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3

Logical Form

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Prelude

This chapter deals with the conception of the syntax–semantics interface in the Principles and Parameters framework and in particular the role of the level of Logical Form (LF) in mediating between the syntactic form of a sentence in terms of its tree structure and its truth conditions and entailments.

The chapter focuses on the differential LF representations of quantificational (including interrogative) expressions as opposed to nonquantificational ones. The processes of *quantifier raising* (QR) and *wh-movement* at LF are discussed in detail, and several versions of these leading ideas are compared and evaluated. The relative adequacy of restrictive as opposed to unrestrictive quantification as the representation of the semantics of quantificational sentences is provided as one of the arguments for the existence of QR and LF as a level of representation. Other arguments for this conception come from the similarity between constraints on overt movement and restrictions on the scope of elements which have not undergone visible movement.

The chapter also covers the behavior of various types of pronouns in connection with crossover phenomena and so-called "donkey" sentences and discusses competing analyses of these phenomena.

A discussion of *wh*-in-situ elements, the role at LF of general locality conditions from the theories of bounding and binding, and the contributions of the assumptions about LF to a general theory of comparative semantics conclude the chapter.

1 The Syntax–Semantics Interface

The relationship between syntax and semantics, or between linguistic form and logical form, has been a persistent issue of central concern to modern linguistic theory. How is the meaning of a sentence, where one talks about its truth conditions and entailment properties, etc., determined by its syntactic form, where elements of the sentence are presented in one constituent structure or another? In GB theory, the answer to this question is that grammar and meaning are mediated through a linguistic level of Logical Form. This is an abstract level of representation

derived from the level of S-Structure through transformational operations (e.g. the rule Move α), operations which are also responsible for mapping D-structure to S-Structure representations. It is assumed that semantic interpretation rules apply to representations at this level of mediation, but not directly to S-Structure representations, to derive the appropriate semantic interpretations. LF is thus the interface between grammar and the conceptual-intentional properties of language, just as the level of Phonetic Form (PF) is an interface between grammar and the audio-perceptual properties of utterances. LF is not to be equated with the level of semantic structure any more than PF is to be treated as a level specifying the sound waves of any given utterance. It expresses only aspects of semantic structure that are syntactically expressed, or that are contributed by grammar.

The supposition that the meanings of sentences are not directly "read off" from their surface forms is based to a large extent on the combination of the following three facts: (a) that sentences with quantifiers and question words exhibit special *semantic* properties which distinguish them from non-interrogative, non-quantificational sentences; (b) that these properties reflect *syntactic* generalizations that are best captured by reference to their structure at LF; and (c) that the derivation of LF representations from S-Structure involves little or no extra cost other than what is already made available by a proper theory of overt syntax.

A simple difference between quantificational and referential sentences can be seen by comparing a pair like (1)–(2):

(1) John flunked
(2) Every student flunked

The mapping of a non-quantificational sentence to its logical structure is relatively straightforward. The predicate in (1) says something about the individual named John, and a simple rule will interpret this sentence to be true if and only if this individual, John, flunked, and false otherwise. For our present purposes, the logical structure of (1) does not differ from its linguistic structure in any essential way. The situation with (2) is different, however. Here the predicate cannot be said to be predicated of an individual named "every student," and the truth of (2) cannot be determined in the same way. The truth conditions of (2) are more appropriately captured by the logical formula (3) or (4):

(3) $\forall x$ ((x is a student) $\rightarrow$ (x flunked))
(4) ($\forall$x: x is a student) (x flunked)

That is, (2) is more appropriately interpreted through a quantification. The subject of the VP *flunked* occurs in the form of a variable bound by a universal quantifier, either one that ranges over all elements in the domain of discourse as in (3), or one that ranges over the restricted domain defined by the set of x such that x is a student as in (4). The appropriate semantic rule can apply to either (3) or (4) to yield the correct semantics of the sentence. In set-theoretic terms, these logical structures yield truth iff the intersection of the set X comprising all students and the set Y comprising all students who flunked equals the former set X, and falsehood otherwise. More informally, (3)–(4) are interpreted as true just in case they are true on every assignment of the value of x, x a student, that x flunked.

To interpret quantificational sentences properly, then, S-Structure representations need to be mapped to semantic structures like (3)–(4). In GB, it is assumed that this mapping from syntax to semantics is mediated through LF. Following May (1977), quantificational sentences are subject to the rule QR (Quantifier Raising), which Chomsky-adjoins a quantified NP to IP, leaving a trace A′-bound by the adjoined NP. This operation gives (2) the LF-Structure (5):

(5) $[_{IP}$ Every student$_i$ $[_{IP}$ t_i flunked]]

A structure of this sort already has the form of a restrictive quantification structure as given in (4). The A′-bound trace corresponds to the variable x in (4). The QP specifier of *every student* corresponds to the universal quantifier, and the N′ *student* corresponds to its restriction, specifying that the universal quantifier ranges over individuals who are students. Everything that is contained in (4) is already provided in (5). Much of the mapping that is required to relate a linguistic structure to its logical structure is achieved in the domain of syntax already, i.e. in the syntax of LF. Given LF as a syntactic level of representation, the mapping between syntax and semantics is relatively trivial in this case.

An LF representation like (5) captures one distinctive property of quantificational sentences: they convey a sense of generality which referential sentences do not. Another property of quantificational sentences is that they exhibit the phenomena of scope. Thus (6) below is ambiguous as to whether the existence of someone is true to the speaker or only in the mind of the matrix subject:

(6) John believes that someone is in the cellar

A common view holds that these two readings differ in whether the existential quantifier has scope over the matrix or the embedded clause. Their simplified logical structures are given in (7)–(8):

(7) (∃x: x a person) (John believes that x is in the cellar)
(8) John believes that (∃x: x a person) (x is in the cellar)

These logical structures are, again, directly obtainable at LF by applying QR, depending on which IP the QNP *someone* is adjoined to:

(9) $[_{IP}$ Someone$_i$ $[_{IP}$ John believes that $[_{IP}$ t_i is in the cellar]]]
(10) $[_{IP}$ John believes that $[_{IP}$ someone$_i$ $[_{IP}$ t_i is in the cellar]]]

Another kind of ambiguity arises from the difference in relative scope among QNPs. In (11) the universal quantifier may have a distributive or a collective reading, meaning, respectively, either that everyone loves someone or other, or that there is someone that everybody loves.

(11) Everyone loves someone

The distributive and collective readings are the readings one gets when the universal quantifier is interpreted as having wide or narrow scope, respectively, with respect to the existential quantifier. The appropriate representations for these readings are directly derived by QR:

(12) $[_{IP}$ Everyone$_i$ $[_{IP}$ someone$_j$ $[_{IP}$ t_i loves t_j]]]
(13) $[_{IP}$ Someone$_j$ $[_{IP}$ everyone$_i$ $[_{IP}$ t_i loves t_j]]]

Note that the two facts that distinguish QNPs from referential NPs, with respect to generality and scope ambiguities, are semantic facts and, by themselves, do not argue for the existence of a syntactic level of LF. Since LF structures are subject to interpretation, one may as well devise mapping rules that convert S-Structure representations directly into semantic structure, without the mediation of LF. No appeal to semantics per se can provide a real argument for the existence of this level of syntactic representation. In spite of common misunderstandings, LF is not motivated merely as a level of disambiguation.

One argument for LF lies in the fact that representations at LF are derivable through syntactic means at little or no cost to the grammar. Since LF more faithfully represents the semantics of certain sentences than overt syntax, postulation of this level reduces the burden of mapping from syntax to semantics. If LF structures are derived at little or no cost, a grammar that incorporates such a level is a simpler grammar than one that does not. For example, notice that the LF structures (5) and (9)–(10) have the syntactic form of A′-binding, commonly observed with *wh*-questions in overt syntax:

(14) [Who$_i$ [t_i flunked]]
(15) [What$_i$ [do you think [Bill will buy t_i]]]
(16) [I wonder [what$_i$ [Bill will buy t_i]]]

Other examples of overt A′-binding include topicalization in various languages, and Scrambling in certain "order-free" languages. These structures are derived by a process of movement from A to A′ position, some involving adjunction to IP, others involving movement into Spec of CP. All of these are but special instances of the single rule Move-α, α any category. The rule QR is also an instance of Move-α, so its postulation does not add to the burden of grammar. The mapping of S-Structure to LF is thus fundamentally an extension of overt syntax, of the mapping from D-structure to S-Structure.

The more important arguments for the existence of LF as a linguistic level come from the fact that quantificational sentences exhibit properties that are best captured by principles and constraints that have been independently motivated in overt syntax. Arguments of this form can be found in various areas, in discussions of constraints on quantifier scope, on the possibility of interpreting pronouns as bound variables, on the syntax and interpretation of constituent questions, and so forth.

The idea that there is a linguistic level with representations resembling formulas of Predicate Calculus can be found in early generative literature, most notably in the works of generative semanticists (see Lakoff (1971), Bach (1968), and McCawley (1970b)). In Lakoff's work, for example, quantifiers are represented as higher predicates in underlying structure, and lowered to their surface syntactic position through a lowering process. But the notion of Logical Form as an independently motivated level of syntax, derived by syntactic rules and defined by generalizations and principles governing syntax, was not crystallized until Chomsky (1976) presented his well known arguments from weak crossover which show that the conditions governing the use of pronouns as bound variables are defined at the level of LF. The case for LF was considerably strengthened with May's (1977) formal proposal of the rule QR, and his analysis of "inversely linked quantification" and of other matters of scope. The significance of this level gained widespread recognition in the early 1980s when weak crossover and the syntax of scope became the subject matter of several highly influential publications, and when the notion of LF was extended to the syntax of *wh*-in-situ, as in Aoun, Hornstein and Sportiche (1981), Jaeggli (1982), and to the syntax of *wh*-questions in languages without *wh*-movement, as in Huang (1982). Although some of the crucial facts that were used to motivate the existence of LF have been reanalyzed in one way or another (see, for example, Lasnik and Saito (1984, 1992), Rizzi (1990),

Cinque (1990b), Aoun (1986), Aoun, Hornstein, Lightfoot, and Weinberg (1987), Pesetsky (1982b, 1987), and May (1985)), the level of LF has continued to play a crucial role in these recent accounts.

Three areas of research constitute the core of the syntax of LF: (a) quantifier scope, (b) variable binding, and (c) the grammar of *wh*-in-situ.[1] In sections 2, 3 and 4, I take up each of these in some detail, and review the major achievements in these areas. In section 5, I will discuss a few current issues in the theory of LF that have gained prominence in more recent years. Section 5.1 touches on the status of Subjacency in LF and the issue of pied-piping in LF. Section 5.2 discusses recent developments in Binding Theory. In section 5.3, several issues of "comparative semantics" are broached, concerning cross-linguistic variations in superiority violations, scope ambiguities, bound variable pronouns, and the typology of *wh*-questions.

2 The Syntax of Scope

2.1 Inverse Linking

One of the strongest arguments for the existence of QR, hence also of LF, was put forth by May (1977) in his analysis of "inversely linked quantification," illustrated below:

(17) $[_{NP1}$ Somebody from $[_{NP2}$ every California city]] owns a Porsche
(18) $[_{NP1}$ Every senator on $[_{NP2}$ a key congressional committee]] voted for the amendment

Each of these sentences contains two QNPs, one properly contained in another. In both cases, NP2 is contained in a PP that is itself part of NP1. In both sentences, NP1 has scope over the sentence of which it is the subject. NP2, on the other hand, may be interpreted as having scope either internal to NP1, or over the entire sentence. According to the internal reading, NP2 has scope over the clause that provides the restriction of NP1's domain, so (17) means that somebody who comes from every California city owns a Porsche; and (18) means that every senator who comes from a key congressional committee or another voted for the amendment.[2] On the external, sentential-scope reading of NP2, (17) may be paraphrased as "every California city is such that there is someone from it who owns a Porsche," and (18) means that

there is a congressional committee such that every senator on that committee voted for the amendment.

The relevant property of interest here is that, when both the QNPs have sentential scope, the less inclusive NP2 must have wider scope than the more inclusive NP1. Thus the sentences have the meanings just indicated, but (17) cannot be paraphrased as "for some person x, every California city is such that x owns a Porsche." (18) does not mean "for every senator there is a congressional committee such that he voted for the amendment." That is, more generally, for two QNPs one of which contains the other, the relative scope of these QNPs is "inversely linked" to their relation of domination, so that the smaller, contained NP must have wider scope than the larger, containing NP. May (1977) argues that this otherwise rather surprising fact is readily explained under QR by the independently motivated conditions of (a) Proper Binding (PB), which requires all variables to be properly A′-bound, and (b) Non-Vacuous Quantification (NVQ), which requires all quantifiers to each properly bind a variable. Assuming that QR affects whole QNPs, (17) may be turned into the structure (19) in which the smaller NP2 has wider scope, or the structure (20), in which the larger NP1 has wider scope:

(19) $[_{IP}$ [every California city]$_i$ $[_{IP}$ [somebody from $t_i]_j$ $[_{IP}$ t_j owns a Porsche]]]

(20) $[_{IP}$ [somebody from $t_i]_j$ $[_{IP}$ [every California city]$_i$ $[_{IP}$ t_j owns a Porsche]]]

In (19) *every California city* properly binds the variable t_i, and the larger NP *somebody from* t_i properly binds the variable t_j. The LF structure is well-formed with respect to both PB and NVQ, so (17) is predicted to have the interpretation according to which the smaller QNP has scope over the larger QNP containing it. In (20), however, although the larger QNP and its trace are in a proper binding relationship obeying both PB and NVQ, the variable t_i is unbound, in violation of PB, and the quantifier *every California city* does not bind a variable, in violation of NVQ. The structure is ill-formed, and (17) is predicted not to have a reading with the subject having wider scope than the smaller NP it contains. The same explanation applies to (18).

Note that PB and NVQ are independently motivated in overt syntax, to ensure, among other things, that movement of a *wh*-phrase moves it upward into a position c-commanding the movement site. Thus a D-structure like (21a) can be turned into a grammatical S-Structure by moving the embedded *wh*-phrase upward as in (21b), a D-structure

like (22a) cannot be turned into a grammatical S-Structure by lowering the matrix *wh*-phrase as in (22b):

(21a) John wonders you bought what
(21b) John wonders what$_i$ you bought t_i
(22a) Who wonders John bought the book
(22b) *t_i wonders who$_i$ John bought the book

The ill-formedness of (22b) as opposed to the well-formedness of (21b) is accounted for by PB and NVQ. The restriction on inversely linked quantification also falls out in the same way at no additional cost once QR is assumed to apply to sentences like (17) and (18). Inverse-linking thus provides strong support for QR, and hence for the existence of LF.

May's treatment of inverse-linking also provides an important argument against earlier treatments of quantifier scope by generative semanticists. Although the rule QR might be thought of as simply the EST translation of Lakoff's of Quantifier Lowering, this is not the case. For one thing, QR is an upward movement rule, which makes it an instance of Move-α, whereas Quantifier Lowering does not conform to the general pattern of movement and is not independently motivated. Secondly, once lowering rules are allowed, the requirement of inverse-linking cannot be explained without recourse to some ad hoc mechanisms. A Quantifier Lowering analysis would be justified only by appeal to semantics, and in this case there is little evidence for an abstract syntactic level of scope representation distinct from the level of "real semantics."

2.2 *Opacity in NP*

As noted above, sentences like (17) and (18) have, in addition to the inversely linked reading, a reading according to which the smaller QNP has scope internal to the NP containing it. Two more examples are given below:

(23) Pictures of everybody are on sale
(24) Every professor from two areas of social science was elected to membership in the academy

According to the inversely linked interpretation, (23) says that everybody is such that his/her pictures are on sale, and (24) that there were two areas of social science from which every professor was elected to membership in the academy. According to the internal-scope reading,

(23) says that pictures that have everybody on them (group pictures) are on sale, and (24) that all those who specialize in two areas of social science were elected to academy membership.

The inversely linked interpretation becomes unavailable, however, if the containing NP is definite or specific. Thus in contrast to (23)–(24), the following sentences have only the internal reading of the quantifiers:

(25) This picture of everybody is now on sale
(26) Those professors from two areas of social science were elected to membership in the academy

Fiengo and Higginbotham (1981) propose that the absence of inverse-linking follows from the Specificity Condition (cf. also the Name Constraint in May (1977)).

(27) No specific NP may contain a free variable.

Fiengo and Higginbotham propose that a QNP has NP-internal scope when it is adjoined to N′ at LF, and sentential scope if adjoined to IP. In (25), N′-adjunction of *everybody* yields (28), and IP-adjunction gives (29):

(28) $[[_{NP}$ This $[_{N'}$ everybody$_i$ $[_{N'}$ picture of $t_i]]]$ is now on sale]
(29) $[_{IP}$ Everybody$_i$ $[_{IP}$ $[_{NP}$ this picture of $t_i]$ is now on sale]]

(28) is well-formed, because the variable t_i is bound in the definite subject NP; (29) is ruled out, because the variable is free in the NP. Note that the Specificity Condition is independently observed in overt syntax, accounting for patterns like the following:

(30a) Who did you see pictures of t?
(30b) Who did you see many pictures of t?
(30c) Who did you see three pictures of t?
(30d) *Who did you see this picture of t?
(30e) *Who did you see those pictures of t?

2.3 Wh–*QP Interaction*

Another kind of support for LF turns on the fact that scope interpretation appears to be constrained by established syntactic constraints. One

of these had to do with the contrast brought to light by May (1985), concerning the relative scope of *wh*-phrases and quantifiers:

(31) What did everyone buy for Max?
(32) Who bought everything for Max?

Sentence (31) is ambiguous, admitting both a collective and a distributive reading of the universal quantifier. In the former case it is a singular question, to which one may answer with "They bought a Nintendo set for Max." In the distributive reading, (31) is a family of questions, asking for each person x, what x bought for Max. In this case an answer like "John bought a Nintendo set, Bill bought a Monopoly, and Mary bought a pair of tennis shoes for him" would be more appropriate. In contrast, (32) is not ambiguous. It has only the collective reading, so an answer like "John did" would be appropriate, but not a pair-list sentence like the one just given.

May argues that this contrast manifests an effect of the Path Containment Condition (PCC) proposed in Pesetsky (1982b). Pesetsky shows that an array of grammatical contrasts observed in overt *wh*-movement can be naturally accounted for by observing the interaction of paths that such movement creates. An A′-path is a set of successively dominating nodes leading from a trace to its c-commanding A′-binder. The PCC provides that if two A′ paths intersect, then one must be properly contained in the other. Overlapping but non-nesting paths are ill-formed. May shows that the contrast between (31) and (32) can be seen as an effect of the PCC at LF if quantifiers are subject to QR. The result of applying QR to (31) is (33):

(33) $[_{CP}$ What$_j$ did $[_{IP}$ everyone$_i$ $[_{IP}$ t_i buy t_j for Max]]]

The path connecting *what* and its trace t_j consists of {VP, IP, IP, CP}, and the path connecting *everyone* and its LF trace is {IP, IP}. The latter path is properly contained in the former, so the path structure of this LF representation is well-formed with respect to the PCC. May further assumes that in such a structure as (28), where *what* and *everyone* are in a mutual government relation, either operator may be interpreted as having wider scope than the other, whence the ambiguity of (31) arises. In the case of (32), however, the result of adjoining *everyone* to IP gives (34):

(34) $[_{CP}$ Who$_j$ $[_{IP}$ everyone$_i$ $[_{IP}$ t_j bought t_i for Max]]]

The path connecting *who* and its trace is {IP, IP, CP}, and the path connecting *everyone* and its trace is {VP, IP, IP}. The two paths overlap,

but neither contains the other, in violation of the PCC, so the structure is excluded at LF. To obtain a grammatical LF structure, *everyone* needs to adjoin to VP, yielding (35):

(35) $[_{CP}$ Who$_j$ $[_{IP}$ t_j $[_{VP}$ everyone$_i$ $[_{VP}$ bought t_i for Max]]]]

Here the two paths {IP, CP} and {VP, VP}, do not overlap, so the structure is well-formed with respect to the PCC. In this structure *everyone* does not govern *who*, and so cannot have scope wider than *who*. (32) is predicted to be unambiguous. Since the PCC makes crucial reference to syntactic trees, and is itself motivated independently as a constraint on overt syntax, this account provides evidence for LF as a syntactic level of grammar.

2.4 *Restrictive Quantification*

An indirect argument for QR, and hence for LF, comes from the relative adequacy of restrictive quantification (RQ) over non-restrictive quantification (UQ) as a more faithful representation of the semantics of quantificational sentences. Consider the two logical formulas (3)–(4) again:

(3) $\forall x$ ((x is a student) $\rightarrow$ (x flunked))
(4) ($\forall$x: x is a student) (x flunked)

There are reasons that the RQ schema (4) is to be preferred over the UQ schema (3). For one thing, a sentence like (2) makes a claim about (a set of) students, as indicated by the RQ, but not about humans or objects in general, as implied by the UQ. Secondly, as pointed out by J. Higginbotham (personal communication), a UQ does not adequately distinguish the normal *Which man is a bachelor?* and the semantically odd *Which bachelor is a man?*, since on the existential interpretation of a *wh*-NP (see Karttunen (1977), among others), the two sentences would have the same semantic structure: (Which x) ((x is a man) & (x is a bachelor)), the left-to-right order of the two conjuncts being irrelevant to the semantics of the coordinate structure. On the other hand, the oddity of a sentence like *which bachelor is a man?* follows readily from the RQ formula *for which x, x a bachelor, x is a man?*, since every x such that x is a bachelor is necessarily a man. Thirdly, and most importantly, the semantics of quantifiers like *most, two thirds of*, etc., cannot be described within the vocabulary of the Predicate Calculus and a UQ, even if new operators like *Most x, Two thirds of x*, etc. are introduced. *Most students flunked* means neither *Most x ((x a student)*$\rightarrow$ *(x flunked))* nor

Most x ((x a student) & (x flunked)), but its meaning is faithfully represented in the RQ *(Most x: x a student) (x flunked)*. (See Higginbotham and May (1981), Barwise and Cooper (1981).)

If RQ is to be preferred over UQ, an argument for QR derives itself from the fact that the RQ schema is directly obtainable from the result of applying QR at LF, as explained above, the mapping from LF to semantic representation being quite trivial. In fact, given general constraints on Move-α, the theory of LF is simply unable to turn a simple sentence like (2) into a complex conditional sentence. The fact that the syntax of LF forces the choice of RQ over UQ lends important support to the QR rule, and hence to LF itself.

3 Pronouns as Bound Variables

3.1 *Weak Crossover*

Anaphoric pronouns may take referential or quantificational antecedents. In the former situation they are used in coreference, or overlapping reference, with their referential antecedents, whereas in the latter situation they are used as bound variables, their referential values varying with the value-assignment of their quantificational antecedents. These two uses of pronouns are not independent of each other. In particular, the indexing possibilities of a pronoun as a bound variable constitute a proper subset of the indexing possibilities of a pronoun taking a referential antecedent. Thus all impossible cases of pronouns in coreference are also impossible for pronouns as bound variables, but the reverse is not true.

(36) John$_i$ thinks that Bill$_j$ will praise him$_{i/*j}$
(37) Everyone$_i$ thinks that no one$_j$ will praise him$_{i/*j}$
(38a) John$_i$ loves his$_i$ mother
(38b) John$_i$'s mother loves him$_i$
(38c) His$_i$ mother loves John$_i$
(38d) *He$_i$ loves John$_i$'s mother
(39a) Everyone$_i$ loves his$_i$ mother
(39b) Everyone$_i$'s mother loves him$_i$
(39c) *His$_i$ mother loves everyone$_i$
(39d) *He$_i$ loves everyone$_i$'s mother
(40a) Someone$_i$ loves his$_i$ mother
(40b) Someone$_i$'s mother loves him$_i$

(40c) *His$_i$ mother loves someone$_i$
(40d) *He$_i$ loves someone$_i$'s mother

The ungrammatical indexings in both (36) and (37) are ruled out by condition B. The ungrammatical indexings in (38d), (39d), and (40d) are ruled out by condition C. Neither condition B nor condition C, however, rules out the ungrammatical (39c) and (40c). In other words, Binding Theory provides necessary, but not sufficient, conditions on the use of bound variable pronouns. The following examples illustrate the same point.

(41a) John$_i$ loved the woman who left him$_i$
(41b) The woman who left him$_i$ loved John$_i$
(42a) Everyone$_i$ loved the woman who left him$_i$
(42b) *The woman who left him$_i$ loved everyone$_i$

All of these sentences satisfy Binding Theory, but that is not sufficient to make (42b) grammatical.

Chomsky (1976) proposed to assimilate the paradigm in (39)–(40) to that of *wh*-questions:

(43a) Who$_i$ loves his$_i$ mother?
(43b) Whose$_i$ mother loves him$_i$?
(43c) *Who$_i$ does his$_i$ mother love t$_i$?
(43d) *[Whose$_i$ mother]$_j$ does he$_i$ love t$_j$?

(43d) is a case of "strong crossover," where an R-expression has moved across a c-commanding coindexed pronoun. (43c) involves "weak crossover," in which an R-expression has moved across a non-c-commanding coindexed pronoun. The strong crossover case can be ruled out by condition C,[3] along with the (d) sentences of (38)–(40). But the weak crossover case (43c) is unaccounted for by Binding Theory, as are the (c) examples of (39)–(40). Intuitively, whatever principle accounts for (43c) should also account for (39c) and (40c). A unified structural account is not available at S-Structure, since (43c) and (39c)–(40c) have very different structures at this level. No appeal to pre-movement levels (where the sentences have identical structures) is likely to work either, since pronominal anaphora is affected by movement:

(44a) John$_i$'s mother saw him$_i$
(44b) *He$_i$ was seen by John$_i$'s mother
(45a) *He$_i$ likes several pictures that John$_i$ took
(45b) How many pictures that John$_i$ took does he$_i$ like?

A unified account is available at LF, however. After QR applies to (39c) and (40c), the resulting LF structures are essentially identical to the structure of (43c):

(46) *[$_{IP}$ everyone$_i$ [$_{IP}$ his$_i$ mother loves t$_i$]]
(47) *[$_{IP}$ someone$_i$ [$_{IP}$ his$_i$ mother loves t$_i$]]

The common property of these sentences, then, is that they all involve a weak crossover configuration at the level of LF. To exclude all cases of weak crossover, Chomsky proposed the following "Leftness Principle," applied at LF:

(48) A variable cannot be the antecedent of a pronoun to its left.

The argument for LF comes from the fact that it makes possible a unified account of weak crossover observed across different surface constructions.

3.2 *Scope and Binding*

Although the Leftness Principle excludes weak crossover configurations at LF, it is not a sufficient condition for a pronoun to be used as a bound variable. For example, both of the following sentences are well-behaved with respect to the Leftness Principle and Binding Theory, but (50) is ill-formed:

(49) The woman who loved John$_i$ decided to leave him$_i$
(50) *The woman who loved every man$_i$ decided to leave him$_i$

(50) is not unlike the following sentences with a pronoun following the QNP (hence its trace at LF), but these are all well-formed:

(51) Every man$_i$'s mother loves him$_i$
(52) A report card about every student$_i$ was sent to his$_i$/her$_i$ parents

There is a crucial difference, however. In (51)–(52), the QNP binding the pronoun has scope over the entire sentence which contains the pronoun, but in (50) the QNP *every man* can only have scope over the relative clause containing it, but does not have scope over the matrix clause containing the pronoun. The relevant principle is that, even though the QNP may not c-command the pronoun at S-Structure (as in

all of (50)–(52)), it must c-command, i.e., have scope over, that pronoun at LF:

(53) A pronoun P may be bound by a quantified antecedent Q only if Q c-commands P at LF.

The distinction between (50) and (51)–(52) then follows from the fact that, at LF, the QNP is adjoined to the relative clause in (50), where it does not c-command the pronoun, but to the root IP in (51)–(52), where it does. The requisite distinction can be made at LF, but not at S-Structure.

Recall that a sentence like *A report about every student was sent out* is ambiguous between an inversely linked reading and an internal-scope reading. According to the former reading, every student is such that a report about him was sent out (five reports for five students); according to the latter, a report which contains information about every student was sent out (only one report). The principle (53) predicts, correctly, that (52) is not ambiguous under the bound variable reading of the pronoun, having only the interpretation according to which different reports were issued to different parents. A group reading would entail adjunction of *every student* to the N′ containing it, leaving the pronoun unbound at LF:

(54) $[_{IP}$ Every student$_i$ $[_{IP}$ $[_{NP}$ a report card about $t_i]$ was sent to his$_i$/her$_i$ parents]]

(55) *$[_{IP}$ $[_{NP}$ A $[_{N'}$ every student$_i$ $[_{N'}$ report card about $t_i]]]$ was sent to his$_i$/her$_i$ parents]

If the inversely linked reading is unavailable for some reason (e.g. the Specificity Condition), then a bound variable interpretation of the pronoun is impossible:

(56) *This report card about every student$_i$ was sent to his$_i$/her$_i$ parents

The cases we have examined should be distinguished from "donkey sentences" like the following, where the pronoun apparently can be related to the existential quantifier even though the quantifier does not have scope over the matrix sentence:

(57) Everybody who owns a donkey beats it

(58) Every student who found a cheap book bought it

(57) does not mean that there is a donkey such that everyone who comes to own it will beat it. A donkey pronoun should be distinguished from a true bound variable pronoun. As Evans (1980) puts it, a donkey pronoun (his "E-type" pronoun) is more like a definite description (therefore a referential expression),[4] deriving its reference from a preceding text containing the quantifier. *It* in (57) and (58) can be paraphrased as "the donkey that he owns" and "the book," respectively. But a true bound pronoun cannot be paraphrased in the same way.[5]

Two other properties of donkey pronouns distinguish them from true bound pronouns. First, when a donkey pronoun is used in connection with a universal quantifier, it must be in plural form, whereas either the plural or the singular may be acceptable for a true bound pronoun:

(59) Every student thinks she/they is/are smart
(60) If you see everyone, tell them/*him/*her to come here
(61) That report about every student shocked their/*his/*her parents

Secondly, a negative QNP like *nobody* cannot antecede a donkey pronoun, since the text containing it will derive no reference for the donkey pronoun to refer to. This is not the case with true bound pronouns, which do not refer at all:

(62) Nobody thinks he/she is smart
(63) *Everyone who owns no donkey will beat it
(64) *If you see nobody, tell him/her to come here

Summarizing, putting aside donkey pronouns, the use of pronouns as bound variables is subject to the following two conditions at LF: (a) that they occur in the scope of their antecedent QNP's, (b) that they respect the Leftness Principle.

3.3 *Alternatives to the Leftness Principle*

As stated in (48), Chomsky's Leftness Principle is given in linear terms. Conceptually, such an account is somewhat unsatisfactory, since abstract LF principles otherwise operate in hierarchical terms only. Empirically, furthermore, the Leftness Principle turns out to be too strong in certain cases and too weak in others. Reinhart (1983a, 129) points out the following contrasts:

(65a) Near his_i child's crib $nobody_i$ would keep matches
(65b) *Near his_i child's crib you should give $nobody_i$ matches

(66a) For his$_i$ birthday, each of the employees$_i$ got a Mercedes
(66b) *For his$_i$ birthday, we bought each of the employees$_i$ a Mercedes

In both the (a) sentences here, the pronoun precedes the quantifier antecedent (and hence its trace at LF). The bound interpretation is available in both cases, but it is incorrectly ruled out by the Leftness Principle.

Some examples indicating that the Leftness Principle is also too weak were pointed out by Higginbotham (1980a, 1980b):

(67a) Which pictures of which man$_i$ please him$_i$?
(67b) *Which pictures of which man$_i$ does he$_i$ like?
(68a) Everybody in some California city$_i$ hates its$_i$ climate
(68b) *Its$_i$ climate is hated by everybody in some California city$_i$

The problem is how the ungrammatical cases can be ruled out. In (67b), the pronoun does not precede a trace of *which* man at S-Structure (where there is no such trace), or at LF (where it follows the trace). Therefore the Leftness Principle is unable to rule out the bound construal. In the case of (68b), application of QR to both *everybody in some California city* and to *some California city* gives the following LF structure:

(69) [$_{IP}$ some California city$_i$ [$_{IP}$ [everybody in t_i]$_j$ [$_{IP}$ its$_i$ climate is hated by t_j]]]

In this structure, the pronoun follows the variable t_i and the Leftness Principle fails to rule out the non-existing bound construal.

Reinhart's alternative to Chomsky's account is formulated in terms of *c-command* (p. 122):

(70) Quantified NPs and *wh*-traces can have anaphoric relations only with pronouns in their c-command syntactic domain.

This condition sufficiently rules out all the weak crossover cases reviewed in the previous sections. It also successfully distinguishes the (a) and (b) sentences of (65) and (66), under a slightly modified notion of *c-command* independently defended in Reinhart (1981), according to which a preposed complement PP is c-commanded by a subject (though a sentence-initial topic is not). The examples follow because the preposed PP falls within the c-domain of the subject in (a), but not within the c-domain of the object in (b).

A proposal similar in spirit is made by Koopman and Sportiche (1982/3) in the form of the Bijection Principle (BP), as a condition on LF:

(71) There is a bijective correspondence between variables and A′ positions.

That is, a variable is locally bound by one and only one A′ position, and an A′ position locally binds one and only one variable. Koopman and Sportiche assume the functional definition of variables, according to which α is a variable iff it's locally A′-bound, whether α is an overt pronoun or a trace. The cases of weak crossover are excluded by the BP because they involve an A′ position locally binding two variables at LF (an overt pronoun and a trace):

(72) $[_{CP}$ Who$_i$ does $[_{IP}$ his$_i$ mother love $t_i]]$?
(73) $[_{IP}$ Everyone$_i$ $[_{IP}$ his$_i$ mother loves $t_i]]$
(74) $[_{IP}$ No one$_i$ $[_{IP}$ the woman he$_i$ loved betrayed $t_i]]$

In the permissible cases of bound pronouns below, the BP is obeyed at LF, with the A′ category locally A′-binding the trace, which in turn locally A-binds the pronoun:

(75) [Who$_i$ [t_i loves his$_i$ mother]]?
(76) [Everyone$_i$ [t_i thinks [he$_i$ is smart]]]

The same account also rules in (65a) and (66a), under Reinhart's modified version of *c-command*. In both cases, at LF, the trace of the subject quantifier locally A-binds the pronoun in the preposed PP and is in turn locally A′-bound by the quantifier. A bijective relationship is maintained throughout.[6]

Although they overcome certain difficulties of the Leftness Principle, both Reinhart's and Koopman and Sportiche's proposals still fail to account for the contrasts pointed out by Higginbotham, in (67)–(68). They also incorrectly exclude the bound pronoun in each of the following sentences below:

(77) No one's mother loves him
(78) The election of no president will please his or her opponents
(79) You should blame no one without letting him or her speak first
(80) No attempt by any student will succeed without his parents' help

These sentences also show that any attempt to attribute a pronoun in these contexts to its donkey pronoun use is bound to fail, since as we just saw, a donkey pronoun cannot be used in the context of a negative QNP. In the same way, the following sentences with singular pronouns indicate that they are true bound variables but not donkey pronouns:

(81) Applications from every student should be accompanied by his/her signature
(82) Under our blind review policy, the name of every author must be kept apart from the manuscript that he or she submitted

Higginbotham's (1980a, 1980b) treatment turns out to be more adequate in dealing with these problems. Essentially his solution consists of the condition that in order for a pronoun β to take α, α a QNP or an empty category, as its antecedent, α must be accessible to β. His definition of accessibility is paraphrased below:[7]

(83) α is accessible to β iff:
  (a) α is an empty category c-commanding β, or
  (b) α is coindexed with a category accessible to β, or
  (c) α is contained in an NP accessible to β.

In cases where a QNP c-commands a pronoun at S-Structure, accessibility obtains straightforwardly. The QR trace of the QNP is accessible by (83a), and hence the QNP is also accessible, by (83b). For a permissible case of a bound pronoun where the QNP does not c-command the pronoun, consider the LF structure of (68a):

(84) $[_{IP}$ some California city$_i$ $[_{IP}$ [everybody in $t_i]_j$ $[_{IP}$ t_j hates its$_i$ climate]]]

Neither the QNP *some California city* nor its trace t_i is accessible to *its* by (83a) or (83b) alone. However, the trace t_i is contained in NP_j, and this NP is accessible to the pronoun by (83b), since it is coindexed with t_i, which is accessible to the pronoun by (83a). Therefore, by (83c) the trace t_i is accessible, and in turn by (83b) the QNP is also accessible. However, in the LF structure of (68b):

(85) $[_{IP}$ some California city$_i$ $[_{IP}$ [everybody in $t_i]_j$ $[_{IP}$ its$_i$ climate is hated by t_j]]]

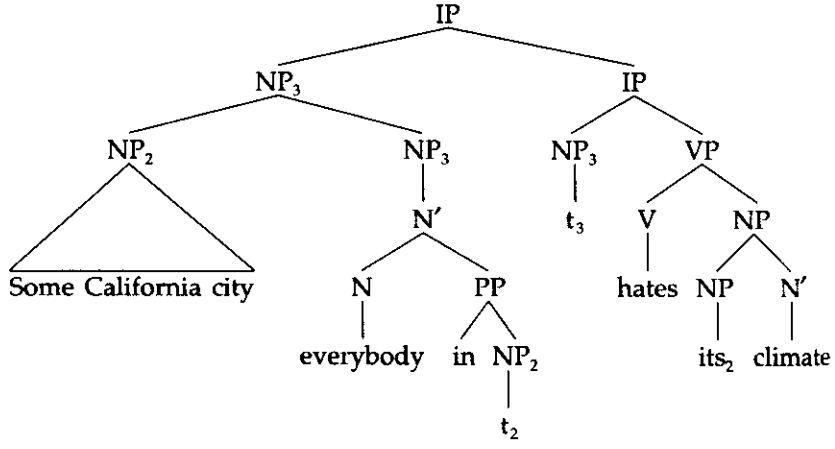
NP_j containing t_i is not accessible to the pronoun by any of (83): not by (a) because it's not an empty category, not by (b) because the only category with which it is coindexed does not c-command the pronoun, and not by (c) because it is not contained in any NP. Thus the trace t_i contained in NP_j is not accessible, hence also the QNP_i. The contrast between (67a) and (67b) follows in the same way, assuming that the QNP *which man* raises in LF, adjoining to CP:

(86a) $[_{CP}$ which man$_i$ $[_{CP}$ which pictures of $t_i]_j$ $[_{IP}$ t_j please him$_i]]]$?
(86b) $[_{CP}$ which man$_i$ $[_{CP}$ [which pictures of $t_i]_j$ $[_{IP}$ does he$_i$ like $t_j]$?

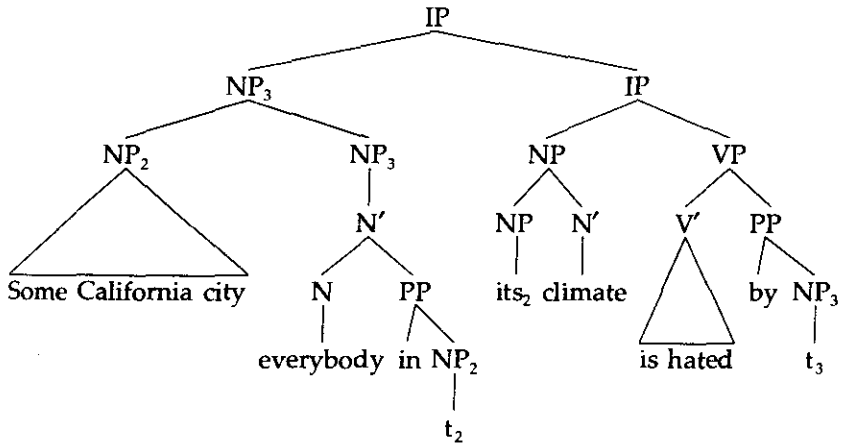
Note that according to the accessibility account, a non-empty category cannot be directly accessible to a pronoun by simply binding it, but must derive its accessibility through a coindexed empty category. This is because NP_j c-commands the pronoun in (86b) as much as it does in (86a). In other words, we cannot save Reinhart's condition by simply allowing a QNP to be contained in some NP that c-commands the pronoun at S-Structure, or the contrast in (67) would be unaccounted for. This means, in turn, that an account of (68) must refer crucially to LF, after QR has created empty categories on the basis of which accessibility is determined.

Another non-linear theory of bound variable pronouns is given in May (1985, 1988b) in terms of Pesetsky's (1982b) Path Containment Condition (PCC). May proposes a theory of adjunction which allows for a QNP adjoined to a subject NP to be directly interpreted as c-commanding the IP containing the subject. Thus the inversely linked readings of (68) of a QNP contained in another are obtained by simply adjoining it to the containing QNP:

(87)



(88)



In both (87) and (88), NP_2 adjoined to NP_3 c-commands both its trace t_2 and the pronoun *its*. In (87), there are three A'-paths. Path (t_3) starts from the lowest IP dominating it and consists of {IP, IP, NP_3}. Path (t_2) starts from PP and includes {PP, NP_3, NP_3}. These two paths meet at the top at NP_3 but do not overlap, so the PCC is irrelevant. Path (*its*) starts from the pronoun and consists of {NP, VP, IP, IP, NP_3}, again meeting the other paths at NP_3 without overlapping with either. The LF structure (87) is thus well-formed. In (88), Path (t_3) consists of {PP, VP, IP, IP, NP_3}, Path (t_2) consists of {PP, NP_3, NP_3}, and Path (*its*) consists of {NP, IP, IP, NP_3}. Path (t_3) and Path (*its*) overlap at three points, i.e. IP, IP, and NP_3. However, there is one link, namely the link between NP and IP in Path (*its*) which is not properly contained in path (t_3). Thus the LF structure (88) is ill-formed. The contrast between (68a) and (68b) thus follows from the PCC at LF.[8]

4 *Wh*-in-situ

That *wh*-phrases are also quantifiers is a relatively old idea and has been widely used in the generative literature (especially since Chomsky (1976)). Like ordinary quantificational NPs, they are non-referential. In standard semantic treatments, *wh*-questions are represented in quantificational schemas which denote possible or actual answers to them (cf. Karttunen (1977), Higginbotham and May (1981), Engdahl (1986) and the references cited there). In GB, *wh*-phrases are operators binding variables at LF, like other QNPs.

4.1 Selection

In English-type languages, *wh*-phrases are moved to [Spec, CP] at S-Structure, so at this level *wh*-questions are represented in quantificational schemas already, the conversion from (89) to (90) being quite trivial:

(89) Who_i did John see t_i?
(90) (Which x: x a person) (did John see x)?

The *wh*-movement observed here not only provides for a quantificational schema suitable for interpretation, but also fulfills a selectional requirement in syntax. Consider the following:

(91a) What does John think Mary bought t?
(91b) *John thinks what Mary bought t
(92a) *What does John wonder Mary bought t?
(92b) John wonders what Mary bought t
(93a) What does John remember Mary bought t?
(93b) John remembers what Mary bought t

These sentences have almost identical D-structure representations:

(94) John thinks Mary bought what
(95) John wonders Mary bought what
(96) John remembers Mary bought what

However, whereas (96) may be mapped into a direct question or a statement containing an indirect question at S-Structure, (94) must surface as a direct question, and (95) as a statement containing an indirect question. The differences in grammaticality among (91)–(93) are clearly to be attributed to the selectional properties of the matrix verbs: *think*-type verbs select declarative clauses, *wonder*-type verbs select questions, and *remember*-type verbs select either, as their complements. These differences are not directly observable in (94)–(96) at D-structure, since in each of these sentences the *wh*-phrase *what* is contained in the embedded clause, but the relevant generalization is captured at S-Structure by the requirement that each verb either requires, prohibits, or permits a question phrase in the Spec of its complement CP, i.e. *think*: +___[–wh], *wonder*: +___[+wh], and *remember*: +___[±wh]. In other words, *wh*-movement provides for a level of representation where the relevant selectional requirements may be stated.

Now consider *wh*-questions in languages of the Chinese type, where the *wh*-words are not moved at S-Structure.

(97) Zhangsan yiwei Lisi mai-le shenme?
Zhangsan thinks Lisi bought what
"What does Zhangsan think Lisi bought?"

(98) Zhangsan xiang-zhidao Lisi mai-le shenme
Zhangsan wonder Lisi bought what
"Zhangsan wonders what Lisi bought"

(99) Zhangsan jide Lisi mai-le shenme (?)
Zhangsan remember Lisi bought what
(99a) "Zhangsan remembers what Lisi bought"
(99b) "What does Zhangsan remember Lisi bought?"

Despite their similar appearance at S-Structure, these sentences nevertheless are interpreted very differently: (97) must be interpreted as a direct question to which an answer is needed, (98) as a statement containing an embedded question, and (99) as either. These restrictions are clearly the same restrictions just observed with the English sentences (91)–(93). The only difference is that whereas the restrictions are observed as a matter of *form* (i.e. grammaticality) in English, they present themselves as a matter of *interpretation* (e.g. presence vs. absence of ambiguity) in Chinese. A unified account of the relevant generalization is clearly desirable across *wh*-questions of these language types. In Huang (1982), it is proposed that such a unified account is readily available if it is assumed that *wh*-phrases in Chinese-type languages, even though they do not move in overt syntax, nevertheless undergo movement in LF. Assuming that *wh*-phrases move to [Spec, CP] in LF as they do in overt syntax, the structures below may be derived from (97)–(99):

(100a) [shenme$_i$ [Zhangsan yiwei [[Lisi mai-le t_i]]]]
for which x: x a thing, Zhangsan thinks Lisi bought x
(100b) [[Zhangsan yiwei [shenme$_i$ [Lisi mai-le t_i]]]]
Zhangsan thinks [for which x: x a thing, Lisi bought x]
(101a) [shenme$_i$ [Zhangsan xiang-zhidao [[Lisi mai-le t_i]]]]
for which x: x a thing, Zhangsan wonders Lisi bought x
(101b) [[Zhangsan xiang-zhidao [shenme$_i$ [Lisi mai-le t_i]]]]
Zhangsan wonders [for which x: x a thing, Lisi bought x]
(102a) [shenme$_i$ [Zhangsan jide [[Lisi mai-le t_i]]]]
for which x: x a thing, Zhangsan remembers Lisi bought x

(102b) [[Zhangsan jide [shenme$_i$ [Lisi mai-le t_i]]]]
Zhangsan remembers [for which x: x a thing, Lisi bought x]

Assuming that the selectional restrictions that account for (91)–(93) apply also at the level of LF, (100b) and (101a) are ruled out as ill-formed LF structures. This leaves (100a), (101b) and (102a)–(102b) as well-formed, representing the only possible interpretations of (97)–(99).

A typological view that emerges under this treatment of *wh*-in-situ is that languages do not differ in whether they have a rule of *wh*-movement or not. Rather, all languages have *wh*-movement as an instance of Move-α, but they differ in where *wh*-movement applies, if not in overt syntax then in LF.

4.2 *Scope*

In addition to accounting for question selection, *wh*-movement also serves to automatically fix the scope of *wh*-phrases *qua* quantifiers. It is commonly assumed that *wh*-phrases are existential quantifiers with interrogative features (*who* being *wh-* + *someone*). These two components of a *wh*-phrase can be taken apart by considering the presupposition of a question and its focus. Thus in uttering *who came?* the speaker presupposes that someone came and demands to know the identity of the one(s) who did come. Similarly, both the questions in (93) (repeated below) may be said to have the sentence (103) as their presupposition.

(93a) What does John remember Mary bought t?
(93b) John remembers what Mary bought t
(103) John remembers Mary bought something
(103a) There is something that John remembers that Mary bought
(103b) John remembers that there is something that Mary bought

Significantly, however, although as a sentence in isolation (103) allows *something* to have wide or narrow scope, as the presupposition clause of (93a) or (93b) it must be interpreted as in (103a) and (103b), respectively. This, of course, follows from the fact that it is impossible to do *wh*-movement without also doing "QR" at S-Structure in English. A similar restriction is observed with (99) in Chinese. Thus LF movement not only accounts for selection but also correctly fixes the scope of interpreted *wh*-phrases *qua* quantifiers.

The properties of *wh*s-in-situ in Chinese-type languages are also observable in multiple questions in English-type languages. A multiple question like (104) has one *wh*-phrase moved to [Spec, CP] and the other in situ:

(104) Who bought what?

A multiple question typically asks for the exact pairings of members from two or more restrictive domains defined by the occurring *wh*-phrases. A possible answer to (104) is (105):

(105) John bought the book, Mary the pencil, and Bill the pen

That is, the sentence is suitably interpreted by a restrictive quantification that ranges over possible ordered pairs, as given in the informal schema: [which pairing <x,y> : x a person and y a thing] [x bought y]. This schema can be obtained, following Higginbotham and May (1981), first by moving the unmoved *what* and adjoining it to *who* at [Spec, CP], thus forming a constituent with multiple operators, and then by invoking the rule of "absorption" which turns a string of unary operators into a single n-ary operator: [Qx, Qy, . . .] → [$Q_{<x, y, \ldots>}$]. Each unary operator ranges over individuals, but an n-ary operator ranges over ordered pairs.

One fact about English multiple questions, well known since Baker (1970), is that a sentence like (106) is ambiguous, admitting either (107) or (108) as an appropriate answer:

(106) Who remembers where we bought what?
(107) John remembers where we bought the books, Bill remembers where we bought the pencils, and Mary remembers where we bought the pens
(108) John does. John remembers where we bought what

(107) is an appropriate answer to (106) as a direct multiple question regarding the pairing <x,y> : x a person, y a thing, such that x remembers where we bought y. (108) is an appropriate answer to (106) as a singular question containing an embedded multiple question, where the matrix operator ranges over individuals and the embedded operator ranges over pairings of places and things. The ambiguity is one of scope, and it arises, under the LF movement hypothesis, out of the possibility of moving the unmoved *what* to the matrix or to the embedded CP.

4.3 *Locality Constraints in LF*

Although the facts surrounding scope ambiguities and the like are in themselves of considerable significance, the most important evidence

for the LF movement hypothesis again comes from the fact that the interpretation of syntactically unmoved *wh*-questions is subject to independently motivated syntactic constraints.

One of these well-known syntactic constraints is the Empty Category Principle (ECP) proposed in Chomsky (1981) and further developed in later works (see chapter 5 for details). In its original version, the ECP requires a trace to be properly governed, i.e. either lexically governed or antecedent-governed. A complement to a lexical category is lexically governed, but a subject is not, so a subject trace needs to be antecedent-governed but an object trace need not. Hence long extraction of a subject gives considerably worse results than long object extraction:

(109a) ??What did you wonder why I bought t?
(109b) *Who did you wonder why t bought the book?
(110a) ??This is the book that I wonder why you bought t
(110b) *This is the person that I wonder why t bought the book

Huang (1982) observes that long extraction of adjuncts exhibits severe locality effects on a par with long subject extraction, indicating that there is a more general asymmetry between complements on the one hand and non-complements on the other.

(111a) ??What did you wonder why I bought t?
(111b) *Why$_i$ did you wonder [what I bought t$_i$]?
(112a) ??This is the book that I wonder why you bought t
(112b) *This is the reason why$_i$ I wonder [what you bought t$_i$]
(113a) ?Of which city did you witness [the destruction t]?
(113b) *On which table did you buy [the books t]?

These contrasts also follow from the ECP. The trace in each of the (b) sentences is not lexically governed in VP or NP; hence it must be antecedent-governed and cannot be moved out of the *wh*-island or NP containing it. The severe locality effects of adjunct extraction are also clear in other island violations:

(114) *How$_i$ do you like the man [who fixed the car t$_i$]?
(115) *How$_i$ did you feel satisfied after [he fixed the car t$_i$]?
(116) *How$_i$ would [for him to fix the car t$_i$] be nice?

This account of adjunct extraction under the ECP has been refined in various ways over the years, most notably in Lasnik and Saito (1984,

1992), Chomsky (1986a), and Rizzi (1990), but the point to be made below about LF remains essentially unaffected.

The relevance of the ECP to LF *wh*-movement was first pointed out in Jaeggli (1982), Aoun, Hornstein, and Sportiche (1981), and Chomsky (1981), concerning the superiority phenomenon first discussed in Chomsky (1973).[9]

(117a) $[_{CP}$ Who$_i$ $[_{IP}$ t_i bought what]]?
(117b) *$[_{CP}$ What$_j$ did $[_{IP}$ who buy t_j]]?

The contrast illustrates a subject/object asymmetry – suggesting an ECP account – though paradoxically the situation is precisely the opposite of the ECP effects observed in (109)–(110), where a sentence is good with an object trace and bad with a subject trace. The paradox disappears, however, if we look at the asymmetry as holding of the unmoved *wh*-phrases: an object *wh*-in-situ is allowed but a subject *wh*-in-situ is not. Given the LF movement hypothesis, the asymmetry now holds of the traces created in LF, and this can be reduced to the ECP. Assume that the Spec of CP carries the index of the first *wh*-phrase moved into it, then the LF structures of (117) are as in (118):

(118a) $[_{CP}$ [What$_j$ Who$_i$]$_i$ $[_{IP}$ t_i bought t_j]]?
(118b) *$[_{CP}$ [Who$_i$ What$_j$]$_j$ did $[_{IP}$ t_i buy t_j]]?

The object trace of *what* is lexically governed in both (118a) and (118b), and the subject trace is not in either. In (118a) the subject trace t_i is antecedent-governed by the Spec of CP whose index is *i*. But in (118b) the subject trace t_i is not antecedent-governed by the Spec of CP whose index is *j*. (118b) is therefore ruled out by the ECP.

Huang (1982) points out that adjuncts also exhibit superiority effects like subjects:

(119a) Why did you buy what?
(119b) *What did you buy why?
(120a) Tell me how John fixed which car
(120b) *Tell me which car John fixed how

These are again reducible to the ECP at LF. The (b) sentences are excluded by the ECP because the LF-created traces of *why* and *how* fail to be properly governed. A similar account will explain the ungrammaticality of (121)–(123):

(121) *Who likes the man [who fixed the car how]?
(122) *Who drove away the car after [John fixed it how]?
(123) *Who said that [for John to fix the car how] would be nice?

The relevance of the ECP at LF receives strong support from the presence of a whole range of adjunct locality effects in Chinese (and other *wh*-in-situ languages). Thus, the following sentence in Chinese can have the interpretation (124a) as a direct question about the object bought, but not the interpretation (124b) as one about the reason for buying:

(124) ni xiang-zhidao [wo weishenme mai shenme]?
you wonder I why buy what
(124a) "What is the x such that you wonder why I bought x?"
(124b) Not: "What is the reason x such that you wonder what I bought for x?"

This complement/adjunct contrast mirrors the contrasts illustrated in (111)–(112) with respect to overt extraction out of *wh*-islands. Furthermore, direct questions with *weishenme* "why" contained in a relative clause, an adverbial clause, or a sentential subject are entirely unacceptable:

(125) *ni zui xihuan [weishenme mai shu de ren]?
you most like why buy book Comp person
"*Why do you like [the man who bought the books t]?"
(126) *ta [zai Lisi weishenme mai shu yihou] shengqi le?
he at Lisi why buy book after angry Prt
"*Why did he get angry [after Lisi bought the books t?]"
(127) *[wo weishenme mai shu] zui hao?
I why buy book most good
"*Why is [that I buy the books t] best?"

These restrictions mirror those observed with (114)–(116), and are accountable for under the ECP account, but only if the relevant *wh*-phrases are assumed to move in LF.

Other restrictions on question interpretation have been observed that also argue for an LF syntactic account. Huang (1982, 1991) observed a similar paradigm with the so-called A-not-A question in Chinese. This restriction may be reduced to the Head Movement Constraint of Travis (1984), or the ECP. Larson (1985) showed that the syntax of disjunction scope, as manifested by the properties of *whether* and *either*, is constrained by the ECP at LF. Baltin (1991) cites additional cases for

head-movement in LF. (In section 5.2 below, two cases of head-movement in LF will be presented in more detail.)

Summarizing, the postulation of LF as a syntactic level of representation has provided a very useful tool for the investigation of the nature of linguistic meaning and of the relationship between syntax and semantics. In particular, the notion that meaning is determined by form is amply demonstrated by the fact that many properties of quantificational sentences which are generally thought of as matters of interpretation are to a large extent seen to pattern on a par with matters of form and are explainable as such at little or no additional cost to the grammar. LF is a syntactic level because it is a level defined crucially by such syntactic entities as c-command, dominance, adjunction, binding, Move α, weak crossover, accessibility, paths, superiority, the Head Movement Constraint and the ECP.

Before we turn to the next section it should be noted that the account just described of the various locality effects of *wh*-in-situ represents only one version of the syntactic approach in GB. In addition to the ECP account represented by the works of Chomsky (1981, 1986a), Huang (1982), Lasnik and Saito (1984, 1992), and Rizzi (1990), at least two other approaches have been proposed in the literature to deal with roughly the same range of facts. One of these is the theory of Generalized Binding proposed by Aoun (1985, 1986) and developed in subsequent works (cf. Aoun, Hornstein, Lightfoot, and Weinberg (1987), Aoun and Li (1988), Hornstein and Weinberg (1991), etc.). In Generalized Binding, the requirement of antecedent government is recast as one of local A′-binding. The other approach that has gained considerable support in the literature considers the fundamental explanation for the movement constraints to lie in a theory of paths, defined over hierarchical syntactic structures, of the sort proposed in Kayne (1983b), Pesetsky (1982b) and developed in May (1985, 1988b). Among other things, Pesetsky (1982b) argues that the PCC, a condition independently motivated by constraints in overt syntax, also explains certain important facts about the distribution and interpretation of *wh*-in-situ. In addition, as we saw above, the PCC was employed in May (1985, 1988b) to account for weak crossover and certain constraints on *wh*–QP interactions.

Although these various approaches to the observed phenomena differ in non-trivial ways both conceptually and in their empirical coverage, they share the important common property of making crucial reference to the syntactic level of LF. In the concluding section of this chapter, I shall address three areas of current research concerning questions and issues which have become meaningful only as a result of recent research on LF.

5 Some Current Issues

5.1 Bounding Theory in LF

We have seen that LF movement exhibits the effects of syntactic constraints on overt movement, including most significantly the ECP or its counterpart in Generalized Binding or the Path Theory. As is well-known, overt syntactic movement is also constrained by conditions of Bounding Theory, including Subjacency (the *wh*-Island Condition (WIC) and the Complex NP Constraint (CNPC)), the Condition on Extraction Domains (CED) (which subsumes the Subject Condition (SC) and the Adjunct Condition (AC)), and the Coordinate Structure Constraint (CSC). If LF movement is constrained by the ECP, the question arises whether it is also subject to these bounding conditions.

Earlier inquiry into the nature of LF showed that the construal of quantifier scope is restricted by the CNPC (see Lakoff (1971), Rodman (1976)), and May (1977) suggested that LF mappings are constrained by Subjacency. Although this assumption works by and large in the cases involving QR, a problem arises when one considers the LF movement of *wh*-phrases from argument positions. Although, as we saw, LF extraction of an adjunct from an island is impossible, LF extraction of an argument appears to be completely free of island effects:

(128a) Who remembers why we bought what?
(128b) Who likes books that criticize who?
(128c) Who thinks that pictures of who are on sale?
(128d) Who got jealous because I talked to who?
(128e) Who bought the books on which table?
(128f) Who saw John and who?

These sentences also contrast sharply with cases where an argument is extracted at S-Structure:

(129a) *What do you remember why we bought t?
(129b) *Who do you like books that criticize t?
(129c) *Who do you think that pictures of t are on sale?
(129d) *Who did you get jealous because I talked to t?
(129e) *Which table did you buy the books on t?
(129f) *Who did you see John and t?

Singular questions in Chinese also exhibit an adjunct/argument asymmetry in LF. An example of this is already shown in (124), repeated below:

(124) ni xiang-zhidao [wo weishenme mai shenme]?
you wonder I why buy what
(124a) "What is the x such that you wonder why I bought x?"
(124b) Not: "What is the reason x such that you wonder what I bought for x?"

The sentence can have the reading (124a), though not the reading (124b). This means that whereas the adjunct *weishenme* "why" cannot be LF-moved across a *wh*-island headed by *shenme* "what," the latter can be LF-moved across a *wh*-island headed by the former. Similarly, in contrast to the ungrammatical (125)–(127) with an adjunct in an island, the following are perfectly grammatical when an argument is involved:

(130) ni zui xihuan [shei mai de shu]?
you most like who buy Comp book
"Who is the x such that you like the books that x bought?"
(131) ta [yinwei shei mai shu] shengqi le?
he because who buy book angry Prt
"Who is the x such that he got angry because x bought the books?"
(132) [wo mai shenme] zui hao?
I buy what most good
"What is it best [that I buy t]?"

These also contrast with those involving overt extraction of an argument (e.g. relativization):

(133) *[wo zui xihuan [t_i mai de shu]] de ren lai-le
I most like buy Comp book Comp person come-Prt
"*The person x such that you like the books that x bought has come"
(134) *[ni [yinwei t_i mai shu] shengqi] de neige ren zou-le
you because buy books angry Comp that person leave-Asp
"*The person x such that you got angry because x bought the book has left"

In other words, extraction of an adjunct shows locality effects both in overt syntax and in LF, whereas extraction of a complement exhibits such effects only under overt movement, not under LF movement. This led Huang (1982) to conclude that Bounding Theory is a condition on overt movement only, but that the ECP applies at both S-Structure and LF. Although the conclusion is not implausible, it raises the question of what makes overt movement and LF movement differ in this way. This

hypothesis remains a stipulation as long as it is not related to other, independently established differences between the two components of grammar. Empirically, furthermore, certain languages exhibit LF island effects that are not attributable to the ECP. In their study of "internally headed relative clauses" in Navajo, Barss, Hale, Perkins, and Speas (1991) (BHPS) argue that such constructions are best analyzed as involving a head-raising rule in LF. Internally headed relative clauses are "relatives-in-situ" constructions, on a par with *wh*-in-situ constructions, which undergo relativization in LF. BHPS further show that it is impossible to relativize an argument within a relative clause (both internally headed) and they suggest that this is a Subjacency effect. (See also Itô (1986) and Cole (1987) on the analysis of similar constructions in Japanese and Imbabura Quechua, respectively and other references cited.) Similarly, Longobardi (1991) shows that the interpretation of certain QNPs, for example the negative quantifier *nessuno* and *only*-phrases in Italian is systematically constrained by Subjacency, the CED and the CSC.

One sort of solution to this question comes from the LF pied-piping hypothesis proposed by Nishigauchi (1990), Choe (1987), and Pesetsky (1987). The idea is that, for some reason, LF movement of a *wh*-phrase is capable of pied-piping a larger chunk of material than overt movement. In the particular cases of apparent island violations observed here, LF movement of a *wh*-phrase in fact pied-pipes the whole island containing the phrase. Since the *wh*-phrase does not move out of the island, no bounding condition has been violated. On the other hand, assuming that adjunct *wh*-phrases cannot pied-pipe, movement must cross syntactic islands. Given this hypothesis, one can maintain that Bounding Theory applies in LF as much as it does in overt syntax, although its effects are generally invisible in LF due to the possibility of pied-piping. This solves the conceptual problem that has arisen under Huang's stipulation.

Fiengo, Huang, Lasnik, and Reinhart (1988) (FHLR) also appeal to the idea of pied-piping, but claim that pied-piping only occurs with *wh*-phrases *qua* quantifiers, not when they move into [Spec, CP] *qua* question words. That is, only QR may pied-pipe. Just as *everyone* is a quantifier ranging over individuals, *pictures of everyone* is also a quantifier, ranging over pictures of individuals. Thus any indefinite phrase containing a quantifier is also subject to QR.[10] The fact that pied-piping occurs more extensively in LF than in overt syntax reduces to the fact that QR is a rule of LF, not of overt syntax. FHLR further adopt the theory of adjunction proposed in May (1985), and the theory of barriers of Chomsky (1986a), according to which adjunction of a category to a barrier has the effect of debarrierizing the barrier. Thus a *wh*-phrase

contained in a syntactic island XP may be moved out of XP after the entire XP is pied-piped to an adjoined position under QR. As in Nishigauchi, Choe, and Pesetsky's proposal, Bounding Theory applies to LF as much as it does in syntax.

Pesetsky (1987) proposes an additional explanation for certain apparent island violations in terms of the notion of "D(iscourse)-linking". Certain *wh*-phrases are used in discourse in which the range of their reference is somewhat transparent. These are assumed not to move in LF, but are simply "unselectively bound" by an appropriate [+*wh*] C^0, as originally suggested in Baker (1970). This explains contrasts like the following, and other apparent island violations:

(135a) What did which man buy?
(135b) *What did who buy?

Adjunct *wh*-phrases are never D-linked, whereas *which*-phrases are always D-linked. And argument *wh*-phrases like *who* and *what* may in some circumstances be D-linked. Thus adjunct extraction always exhibits island effects, but argument extraction need not.

If all apparent island violations in LF are explainable away in terms of either pied-piping (under *wh*-movement or under QR) or D-linking, then all bounding conditions apply in LF as they do in syntax. However, none of these proposals are entirely free of problems, and other authors have taken other directions to explain apparent island violations. For example, Hornstein and Weinberg (1991) propose that LF movement may affect a smaller part of a phrase than syntactic movement does (exactly the opposite of pied-piping), assuming with Huang (1982) that Subjacency does not apply in LF. In (135a), movement may affect only the determiner *which*, leaving a trace properly governed by the head noun *man*.[11] Watanabe (1992) also claims that Subjacency does not apply in LF, arguing that some island effects observed in LF are in fact effects caused by the invisible movement of an abstract operator at S-Structure. The most important evidence comes from the fact that Comparative Deletion in Japanese, which is formed by S-Structure movement as shown by Kikuchi (1987), cannot apply across embedded questions:

(136) *[minna-ga [naze Paul-ga e yonda ka] siritagatteiru
everyone-Nom why Paul-Nom read Q know-want
yori(mo)] John-ga takusan-no hon-o yonda
than John-Nom many-gen book-Acc read
"*John read more books than everybody wants to know why Paul read"

However, at S-Structure an embedded question is still not an island since the *wh*-word has not moved at this level. Watanabe concludes from this and similar considerations that there is an invisible movement that fills the relevant [Spec, CP] at S-Structure, and that it is this movement that forms a *wh*-island, rendering Comparative Deletion impossible in (136). Watanabe also suggests that the LF island effects observed with internally headed relative clauses in various languages and with negative and *only*-phrases in Italian actually arise from S-Structure movement of an invisible operator. Watanabe's analysis, if correct, has important consequences for parametric theory and the theory of LF, which will no doubt interest other researchers in this area.

5.2 *Binding Theory in LF*

A second recent issue concerning the theory of LF has to do with the treatment of Binding Theory at this level. Earlier investigations of LF centered around the properties of quantificational sentences only, including the properties of quantificationally bound pronouns. An exception is Aoun's work on Generalized Binding, which requires Binding Theory (including A-binding and A'-binding) to apply at LF, thus letting LF play an important role in the theory of A-binding as well. More recently, more linguists have relied increasingly on LF as the level where Binding Theory applies.

One line of research originates with Lebeaux's (1983) and Chomsky's (1986b) treatment of nominative anaphors involving an LF process of anaphor raising, which inspired considerable work on long-distance anaphora, among them the work of Pica (1987), Battistella (1987), Huang and Tang (1991), Cole, Hermon, and Sung (1990), and Katada (1991), among many others. It has been well known that in many languages reflexives may have long-distance antecedents. However, long-distance binding is subject to various restrictions, thus casting doubt on solutions that simply parametrize binding categories across languages. For example, in Chinese the bare reflexive *ziji* can have a long-distance antecedent, but only when the remote antecedent agrees with all closer potential antecedents in their phi-features.

(137) Zhangsan$_i$ juede Lisi$_j$ zongshi piping ziji$_{i/j}$
Zhangsan feel Lisi always criticize self
"Zhangsan said that Lisi always criticized him/himself"

(138) Zhangsan$_i$ juede wo$_j$ zongshi piping ziji$_{*i/j}$
Zhangsan feel I always criticize self
"Zhangsan said that I always criticized *him/myself"

(139) ni_i juede $Lisi_j$ zongshi piping $ziji_{*i/j}$
you feel *Lisi always* *criticize self*
"Zhangsan said that Lisi always criticized *you/himself"

Huang and Tang propose that the facts surrounding long-distance *ziji* can be accounted for nicely if *ziji* is assumed to undergo IP-adjunction, i.e. QR, in LF, and if Binding Theory applies at LF, in addition to S-Structure. Since the bare reflexive does not contain phi-features, the first pass of Binding Theory enables the reflexive to inherit the phi-features, but not referential features from the local antecedent. In LF, adjunction of *ziji* to IP enables it to be locally bound by a higher antecedent, as long as the antecedent matches the phi-features that *ziji* now possesses. Long-distance anaphora is blocked in (138) and (139) because the reflexive has received phi-features from the local antecedent prior to LF movement, making it incompatible with the remote antecedent.

Katada (1991) also offers an LF analysis of long-distance *zibun* in Japanese. She shows that *zibun* behaves more like an operator than other forms of the reflexive pronoun, suggesting that it should appear in A′ position in LF. A common property of Katada's and Huang and Tang's proposals is, then, the view that the bare reflexives are both operators and anaphors, and hence they undergo QR (*qua* operators) and are subject to condition A (*qua* anaphors) at LF, which combine to derive their long-distance properties.

The accounts proposed by Pica, Battistella, and Cole, Hermon, and Sung treat the long-distance anaphors more in line with the Lebeaux–Chomsky proposal, taking the movement involved to be one of head-movement of the bare reflexive to I^0. Though these accounts differ non-trivially from the XP-movement account, they share the spirit of reducing apparent long-distance anaphora to successive links of local anaphora, relying on the level of LF. For more details of these analyses, see chapter 4 in this volume, and the references cited.

Although, in contrast to reflexives, reciprocals are typically locally bound, Higginbotham (1981) and Lebeaux (1983) show that they may also exhibit long-distance binding.

(140) John and Mary think they like each other

This sentence is ambiguous, meaning either (a) that John and Mary think that they, John and Mary, like each other, or (b) that John thinks he likes Mary and Mary thinks she likes John. As Higginbotham indicates, this ambiguity is a matter of scope, the first reading instantiating the narrow scope reading of *each other*, and the latter its wide scope

reading. An important contrast with (140) is observed in the following sentences:

(141) John and Mary think that we like each other
(142) *John and Mary think that I like each other

(141)–(142) cannot have the wide scope reading. Thus (141) cannot have the reading that John thinks that we like Mary and Mary thinks that we like John. As Lebeaux (1983) indicates, the wide scope reading is available only when the local subject is understood anaphorically, as in the wide scope paraphrase of (140).

Now the standard Binding Theory does not provide an adequate way to represent the two readings, since the standard indexing system gives only the following representation for both readings of (140):

(143) John and Mary$_i$ think they$_i$ like each other$_i$

The theory also fails to explain why the wide scope reading disappears in (141)–(142).

In a recent paper, Heim, Lasnik, and May (1991) (HLM) take up this problem and show that the relevant facts fall together naturally under an LF account they propose, modifying an earlier proposal by Lebeaux (1983). Specifically, in LF a reciprocal sentence has the element *each* adjoined to an NP:

(144) [[John and Mary] each$_2$] like [e$_2$ other]

The NP to which *each* is attached is then interpreted distributively. The ambiguity of (140) concerns which NP is interpreted distributively, i.e. an ambiguity concerning the scope of *each*:

(145) [[John and Mary] each$_2$] think they like [e$_2$ other]
(146) John and Mary think that [[they] each$_2$] like [e$_2$ other]

To account for the locality or "blocking effects" illustrated in (141) and (142), HLM propose that in a representation like (144), (a) the trace e_2 of *each* in *[e_2 other]* is an anaphor, and (b) the phrase *[e_2 other]* is an R-expression. (Furthermore, both the [NP-*each*] phrase and the *[e_2 other]* phrase are quantificational, subject to QR.) As an anaphor, the e_2 must be bound in its governing category. In both (145) and (146), this requirement is fulfilled, and the sentence is ambiguous, just in case the embedded subject *they* has index 2 and binds e_2. The sentence (141) has only the narrow scope reading because *we* must locally bind the trace

of *each,* and *we* cannot be coindexed with *John and Mary.* (142) is ill-formed because the singular embedded subject cannot have a distributive interpretation.

HLM note that the same proposal also solves the "grain puzzle" discussed by Higginbotham (1985), as illustrated in (147), which poses another serious problem to the classical binding theory:

(147) John and Mary told each other that they should leave

This sentence has at least the following three readings: John and Mary told each other: (a) "I should leave," (b) "You should leave," or (c) "We should leave." The LF representation after *each* is adjoined to *John and Mary* is (148):

(148) $[[\text{John and Mary}]_1 \text{ each}_2 \text{ told } [e_2 \text{ other}]_3 \text{ that they should leave}$

The three readings are simply those according to which *they* takes (a) the distributed sense of *John and Mary,* (b) the R-expression *[e_2 other],* and (c) the group sense of *John and Mary* as its antecedent.

Note that there is a striking similarity between the Huang–Tang–Katada account of long-distance reflexives and the HLM treatment of "long-distance reciprocals." In both cases long-distance binding is subject to some local blocking effects. In both accounts the relevant categories are treated as having a dual status, both as an anaphor and as an operator. And the interactions of Binding Theory and QR give the result that long-distance reciprocals and reflexives are limited in the way they are.[12]

Other principles of Binding Theory have also begun to play an increasing role in LF. For example, within the Generalized Binding framework, Aoun and Li (1988) and Aoun and Hornstein (1991) show that bound variable pronouns are subject to not only an A-disjointness requirement (Principle B), but also an A′-disjointness requirement, at LF. As for Principle C, the idea that it can apply in LF has been around for several years, but it has also been generally assumed that it must also apply at S-Structure. The most important evidence comes from the contrast below:

(149) Which picture that John_i took did he_i like t?
(150) *He_i liked every picture that John_i took
(151) *Who knows he_i likes how many pictures that John_i took?

The distinction between (149) and (150)–(151) is drawn if Principle C applies at S-Structure. At LF, (150) and (151) have their object phrases

preposed, yielding structures which do not differ from (149) as far as Principle C goes:

(152) *[[Every picture that John$_i$ took] [he$_i$ liked t]]
(153) *[[How many pictures that John$_i$ took] who] [t knows he$_i$ likes t]]?

A different possibility is considered in Chomsky (1992), and in Hornstein and Weinberg (1991), who propose that the LF movement may affect only the QP or determiner of a QNP, but need not pied-pipe. (See also Dobrovie-Sorin (1992), who discusses both the determiner-raising and the NP-raising possibilities.) Suppose that there is actually an anti-pied-piping requirement (perhaps based on economy considerations), then in (150) and (151) only *every* and *how many* (or merely *how*) will be moved in LF. The LF structures of these sentences can be ruled out at this level. This makes it possible to require Binding Theory to apply at LF only, trivializing the role of S-Structure, and has other consequences for the general theory of grammatical design.

5.3 *Comparative Semantics*

As indicated in section 4.1, the LF movement hypothesis of *wh*-in-situ has the consequence that languages do not differ in whether they have a rule of *wh*-movement, but in where the rule applies, if not in overt syntax then in LF. The conception of grammar embodying this and other assumptions of LF has led to numerous fruitful studies on a diverse range of languages in the past decade with results that form the basis of a field of "comparative semantics," or typology of LF, as part of comparative syntax. Variations across languages in the interpretive properties of their sentences are reduced to certain parameters of Universal Grammar whose values may be fixed on the basis of primary linguistic data. For example, we noted earlier that although in the Chinese-Japanese type of languages a sentence like (99) (repeated below) is ambiguous, the corresponding English sentences are not, as in (93):

(99) Zhangsan jide Lisi mai-le shenme (?)
Zhangsan remember Lisi bought what
(99a) "Zhangsan remembers what Lisi bought"
(99b) "What does Zhangsan remember Lisi bought?"
(93a) What does John remember Mary bought t?
(93b) John remembers what Mary bought t

This difference in ambiguity is a fact of comparative semantics reducible directly to the parameter of where *wh*-movement takes place. The scope of a *wh*-phrase is fixed once it moves to an A′-position binding a variable. Chinese and English *wh*-questions have the same D-structure representations; in English they are disambiguated in the mapping from D-structure to S-Structure, but in Chinese they are disambiguated in the mapping from S-Structure to LF.

5.3.1 *Quantifier Scope*

A similar cross-linguistic contrast in scope ambiguity of quantifiers is observed by Kiss (1991). Kiss shows that in Hungarian non-interrogative quantifiers may be adjoined to VP at S-Structure, unlike quantifiers in English, or they may stay in their base positions, as in English. One may think of this as meaning that QR may apply in overt syntax in Hungarian, though in English it only applies in LF. What is interesting is that quantifiers that are A′-moved this way do not exhibit scope ambiguities, whereas those that stay in their base positions often display such ambiguities, as quantifiers in English typically do. The difference between Hungarian and English with respect to QR is thus on a par with that between English and Chinese with respect to *wh*-movement. Thus, another fact of comparative semantics follows from the parameter of where a particular instance of Move-α applies in the grammar.

There are other cross-linguistic differences in quantifier scope ambiguities. For example, although in English a sentence like (154) is now generally considered to be ambiguous between a distributive and a collective reading, it has been observed that similar ambiguities are often not found in Chinese or Japanese (S. Huang (1981), Huang (1982); Hoji (1985)). In contrast to (154), (155) does not have a *purported* collective reading:

(154) Every student bought a book (ambiguous)
(155) mei-ge xuesheng dou mai-le yi-ben shu
every student all bought one book
"Every student bought one book or another" (unambiguous)

Huang (1982) proposed that the non-ambiguity of (155) follows from a general correspondence principle which says that if QNP1 c-commands QNP2 at S-Structure then there is a representation at LF in which the same c-command relationship is preserved. In fact, the correspondence principle, which has been dubbed the Isomorphic Principle in Aoun and Li (1989) (A&L), has its origin in earlier works on quantifier scope

in English (Lakoff (1971), Reinhart (1976); cf. also a linear version given in Kroch (1974) and S. Huang (1981)). The essence of the principle is also found in current work (e.g., the Rigidity Condition of Lasnik and Saito (1992), and the principle of "Relation Preservation" in Watanabe (1991).) A&L proposed a modification of the Isomorphic Principle to allow the trace of a QNP to play a role in determining quantifier scope. That is, for two QNPs α and β, α may have scope over β if α c-commands β or a trace of β. This offers a simple account of the contrast between (31) and (32) highlighted in May (1985):

(31) What$_i$ did everyone buy t_i for Max?
(32) Who$_i$ t_i bought everything for Max?

In (31), *what* c-commands *everyone*, and *everyone* c-commands the trace of *what*, so the sentence exhibits scope ambiguity. In (32), *everything* c-commands neither *who* nor the *wh*-trace, so the sentence has only a collective reading.

The necessity of some version of the Isomorphic Principle appears to be beyond doubt then. Its incorporation into the theory of grammar is also quite natural, and conceptually fits into the general considerations of economy of derivation (Chomsky (1991, 1992)). The question that remains is, how the cross-linguistic difference illustrated in (154)–(155) is to be explained. One cannot, of course, account for the difference by parametrizing the Isomorphic Principle itself; this move is excluded not only on learnability grounds, but also on grounds of examples in English (e.g. (31)–(32)) which show the relevance of the principle. Therefore this fact of comparative semantics must be explained in some other way. Attempts at an explanation were made in Huang (1982) and A&L (1989). Huang's proposal was that the English–Chinese difference should follow from the head-directionality parameter which characterizes the surface word order differences between the two languages, and a concomitant difference in the possibility, or lack thereof, of vacuously extraposing one quantifier above the other.[13] A&L's was to relate the difference to a difference in the D-structure position of the subject in these two languages, which amounts to parametrizing the VP-internal Subject Hypothesis. Both accounts are somewhat incomplete (see A&L and Huang (1993) for discussion), however, and a thorough explanation of this contrast is still yet to come.

5.3.2 *Bound Variable Pronouns*

The properties of bound variable pronouns also show considerable variation among languages. One of the earliest observations in this area

was made by Higginbotham (1980b), who showed that, although sentences like *Whose mother loves him?* admit a bound reading of the pronoun, corresponding sentences in Chinese are generally judged to have no bound reading. An important fact of variation was brought to light in Saito and Hoji's (1983) study of weak crossover in Japanese, where it is reported that overt pronouns only have a referential use, and that only zero pronouns or reflexives can take quantificational antecedents in this language. The following sentences are ungrammatical under a bound construal, but become grammatical once the overt pronoun is replaced by *zibun* "self" or a zero pronoun:

(156) *daremo-ga [kare-ga atamaga ii to] omotteiru
everyone-Nom he-Nom smart-be Comp think
"Everyone thinks he is smart"

(157) *daremo-ga [John-ga kare-o nagutta to] omotteiru
everyone-Nom John-Nom he-Acc hit Comp think
"Everyone thinks that John hit him"

Montalbetti (1984) observes that there is also a ban on using overt pronouns as bound variables in Spanish, but only when they appear as subjects. So sentences corresponding to (156) are also ill-formed in Spanish, though those corresponding to (157) are well-formed. Aoun and Li (1988) also observe a similar but somewhat different restriction on overt pronouns in Chinese.

The question raised by these facts for comparative semantics is how the differences among these languages can be reduced to independent, learnable parametric differences among them. Montalbetti (1984) observed that the environments in which overt pronouns are excluded from bound variable interpretations are those in which an empty pronoun is available. English does not allow *pro*-drop, so overt pronouns may be used as bound variables. Spanish allows *pro*-drop in subject positions, but not in object positions, so only in the subject position are overt pronouns prohibited from having bound interpretations. And Japanese disallows overt bound pronouns in both subject and object positions, because zero pronouns are allowed in both positions, etc. Montalbetti proposed the Overt Pronoun Constraint (OPC), which prohibits an overt pronoun to be linked to a variable just in case the overt/empty alternation obtains. The explanation provided by the OPC appears to be quite natural; in fact, it may simply be a formal statement of the informal "Avoid Pronoun" principle suggested in Chomsky (1981) which accounts for the following:

(158) John$_i$ enjoys PRO$_i$ reading these books

(159) ??John$_i$ enjoys his$_i$ reading these books

Although (159) is not nearly as bad as (156)–(157), this is probably due to the fact that although binding is prohibited in (159), the sentence may nevertheless be acceptable under accidental coreference. With a non-referential antecedent, the Avoid Pronoun effect is clear:

(160) Who enjoys PRO reading these books?
(161) *Who enjoyed his reading these books?

Aoun and Li (1988) and Aoun and Hornstein (1991) take the restriction on overt bound pronouns to be a reflection of their A′-disjointness principle, which requires an overt pronoun to be A′-free in its minimal governing category with a subject. For some of the speakers they consulted, the following facts obtain:

(162) *shei shuo ta kanjian-le Lisi?
who say he see-Perf Lisi
"Who said that he saw Lisi?"
(163) shei shuo Lisi kanjian-le ta?
who said Lisi see-Perf he
"Who said that Lisi saw him?"
(164) shei zhidao ni shuo ta kanjian-le Lisi?
who knows you say he see-Perf Lisi
"Who said that you said that he saw Lisi?"

That is, an overt pronoun in an embedded clause cannot be quantificationally bound in the immediate clause up if it occurs as a subject (162), but binding is possible if it occurs as an object (163), or in a further embedded clause (164). This locality effect is accounted for by their principle, in effect a "condition B" of A′-binding. In (162), the minimal CP containing the overt pronoun and a distinct subject is the root clause, so the pronoun cannot be A′-bound in this clause. In both (163) and (164), the minimal CP containing the pronoun and a distinct subject is embedded under the main verb, so the pronoun may be A′-bound in the main clause.

The A′-disjointness theory accounts for certain contrasts that Montalbetti's OPC account does not. For example, although the subject/object asymmetry between (162) and (163) is explained by the OPC under the assumption that Chinese has subject *pro*s but no object *pro*s (Huang (1984)), the well-formedness of (164) is unexpected with an overt subject pronoun.[14] Furthermore, the following seems to obtain for some speakers of English:

(165a) ?*The election of no president$_i$ will please him$_i$
(165b) The election of no president$_i$ will please his$_i$ critics

The ameliorating effect of further embedding observed here may be explained under some appropriate version of the A'-disjointness principle (on a par with the contrast **John saw him* vs. *John saw his mother*), but the OPC has nothing to say here since English is not a *pro*-drop language.

The theory of A'-disjointness is not without its problems, however. For example, Japanese disallows overt bound pronouns regardless of their depth of embedding, and Italian/Spanish excludes overt bound pronouns from embedded subject position even though the embedded clause is the disjointness domain in this language (with Agr). Furthermore, it is not clear why zero pronouns are not subject to the A'-disjointness principle given that they are obviously subject to the A-disjointness principle, though this question does not arise in the OPC account. Finally, for the speakers who accept all of (162)–(164), neither the OPC nor the disjointness theory provides an account for these sentences. So the issue surrounding variations in bound variable pronouns is still open.

5.3.3 Wh-*in-situ*

An issue of variation that has emerged since Huang's (1982) and Lasnik and Saito's (1984) investigation of *wh*s-in-situ is that, although the complement/adjunct asymmetry with respect to *wh*-extraction evidently holds universally of all languages, and of both overt and covert movement, languages like Chinese and Japanese do not display the familiar subject–object asymmetry observed in English and other languages. Thus, although the following sentences cannot be interpreted as a direct *why*-question or a direct A–not-A question, they can be easily interpreted as direct questions regarding the embedded subject *shei* "who":

(166) ni xiang-zhidao [shei weishenme mai shu]?
you wonder who why buy book
"Who is the x such that you wonder why x bought the books?"

(167) ni xiang-zhidao [shei you-mei-you mai shu]?
you wonder who have-not-have buy book
"Who is the x such that you wonder whether x bought the books?"

The absence of subject-ECP effects under overt *wh*-movement in certain "free inversion" languages is, of course, familiar since Rizzi (1982), but their absence in Chinese–Japanese crucially cannot be accounted for along Rizzi's well known solution in terms of inversion, since the

issue concerns *wh*-in-situ and since these languages do not allow free inversion.

The account for this variation suggested by Huang (1982) was that the subject is somehow properly governed internally in Chinese. The specific execution of this idea was to simply stipulate that I^0 is a proper governor in this language. A more satisfactory execution of the idea was proposed by Koopman and Sportiche (1991) (K&S), under the VP Internal Subject Hypothesis. K&S propose, in essence, that although in all languages the subject is base-generated in [Spec, VP], languages differ as to where the subject is at S-Structure. In particular, in English-type languages the subject raises from [Spec, VP] to the [Spec, IP] position, binding an NP trace, prior to *wh*-movement, whereas in Chinese-type languages raising to [Spec, IP] is not required. Hence, *wh*-movement of a subject must always take place from the [Spec, IP] position in English, whether it takes place at S-Structure or in LF, but in Chinese extraction may directly take place from the [Spec, VP] position. The lack of subject ECP effects in Chinese thus follows from the fact that its subjects are lexically governed in [Spec, VP] and need not be antecedent-governed.[15]

K&S's account works as far as the above facts go. It has been observed recently, however, that even in English a subject *wh*-in-situ may fail to display locality effects (see May (1985), Lasnik and Saito (1992), Tiedeman (1990)). Consider English multiple questions corresponding to (166)–(167):

(168) Who remembers why who bought the books?
(169) Who remembers whether who went to the movies?

These sentences are in fact well-formed if the embedded subject is paired with the matrix subject, but not if it is paired with the embedded *wh*-phrase (cf. **Why did who buy the books?*, **What did who buy?*). On the matrix paired-list reading, the embedded subject does not exhibit any ECP effect. English and Chinese do not differ, then, in allowing subject long extraction in LF. The real difference seems to lie between overt movement, where long extraction of the subject is excluded, and LF movement, where it is not. Tiedeman (1990) suggests that the difference stems from the nature of proper government, which should be defined in linear terms at S-Structure (*à la* Kayne's (1983b) notion of canonical government), but in pure structural terms at LF. This has the effect that subjects are properly governed by I^0 at LF but not at S-Structure, since I^0 occurs to the right of subjects. Huang (1993), on the other hand, proposed that the possibility of long subject extraction follows from the

assumption that the LF-created trace in [Spec, IP] can be deleted freely in the presence of a trace in VP-internal subject position, in accordance with general considerations of economy of representation. Because of the possibility of deletion, an LF-created subject trace will not cause any ECP violations.[16]

A final issue of variation has to do with the very fact that languages vary in whether or not they exhibit (overt) *wh*-movement. The theory of LF states this variation in terms of where *wh*-movement takes place in grammar, but deeper questions concerning this typology have not been addressed. For example, why is it that in Chinese and Japanese, but not in English, *wh*-phrases move only in LF? And why is it that in Polish but not, say, in French, all *wh*-phrases have to be fronted in overt syntax? One plausible answer to the first question may be derived from Nishigauchi's (1990) and Li's (1992) recent studies concerning the various uses of *wh*-phrases. It is well known that *wh*-words in Chinese and Japanese, in addition to their uses as question words, may also be used as existential or universal quantifiers, though in English they are used as question words only. Thus depending on different contexts the phrase *shenme* may have an interrogative, universal, or existential reading:

(170) ni xiang mai shenme (ne)?
you want buy what Q
"What do you want to buy?"

(171) wo shenme dou mai
I everything all buy
"I will buy everything"

(172a) wo bu xiang mai shenme
I not want buy anything
"I don't want to buy anything"

(172b) ni xiang mai shenme ma?
you want buy something Q
"Would you like to buy something?"

(172c) ta dagai mai-le shenme le
he probably buy-Perf something Part
"He probably bought something"

In brief, a *wh*-word is interpreted as an existential quantifier in a negative or affective context (172a–b), or minimally a context where the truth of a proposition is not positively asserted (172c); as a universal quantifier in the context of the adverb *dou* "all"; and as a question word otherwise. The exact quantificational force of a *wh*-word is therefore not inherently fixed, but determined by its context. This

reminds one of a similar property of indefinite NPs, as treated in Lewis (1975) and Heim (1982), whose quantificational force seems to vary depending on the types of adverbs of quantification that "unselectively" bind them. One natural answer to why *wh*-phrases in Chinese and Japanese must stay in situ may then be that they must be in the domain of some appropriate binder at S-Structure in order to be interpreted as interrogative phrases. If they were moved to [Spec, CP] at S-Structure outside of the domain of an unselective binder, they would be left uninterpreted. One way to execute this idea is to invoke a rule that assigns a *wh*-phrase the features of a universal, existential, or interrogative quantifier at S-Structure under an appropriate binder. Once the appropriate features are assigned, the *wh*-phrases may then be subjected to the appropriate LF-movement process (QR or *wh*-movement).

Cheng (1991) observes that the lack of syntactic *wh*-movement in a given language generally correlates with the availability of question particles in that language. For example, in Mandarin Chinese yes/no questions require the final particle *ma*, and direct *wh*-questions, disjunctive questions, and A–not-A questions may optionally take the particle *ne*. In Japanese the question particle *ka* or *no* is routinely required of all questions. And these languages employ the in-situ strategy of forming questions. English, on the other hand, does not have question particles, and *wh*-movement is obligatory in this language. Cheng proposes a theory of Clausal Typing to account for this correlation. According to this theory, all interrogative clauses must be typed as such by some marking within the CP constituent, and languages may type a clause as a *wh*-question by base-generating a question particle under CP, or by moving a *wh*-phrase into its Spec. Question particles in Chinese and Japanese thus not only unselectively bind *wh*-words and give them their interrogative force, but also serve to type clauses as interrogatives. The lack of syntactic *wh*-movement in Chinese-type languages then comes from the existence of question particles in them, and from the principle of economy of derivation. Economy considerations also prohibit English-type languages (or any language) from overtly moving more than one *wh*-phrase into [Spec, CP]. Movement of the second *wh*-phrase, like that of all *wh*-phrases in Chinese, must be delayed until LF, where it is motivated by other considerations (scope, the *wh*-Criterion, the ECP, etc.). As Cheng shows, her proposal has significant implications for the analysis of other languages, some of which she discusses in detail, including those with apparent cases of optional movement and multiple fronting, and it has other theoretical consequences yet to be fully addressed.

Related Material in Other Chapters

Given that the linguistic level of Logical Form most directly represents the contribution of the syntactic structure to the meaning of a sentence, practically every other chapter contains material that in one way or the other relates to the theory of LF. The treatment of X-bar theory and Case theory in chapter 1 as well as the theory of the structural conditions on the assignment of thematic roles and the realization of arguments from chapter 2 complement the conditions on the representations of quantified arguments, selection for different clause types, and the treatment of scope and various pronoun types in the present chapter. The remarks on binding at LF overlap with the discussion of anaphors and LF movement in chapter 4 and hence with the conditions the ECP imposes on movement, the topic of chapter 5. Chapter 7 details the strengthened role that the level of LF plays in the Minimalist Program.

NOTES

1 Other topics that have figured prominently in the syntax of LF include the syntax of "antecedent-contained deletion" (widely discussed since May (1985); see Baltin (1987), Larson and May (1990), Clark (1992)), Ellipsis (Reinhart (1991)) and the problem of reconstruction (Barss (1986) among others). Due to space limitations, these will not be addressed in this chapter. It should also be noted that even the existence of LF is not entirely uncontroversial among linguists working within the GB framework. For some recent exchanges of opposing views, see Williams (1977, 1988), May (1988a), Hornstein and Weinberg (1991) and references cited there.

2 That this reading of (17) seems difficult to get is presumably due to pragmatic factors, since there is no possibility for there being anybody who has every California city as his/her place of origin.

3 On a par with **Who*$_i$ *did he*$_i$ *say I saw* t_i*?* and **John*$_i$*, he*$_i$ *said I saw* t_i, where a variable (as an R-expression) is A-bound. (43d) is actually not readily excluded by condition C, as it stands, because the trace is the trace of *whose mother*, not that of *whose*. Several proposals have been made to bring (43d) under condition C. Chomsky's proposal (1976) is to convert, or reconstruct, (43d) into the structure (i) or (ii) at LF:

(i) Who$_i$ does he$_i$ love t_i's mother?
(ii) For which x: x a person, he loves x's mother?

The ill-formedness follows if condition C is made to apply at LF. Other proposals to deal with such problems of reconstruction include the "layered traces" hypothesis discussed in Riemsdijk and Williams (1981) and the approach of Barss (1986), who modified the notion of binding by incorporating into it the relevance of chains.

4 A definite description (including anaphoric epithets) should probably be classified as both a referential expression and a pronominal, as Lasnik (1989a) has argued. The donkey pronoun is clearly *also* a pronoun, in addition to being an R-expression.

5 The pronoun in *Everybody thinks he is smart* cannot have a donkey pronoun reading. This illustrates an anti-c-command requirement of the donkey pronoun. This requirement follows from the donkey pronoun's being an R-expression, which cannot be A-bound.

6 The BP, as given, fails to account for an important difference between weak crossover and permissible parasitic gap constructions like the following:

(i) What book$_i$ did you buy t_i without reading e_i?

In this construction the A′-phrase locally A′-binds both its trace and the empty category in violation of the BP, but the sentence is quite good. Safir (1984) explains this by a parallelism condition that allows an A′ category to bind more than one variable, as long as the variables are of the same type (all overt pronouns or all empty categories).

7 Higginbotham in fact took accessibility as a condition on an LF re-indexing rule that changes the index of a pronoun to that of a QNP or its variable.

8 It has been observed that weak crossover effects are considerably weaker in relative and topic structures and other null-operator constructions. Thus examples like *the man who his mother saw* and *John, his mother saw* are quite acceptable with bound variable readings. Chomsky (1982) attributed this ameliorating effect to a post-LF predication rule. See Lasnik and Stowell (1991) for detailed discussions.

9 The relevance of the ECP to QR was first demonstrated by Kayne (1981), on the basis of the following distribution of the negative polarity item *ne . . . personne* in French:

(i) ?je n'exige que tu vois personne
I (neg)-require that you see nobody
"There is nobody that I require that you see"

(ii) *je n'exige que personne vienne
I (neg)-require that nobody come
Intended: "There is nobody that I require to come"

Kayne shows that the scope interpretation of *personne* depends on the position of *ne*. So, in sentences like the above with *ne* occurring in the matrix clause, the embedded *personne* is required to have matrix scope. As illustrated, however, although *personne* can occur in the object position, it cannot occur as a subject. Kayne argues that this is a subject/object asymmetry to be attributed to the ECP at LF. In particular, after QR applies to *personne* in LF, the subject trace in (ii) will not be properly governed and will be ruled out by the ECP.

10 That QR can pied-pipe an entire phrase like *pictures of everybody* or *everyone's friend's mother* was already shown to be a necessary assumption by Higginbotham (1980b) for his accessibility account of weak crossover.

11 The operator can then be interpreted as a restrictive quantifier ranging over determiner meanings (i.e., {this, that, the one you met yesterday, etc.}).

12 HLM show that long-distance reciprocals exhibit clear island effects. This follows because the trace of *each*, though an anaphor, occurs in an adjunct position, and thus is subject to antecedent government in addition to local binding. Huang and

Tang (1991) show, on the other hand, that long-distance *ziji* in Chinese does not exhibit island effects. Thus a bare reflexive contained in a relative clause may have as its antecedent an NP outside the relative clause. This again is expected because *ziji* is an argument, and as indicated already in the discussion above, LF movement of a *wh* argument does not show Subjacency effects.

13 That is, English (as a head-initial language) allows the object to be vacuously extraposed to the right to a position where it can c-command a preceding argument, but Chinese (being essentially head-final) does not. This possibility is quite natural and is in line with Fukui's (1993) hypothesis that the difference between English and Japanese with respect to the existence of scrambling also follows from the head-directionality parameter, under the hypothesis that the economy of derivation principle allows for free optional movement where the movement does not change the head-directionality pattern of a given language. (Leftward Scrambling is possible for head-final languages, and rightward Scrambling possible for head-initial languages.)

14 Actually the difficulty presented by (164) for the OPC may be solved given the fact that, even though the most deeply embedded subject may be a *pro*, it needs to take the immediate superordinate subject as its antecedent under some minimal distance requirement. In other words, the OPC applies only when the overt/empty alternation obtains under the same interpretation.

15 In fact, K&S's account is formulated in terms of the Condition on Long Extraction, instead of antecedent government. The theory of proper government has undergone substantial development since it was first proposed in Chomsky (1981), as can be seen from chapter 5 in this volume and references cited there. But I will keep to the classical version where differences from recent formulations are irrelevant to our discussion.

16 This account has the consequence that the Superiority Condition cannot be subsumed under the ECP, but may be reformulated in terms of economy of derivation. Thus, the contrast between *Who bought what?* and **What did who buy?* obtains because the principle prefers shorter moves than longer moves. *Who* has to be moved first at S-Structure, and the longer move of *what* is postponed until LF by the principle "Procrastinate" (Chomsky (1992)). See also Lasnik and Saito (1992) for a restatement of the Superiority Condition.