present allegiances.

[56] This view is not as heretical as it may first appear. In correspondence, Chomsky has informed me that he is presently engaged in reworking the central tenets of his theory in such a way that D-Structure plays no rôle.

I am not going to attempt to spell out such a revision of Chomskyan theory here, but the general idea ought to be clear enough. A well-understood base component would generate LF representations (variables would be base-generated in argument positions). This component might take the form of X-bar theory or a set of formation rules similar to those used to generate the formulae of RQ, and it might be augmented by a set of constraints very much like the usual constraints on well-formed LF representations (for example, a constraint to the effect that a well-formed LF representation may contain no free variables). Alternatively, analogs of such constraints might be imposed on SF representations. For present purposes, the main point is that a sentence would consist in an ordered pair ⟨LF, SF⟩, where each element of the pair satisfies a distinct set of well-formedness conditions. In a grammatical sentence, only RNPs would occupy argument positions at LF; SNPs would occupy non-argument positions (would this be arranged by the base rules themselves? Or would it follow from conditions on well-formed SFs?).[57] In effect, more or less everything would be running "backwards." QNPs would evacuate between LF and SF. The only place an NP could evacuate to would be a position it c-commanded (at LF) and which contained a coindexed variable (at LF). *Wh*-phrases (typically) would not evacuate between LF and SF (corresponding to the fact that they (typically) *do* evacuate between D-Structure and SF in current theory).[58]

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[57] On such a conception of grammar, it might be more reasonable to say that NP is not genuine category. Rather, there are two distinct categories: terms and quantifiers. Syntactical and semantical categories might well coincide in underlying (i.e. logical) syntax.

[58] I ought now say a little about how I would envisage NP-trace and PRO fitting into this picture. The question of what happens to NP-trace at LF simply does not arise because unlike variables, NP traces would not be base-generated: they would be viewed as emerging as products of "argument movement" (optional) between LF and surface syntax. For example, the surface forms (ii) and (iii) would be derived from an LF something like (i):

(i) $[_S$ — seems $[_S$ John$_1$ be tired]]
(ii) $[_S$ John$_1$ seems $[t_1$ to be tired]]
(iii) $[_S$ it seems $[_S$ John$_1$ is tired]].

(A constraint on surface syntax to the effect that every NP position must have an occupant would ensure that either 'John' or a pleonastic element ('it') occupied the (non-argument) position that was empty at LF. The case filter would apply as usual.)

What of PRO as it appears in sentences like he following?

(iv) Mary persuaded John PRO to leave
(v) Every man wants PRO to leave.

I would maintain that in such sentences PRO is a term that takes as its value the value of the term upon which it is anaphoric. The LFs for (iv) and (v) would be given by (vi) and (vii) respectively:

(vi) $[_S$ Mary$_1$ persuaded John$_2$ $[_S$ PRO$_2$ to leave]]
(vii) $[_S$ [Every man]$_1$ $[_S$ e_1 wants $[_S$ PRO$_1$ to leave]]]

In (vi), 'PRO$_2$' would be anaphoric on 'John$_2$', hence it would function just like a pronoun anaphoric on 'John$_2$'. In (vii), 'PRO$_1$' would be anaphoric on the variable 'e_1', hence it would function as a variable 'e_1'. The upshot of all this is that the occurrences of PRO in (vi) and (vii) would not create problems for the position that only RNPs occupy argument position at LF because these occurrences of PRO are RNPs in the same way that pronouns anaphoric on RNPs are RNPs. (There may well be other occurrences of PRO that require more thought (e.g., so-called "free PRO") but I cannot go into such matters here.)

On such an account, the aim would be to view something like the pair $\langle(44_1), (44_2)\rangle$ as constituting a sentence:

(44_1) $[_S$[which linguist]$_1$ $[_S$[every philosopher]$_2$ $[_S$ e_1 respects e_2]]]
(44_2) $[_S$[which linguist]$_1$ $[_S$ e_1 respects [every philosopher]$_2$]]

The *History* of a sentence $\langle$LF, SS$\rangle$ would be a sequence of representations $\langle R_1, \ldots, R_n\rangle$, where R_1 is LF, R_n (for $n > 1$) is SS, and each R_k is obtained from R_{k-1} by at most one evacuation. For any $k > 1$, a representation R_k in a History would be a *candidate-SF* representation. And a candidate-SF representation satisfying the conditions on well-formedness for SF would be an SF.

An affinity to earlier work might also be seen when it came to the topic of anaphoric pronouns. At one time, it was common to view certain anaphoric pronouns as derived transformationally from underlying "full NPs." Subsequent work demonstrated conclusively that at least some pronouns are not derived transformationally. But at that time, the matter of *D*-type pronouns was not in focus, and it is at least worth exploring the idea that *D*-type pronouns are the (optional) surface manifestations of underlying definite descriptions. That is, the LF representation (45_1) might be viewed as the LF representation of two distinct sentences $\langle(45_1), (45_2)\rangle$ and $\langle(45_1), (45_3)\rangle$:

(45_1) $[_S$ $[_{NP}$ Just one man]$_1$ $[_S$ e_1 drank rum]] and
$[_S$ $[_{NP}$ the man who drank rum]$_1$ $[_S$ e_1 was ill this morning]]

(45_2) $[_S$ $[_{NP}$ Just one man]$_1$ drank rum] and
$[_S$ $[_{NP}$ the man who drank rum]$_1$ was ill this morning].

(45_3) $[_S$ $[_{NP}$ Just one man]$_1$ drank rum] and $[_S$ he$_1$ was ill this morning].

Whereas the SF (45_2) would be derived from the LF (45_1) in the expected way by the evacuation the QNPs 'just one man' and 'the man who drank rum', the SF (45_3) might be viewed as derived by the evacuation of 'just one man' and the pronominalization and evacuation (or evacuation and pronominalization) of 'the man who drank rum'.

Clearly, a lot of work would need to be done before anything like this picture of the organization of a grammar could be endorsed; but it seems to me that it is a picture well worth developing.

11. CONCLUSION

I have attempted to present in a positive light the view (found in the work of Chomsky, Higginbotham, and May) that the level of syntactical representation dubbed "LF" will play an important role in theorizing about the syntax and semantics of natural language. I have claimed (following Bach, Harman, Lakoff, and McCawley) that the structural (tree-geometric) characterization of *scope* (in exactly Whitehead and Russell's sense) in simple formal languages carries over without modification to natural languages: the scope of an expression is everything it c-commands (at LF, of course, in the case of natural languages). I have suggested (following Davidson, Wiggins, and Platts) that the "logical form" of a sentence *S* belonging to a language *L* is the structure imposed upon *S* in the course of providing a systematic and principled truth definition for *L*. On a more contentious note, I have claimed that the logical form of a sentence in this sense can be identified with its LF representation (a view that many LF theorists themselves reject, either explicitly or by implication). Additionally, I have suggested that it might be profitable to explore the view that representations of logical form (LF) might be base-generated. Finally, I have suggested that the class of meaningful NPs splits into (i) a class of semantically unstructured terms that occupy argument positions at LF, and (ii) a class of semantically structured, variable-binding, sentential operators that (depending upon the language in question) may occupy argument positions only at SF (and then only when certain specified conditions obtain at LF).[59]

The resulting picture seems to me not entirely devoid of philosophical or linguistic merit. Indeed, I expect the conception of logical form I have defended to be of philosophical utility: it meshes very cleanly with important technical and conceptual work in the philosophy of language and as such holds out the hope of genuine philosophical grammar. If it is correct that a useful notion emerges from combining insights from philosophical logic and generative grammar in the way I have suggested, then it cannot be denied that Chomsky's work on the syntax of natural language has application well

[59] I have not had a chance, in this paper, to address the obviously interconnected issues of (i) the complexity of the LFs of sentences containing adverbs (especially modal adverbs and adverbs of action), (ii) the nature of the background logic needed for an adequate truth definition, (iii) the notion of a logical constant, and (iv) the rôle of a theory of logical form in a theory of inference. The issues raised by adverbs are of more than technical interest because they force philosophers to think hard about (ii)-(iv). As is well known, there are various ways one can go about constructing truth definitions for languages containing adverbs, and a particular philosopher's preferences often will be shaped by thoughts about ontology, extensionality, logical implication, and the nature of the gap between the structure of the object language and the structure of the metalanguage. In the case of the modal adverbs 'necessarily' and 'possibly', one can choose to view both the object language and the metalanguage as intensional (Peacocke (1978), Davies (1981)) a move that requires using a modal background logic; or one can choose to make the metalanguage extensional by quantifying over possible worlds and using an extensional background logic. A third idea would be to import explicit quantification over worlds into the object language; and within the present conception of LF this would amount to LF representations further removed from surface syntax than is customary (I bring this up as an observation rather than as a complaint). Similar remarks pertain to the construction of a truth definition for a fragment containing adverbs of action, quantification this time being over *events* rather than worlds. For some discussion, see (e.g.) Davidson (1967a), Platts (1979), Higginbotham (1983a), and Wiggins (1985). The matters of the richness of LF representations and the richness of the background logic seem to me very pressing at this stage of inquiry.

beyond theoretical linguistics: it is of the utmost importance to any philosophical inquiry that prides itself on logical clarity.

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