2.1.3 Binding

The representation of traditional relations of dominance and command at the level of predicate-argument structure is independent of the derivation, although in the examples so far the two have been homomorphic. However, it will become apparent later that CCG derivations do not preserve these relations. I therefore follow much recent theory in defining the binding of reflexives and related anaphors at the level of predicate-argument structure alone.4

I also follow Pollard and Sag (1992) and Reinhart and Reuland (1993) in assuming that reflexive and reciprocal anaphors in English are homonymous between two distinct types. The first is a true bounded reflexive, whose binder is assumed here to be strictly limited to clausal-mates that are less oblique on the thematic hierarchy of Jackendoff (1972) and much subsequent work. The implication is that not only the reflexives in (19a) and (19b) but also the one in (19c) are objects of the tensed verb, or otherwise clausal-mates of the subject.

(19) a. Keats and Chapman saw themselves/each other.
    b. Keats and Chapman talk to themselves/each other.
    c. Chapman believes himself to be a genius.

The second type of anaphor is an exempt or “logophoric” category that (unlike a true bound anaphor) can frequently be substituted for by an ordinary pronoun, as in (20a), below.

(20) a. The pictures of himself/him in Newsweek embarrassed Chapman.
    b. The pictures of *himself/him in Newsweek embarrassed Chapman’s mother.

We will not be concerned here with the grammar of exempt anaphors, except to assume on the basis of such facts that they are some form of true pronoun, noting that in many languages such as Dutch, Norwegian, and Icelandic (see Koster 1987, chap. 6; Hellan 1988, chap. 2, esp. 87ff. and references therein) they are represented by lexical items distinct from true bound anaphors, that there is some variation across languages as to exactly what they can take as antecedents, and that in many cases the allowable antecedents have the character of the “perceiver,” “experiencer,” or “topic” of the propositions and events under discussion, as is evident from the contrast between (20a) and (20b) (adapted from Pollard and Sag 1992).

Within any lexicalist grammar, the natural place to handle any clause-bounded phenomenon, including bound anaphora, is in the lexicon.5 I will assume here (in contrast to the alternative categorial approaches of Szabolcsi (1989) and Morrill (1988, 1994)) that true bounded anaphors are syntactically identical to other NPs, that they are marked with the value + on a feature ANA, and that their interpretation is a function specific to reflexives or reciprocals that I will write self' or other', respectively. For example:

(21) a. himself := NP_{ANA,3SM} : self'
    b. each other := NP_{ANA,PL} : other'

We can then handle local anaphor-binding by assuming a lexical rule that pairs all verbs with NP and PP complements with verbs taking an anaphoric complement instead, and reflecting its binding at the level of predicate-argument structure. Such a rule for transitive verbs might provisionally be written as follows, using the notation of the λ-calculus to define the logical form as a function yielding a predicate-argument structure $gf((\text{ana'}y))y$, in which $g$ is a variable ranging over anaphor interpretations like self' and other', and ana'y is a term representing the bound argument.6

(22) $(S\backslash NP_{agr})/X : f \Rightarrow (S\backslash NP_{agr})/X_{AN\text{A},agr} : \lambda g.\lambda y.gf((\text{ana'}y))y$

We will assume that the argument $X$ is restricted to the types NP or PP. The symbol $S$ here schematizes over (tensed, untensed, participial etc.) $S$, so that $S\backslash NP$ schematizes over (tensed, untensed, participial etc.) VP. I will often abbreviate such a VP schema as $V$.

For example, for a transitive verb like sees ($S\backslash NP$)/NP, rule (22) yields a second lexical category as follows:

(23) sees := $(S\backslash NP_{3S})/NP_{ANA,3S} : \lambda g.\lambda y.gse'e((\text{ana'}y)y$

This category allows the following derivation:7

(24) Keats
    sees
    himself

\[
\begin{array}{c|c|c}
\text{NP}_{3S} & (S\backslash NP_{3S})/NP_{ANA,3S} & NP_{ANA,3S} \\
\hline
:keats' & \lambda g.\lambda y.gse'e((\text{ana'}y)y & :self' \\
\hline
S \backslash NP_{3S} : \lambda y.se'e((\text{ana'}y)y & \text{self'}se'e((\text{ana'}y)y & \text{Keats'}keats'
\end{array}
\]
It will be convenient to refer to terms like and'y and and'keats' that translate anaphors at predicate-argument structure as “pro-terms.” A further convention is assumed whereby all arguments of verb categories that are not explicitly marked as +ANA (including so-called exempt anaphors and the one involved in the complement of the relative pronoun discussed in chapter 3) are implicitly −ANA. They are thereby prohibited from combination with reflexive anaphors and the like, although the notation suppresses this detail.

The reflexivizing rule (22) can also apply to verbs of the form \((S\backslash NP)/PP\_TO\), like talks, to capture sentences like Keats talks to himself, if we follow Pollard and Sag’s (1992, 286) analysis of anaphor “pied-piping” over nonpredicative prepositions like to, and assume that they transmit values on the attributes ANA and AGR via variables ana,agr and are semantically the identity function. This allows them to combine with NPs of type +ANA, to yield a PP that is also an anaphor.\(^8\)

\[(25) \quad PP\_TO,ana,agr/\{NP\}_{ana,agr}: \lambda g . g\]

The reflexivizing rule yields the category in (26) for talks.

\[(26) \quad \text{talks := } (S\backslash NP)_{35}/PP\_TO,+ANA,35 : \lambda g . \lambda y . g \\text{talkto'}(\text{and'}y)\]

The derivation is as follows:

\[
\begin{align*}
\text{Keats} & \quad \text{talks} \quad \text{to} \quad \text{himself} \\
NP_{35} & \quad (S\backslash NP)_{35}/PP\_TO,+ANA,35 : \quad \lambda g . \lambda y . g \\text{talkto'}(\text{and'}y) \\
PP\_TO,ana,agr/\{NP\}_{ana,agr} & \quad \lambda y . g \\
NP\_TO,+ANA,35 & \quad \lambda g \quad \text{self'} \\
\Rightarrow & \quad PP\_TO,+ANA,35 : \quad \text{self'}
\end{align*}
\]

\[
\begin{align*}
S\backslash NP_{35} & \quad \lambda y . \text{self'} \text{talkto'}(\text{and'}y) \\
\Rightarrow & \quad S : \text{self'} \text{talkto'}(\text{and'}keats')\text{keats'}
\end{align*}
\]

Examples like the following suggest that some predicative prepositions and even some NP prefixes also allow true reflexives:

\[(28) \quad \text{a. Harry\text{,} was angry with himself,}^{\text{*himi.}}
\]
\[
\text{b. Louise\text{,} painted a picture of herself,}^{\text{*sheri.}}
\]

If such prepositions have a category like (29b), as well as the normal category (29a), then they too will pied-pipe the reflexive, and their binding can be handled by the same lexical apparatus, provided that the verbs lexically subcategorize for the relevant PP arguments.

\[(29) \quad \text{a. with := } PP\_\{WITH\}/NP : \lambda x . \text{with'}x
\]
\[
\text{b. with := } PP\_\{WITH\}+ANA,agr/\{NP\}_{ANA,agr} : \lambda g . \lambda f . \lambda x . \text{g} \text{ with'}(\text{and'}x)
\]

Discussion of nonsubcategorized PPs is deferred, together with discussion of how the binding of a reflexive to the subject of its local verb can pass up to that of an auxiliary by the mechanism of control.

The convention of left-associativity means that predicate-argument structures like self' see (and' keats') keats' are a shorthand for corresponding structures such as ((self' see') (and' keats')) keats', which we have seen are equivalent to binary trees. It will be convenient to refer to the elements of such structures as "nodes" and to define dominance relations over them in terms of dominance in these implicit binary trees. A standard relation of c-command can then be recursively defined on predicate-argument structures in the earlier sense of sentential logical forms as follows.\(^9\)

\[(30) \quad \text{C-command}
\]

A node \(\alpha\) in a predicate-argument structure c-commands another node \(\beta\) if the node immediately dominating \(\alpha\) dominates \(\beta\) and \(\alpha\) does not dominate \(\beta\), or if \(\alpha\) is the argument in a pro-term and the pro-term c-commands \(\beta\).

The relation “dominates” is here the transitive closure of “immediately dominates.”

The recursive second clause in the disjunction is required because, as will become apparent, the variable in a pro-term can become bound to a pro-term, generating terms like and' (and' x). It follows that such variables must be defined as c-commanding everything that the entire pro-term c-commands. This detail of the definition can usually be ignored.

We can now define binding in the following simple terms:

\[(31) \quad \text{Binding}
\]

A node in a predicate-argument structure is \text{bound} when it is identical to another node that c-commands it at predicate-argument structure.

("Identical" here refers to literal identity, in the sense that the two nodes in question arise from unification of two occurrences of the same variable with the same content. Accidental equality of content of nodes arising from sentences like #Keats likes Keats doesn’t count.)\(^10\)
I will assume that a binding theory much like that developed in Chomsky 1981 holds over such structures. In particular, the lexical treatment of anaphor binding defines its domain of locality as the domain of the lexical verbal category itself. It thereby imposes a form of Condition A (that the binder of an anaphor must be found in its governing category) without further stipulation, since (nonexempt) reflexives and the like are included in the grammar only when they are lexically, and therefore locally, bound, via reflexivized verbs. Condition B (that pronouns must not be locally bound) remains a stipulation at this point.11

Condition C can be defined as follows:

(32) Condition C

Nothing but the argument in a pro-term may be bound.

This condition strengthens the previous interpretation of Condition A. It means that any lexical rule parallel to (22) but binding anaphoric subjects to more oblique arguments will always give rise to illegal predicate-argument structures, because that more oblique argument would then result in a predicate-argument structure contravening Condition C, such as (33b) for the nonsentence, (33a).

(33) a. *Each other saw the dogs.
   b. *Other see'dogs' (and'dogs')

The claim is that this sentence is excluded because dogs' is illegally bound under Condition C, not because and'dogs' is unbound.

On the assumption that pronouns have lexically unbound pro-terms as their interpretations, as in (34), Condition C similarly captures the asymmetry in (35).

(34) him := NP_{pron} : pro'x

(35) a. Every man, thinks that he, is a genius.
   b. *He, thinks that every man, is a genius.

Of course this says no more than any other theory about why Condition C should hold, a question whose answer presumably depends on the nature of the mechanism that is actually doing the work of variables in the semantics in our heads, and the character of the notion of scope that it entails.

The predicate-argument structure self see'(and'keats')keats' that results from derivation (24) happens to be homomorphic to the context-free derivation itself, and to reflect the same dominance relation between binder and bindee. However, the following asymmetry in binding possibilities for English reflexives and reciprocals has often been explained in terms of the claim that the binder must take scope over the anaphoric bindee on some dimension of "obliqueness," not necessarily identical to derivational structure (see Barss and Lasnik 1986):

(36) a. I showed the dogs themselves/each other.
    b. I showed *themselves*/each other the dogs.

(37) a. I showed the dogs to themselves/each other.
    b. I showed *themselves*/each other to the dogs.

The phenomenon can be captured by assuming that the complements of verbs are ordered under a relation of obliqueness distinct from dominance in the surface derivation, such that the subject is the least oblique argument, followed by the object and other arguments, as variously captured in the thematic hierarchy of Jackendoff (1972), the relational hierarchy of Perlmutter and Postal (1983), the accessibility hierarchy of Keenan and Comrie (1977); argument order in Montague Grammar (Bach 1979, 1980; Ladusaw 1979; Bach and Partee 1980; Dowty 1980, 1982, 1992; Jacobson 1990, 1992b), obliqueness in other versions of categorial grammar (Chierchia 1985, 1988; Hepple 1990) the control hierarchy in Lexical-Functional Grammar (LFG; Bresnan 1982; Manning 1994), the SUBCAT order in HPSG (Pollard and Sag 1987, 1991, 1992), and prominence order (Grimshaw 1990).

One way of capturing obliqueness in present terms is to assume categories like the following for "dative alternation" verbs like show in VPs like show the dog the rabbit and show the rabbit to the dog:

(38) a. showed := ((S\NP)/NP)/NP : λx.λy.λz.show\x\y\z
    b. showed := ((S\NP)/PP)/NP : λx.λy.λz.show\x\y\z

These categories exhibit subtly different relations of dominance in predicate-argument structures like show\x\y\z from those in the context-free derivation that the category permits.12

Such categories can be reflexivized by lexical rules such as the following:

(39) ((S\NP_{agr1})/X)/NP : f =>
    ((S\NP_{agr1})/X_{ANA,agr2})/NP_{agr2} : λx.λg.λy.gf(and'x)xy
rules analogous to (22) for ditransitive verbs. It will be convenient to use a notation introduced in a different form in Ades and Steedman 1982 to schematize over verbs with different numbers of arguments, which I will refer to as the "$\$" convention." It is defined recursively as follows for present purposes.\textsuperscript{14}

(42) The $\$" convention

For a category $\alpha$, \{\alpha$/\$\}$ (respectively, \{\alpha$/\$\}) denotes the set containing $\alpha$ and all rightward (leftward) functions into a category in $\alpha$/\$\$ (\{\alpha$/\$\}).

I will use unbracketed $\alpha$/\$ and $\alpha$/\$ to schematize over the members of the sets $\{\alpha$/\$\}$ and $\{\alpha$/\$\}$, using subscripts as necessary to distinguish distinct schematizations. For example $\{S$/\$\}$ is the set $\{S, S$/\$NP, (S$/\$NP)/NP, ... \}$ and $S$/\$S$/\$,... etc. are schemata over that set. Rule (22) for subject-controlled anaphora can then be generalized as follows:

(43) $\{(S$/\$NP)/NP!/$/\$X!/$/\$NP!$/\$NP!/\$NP!, ... \}: \ldots \lambda \ldots \lambda y f \ldots x \ldots y \mapsto \ldots \lambda \ldots \lambda g \ldots f \ldots (y \ldots y) \ldots y$

(The semantics also has to be schematized, as informally indicated by dots ... indicating zero or more $\lambda$-bound semantic arguments. A more explicit representation would have to spell out the wrapping of these arguments characteristic of English verbs.)

Since these are lexical rules, and the maximum valency of verbs in English is four, the schema can be expanded as a finite, indeed small, number of instances. The schema permits derivations like the following, in which the relevant instance is spelled out in each case:

(44) Sid shows himself a movie and Sid showed Nancy himself, we need further lexical
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(47) \( (S\backslash NP) \rightarrow \lambda p. \lambda y. try'y_p y \)

However, such a category does not of itself determine the binding and agreement of anaphors in sentences like the following:

(48) Keats tries to shave himself.

We might therefore consider the following more explicit category, essentially as proposed by Carpenter (1989), among others:

(49) \( (S\backslash NP_{3S}) \rightarrow (S_{TO} \backslash NP_{3S}) : \lambda p. \lambda y. try'(p_y) y \)

However, as Carpenter was aware, the predicate-argument structure in this category violates Condition C (because two instances of the variable \( y \) are in a c-command relation).

What we need instead is a related category in which the controlled subject is a pro-term at predicate-argument structure, whose argument is licensed under Condition C to be bound. Since the relation between controller and controlled is one of identity, we may as well use the functor \( and' \) that appears in reflexives.

(50) \( (S\backslash NP_{3S}) \rightarrow (S_{TO} \backslash NP_{3S}) : \lambda p. \lambda y. try'(p_{(and'y)}) y \)

This of course is the standard GB analysis, with one slight departure. Rather than merely using the constant \( PRO \) to represent the controlled argument at surface- or \( S \)-structure, leaving to the binding theory or an autonomous module of control theory the task of establishing the antecedent, we have made the lexical entry for the control verb do part of that work, by making (the interpretation of) its complement's subject a pro-term of exactly the same type \( and'y \) as an anaphor bound to the (interpretation \( y \) of the) subject of the control verb.

This analysis at the level of predicate-argument structure is not equivalent to an analysis in terms of a surface-syntactic empty NP anaphor category. Although the symbol \( NP_{3S} \) appears as part of the syntactic type \( ST_0 \backslash NP_{3S} \) of the VP complement, this entire type could be replaced by a monolithic symbol \( VPT_0_{3S} \) bearing the same agreement feature, and I will frequently abbreviate (tensed, untensed, etc.) \( S \backslash NP \) in this way. In this respect the present theory is more akin to the “VP analysis” of Brame and Bresnan and the “lexical entailment” theory of Jacobson.

On the assumption that the infinitival verb \( like \) has the obvious category \((5a)\), below, that the lexical rule \((22)\) (or its generalization \((43)\)) applies to yield \((5b)\), and that the complementizer \( to \) has the trivial

\[ (\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)x) xy \rightarrow (\lambda x. \lambda g. show'_{2}(an'd'y)x) (\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)x) y \]

\[ (\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)(\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)x)) y \rightarrow (\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)(\lambda x. \lambda y. \lambda g. show'_{2}(an'd'y)x)) y \]

The schema (43) also generates verbal categories that accept \( Sid \) showed himself to Nancy, Gilbert persuaded himself to like George, Harry showed Louise himself, and Keats bet himself a bottle of champagne that it was Thursday. If we generalize (39) in the same way, we apparently exhaust the possibilities for true reflexive binding among classmates. In any case the number of instances remains small. If four is the maximum valency, Condition C limits us to categories in which the binder is less oblique than the bindee, and since the bound item can only be NP or PP, a maximum of twelve instances of these schemata are needed to capture all bounded reflexive NP anaphora, of which two appear to be unused because of the nonexistence of verbs relating four nominal arguments. The schemata themselves are therefore finite.

2.1.4 Control

Many authors who have appealed to versions of the obliqueness hierarchy in theories of binding have pointed out that the phenomenon of control, as exhibited by verbs like persuade, can be analyzed in similar terms, arguing that such bounded dependencies are base-generated and mediated in lexical semantics. A similar position is implicit in the postulation of minimalist program of Chomsky 1995 that movement is not optional but determined by specific lexical properties of input lexical items.

In present terms this might be taken to imply the following syntactic category for “equi” verbs like triex:

(46) \( \text{tries} := (S\backslash NP) \rightarrow \text{VP}_{TO} \)

A first approximation to the semantics of this category might be the following, roughly as proposed by Chierchia (1988) and Jacobson (1990, 1992a,b):
category in (51c), which can compose with either infinitival, the category (50) will yield the results in (52) and (53):

(51) a. like := VP_{INF,agr}/NP : \lambda x. \lambda y. like'xy
   b. like := VP_{INF,agr}/NP_{ANA,agr} : \lambda g. \lambda y. g like'(and'y) y
   c. to := VP_{TO,agr}/VP_{INF,agr} : \lambda x. x

(52) Keats tries to like Chapman

\[
\begin{align*}
\text{NP}_{35} &\rightarrow \text{VP}_{TO,agr}/NP \rightarrow \text{NP}
\end{align*}
\]

\[
\begin{align*}
\text{keats}' &\rightarrow \lambda p. \lambda y. \text{try}'(p(\text{and}'y)) y
\end{align*}
\]

\[
\begin{align*}
\text{chapman}' &\rightarrow \lambda x. \lambda y. \text{like}'xy
\end{align*}
\]

\[
\begin{align*}
\text{try}' &\rightarrow \lambda y. \text{like}' \text{chapman}'(\text{and}'y) y
\end{align*}
\]

\[
\begin{align*}
S &\rightarrow \text{try}'(\lambda y. \text{like}' \text{chapman}'(\text{and}'y) y)
\end{align*}
\]

(53) Keats tries to like himself

\[
\begin{align*}
\text{NP}_{35} &\rightarrow \text{VP}_{TO,agr}/NP_{ANA,agr} \rightarrow \text{NP}_{ANA,35}
\end{align*}
\]

\[
\begin{align*}
\text{keats}' &\rightarrow \lambda p. \lambda y. \text{try}'(p(\text{and}'y)) y
\end{align*}
\]

\[
\begin{align*}
\text{self}' &\rightarrow \lambda z. \lambda y. \text{like}'(\text{and}'z) y
\end{align*}
\]

\[
\begin{align*}
\text{try}' &\rightarrow \lambda y. \text{like}' \text{self}'(\text{and}'y) y
\end{align*}
\]

\[
\begin{align*}
S &\rightarrow \text{try}'(\lambda y. \text{like}' \text{self}'(\text{and}'y) y)
\end{align*}
\]

In (53), the translation of “himself” in the result of the derivation is the pro-term and'(and'keats'), rather than and'keats', because it is bound to the pro-term subject of like', which in turn is bound to keats'. It thus represents a concatenation or chaining of binding and control relations.

The possibility for reflexives to be bound across multiple auxiliaries, while remaining strictly clause-bound, can now be captured by making the nonstandard assumption that modal and auxiliary “raising” verbs are in fact subject-control verbs, with categories like the following:

\[
\begin{align*}
(54) &\text{might := (S\text{\(\backslash\)NP}_{agr}/\text{VP}_{INF,agr} : \lambda p. \lambda m. \text{might}'(p(\text{and}'y)y)
\end{align*}
\]

Such a category accounts for the following pattern:

(55) a. Sid might find himself/*herself.
   b. Sid might try to find himself/*herself.
   c. *Sid said Nancy might try to find himself.

These examples depend crucially on the interpretation of himself being bound in the predicate argument structure to the (pro-term) subject of

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find himself. In the case of (55a), it in turn is controlled by the subject of the tensed verb, might, just as in (52). In (55b), the succession of bindings is one link longer. The derivation of (55a) is as follows:

(56) Sid might find himself

\[
\begin{align*}
\text{NP}_{35} &\rightarrow \text{VP}_{TO,agr}/\text{VP}_{INF,agr} \rightarrow \text{NP}_{ANA,agr} \rightarrow \text{NP}_{ANA,35}
\end{align*}
\]

\[
\begin{align*}
\text{Sid}' &\rightarrow \lambda p. \lambda z. \text{might}'(p(\text{and}'z)) y
\end{align*}
\]

\[
\begin{align*}
\text{find}' &\rightarrow \lambda y. \text{self}'(\text{and}'y) y
\end{align*}
\]

\[
\begin{align*}
\text{himself}' &\rightarrow \lambda y. \text{self}'(\text{and}'y) y
\end{align*}
\]

\[
\begin{align*}
S &\rightarrow \text{find}'(\lambda y. \text{self}'(\text{and}'z)) y
\end{align*}
\]

(VP_{INF,agr} abbreviates S_{INF}/NP_{agr}, as usual.) The same argument can be applied to the analysis of object control. The following is the category of the verb persuades:

(57) persuades := ((S\text{\(\backslash\)NP}_{agr}/\text{VP}_{TO,agr})/\text{NP}_{agr} : \lambda x. \lambda p. \lambda y. \text{persuade}'(p(\text{and}'x)) x y

This category again embodies a wrap analysis of object-control verbs, akin to that proposed by Bach (1979, 1980), Dowty (1982), Szabolcsi (1989), Jacobson (1990, 1992b), Hepple (1990), and Bouma (1993), again at the level of lexical predicate-argument structure rather than syntactic or phrasal derivation. That is, the command relation between the interpretation of the object NP and the predicate argument is reversed with respect to the derivation. Again, the reason for doing this in the lexicon rather than in syntax will become apparent when we turn to coordination.\(^{18}\)

When applied to an object like Nancy and an infinitival like to go, the category (57) gives rise to derivations like the following:

(58) Sid persuades Nancy to go

\[
\begin{align*}
\text{NP}_{35} &\rightarrow \text{VP}_{TO,agr}/\text{VP}_{INF,agr} \rightarrow \text{NP}_{agr} \rightarrow \text{NP}_{35F}
\end{align*}
\]

\[
\begin{align*}
\text{Sid}' &\rightarrow \lambda x. \lambda y. \text{persuade}'(p(\text{and}'x)) x y \rightarrow \lambda x. \text{go}' x
\end{align*}
\]

\[
\begin{align*}
\text{persuades}' &\rightarrow \lambda y. \text{persuade}'(p(\text{and}'\text{nancy})) x y \rightarrow \lambda y. \text{nancy}' y
\end{align*}
\]

\[
\begin{align*}
\text{to}' &\rightarrow \lambda y. \text{nancy}' y
\end{align*}
\]

\[
\begin{align*}
S &\rightarrow \text{persuade}'(\lambda y. \text{nancy}' y)
\end{align*}
\]
This derivation does not bind the interpretation pro’z of the pronoun at all. It is only if some further process, such as discourse anaphora or quantification, binds the pronoun as in (60b) that Condition B applies at the level of predicate-argument structure to exclude the sentence.

In view of the necessarily multiclausal nature of pronominal binding, and its considerable complexity with respect to structural quantifier scope, it seems possible that Condition B could be regarded as arising from the nature of this process itself, which, as Dowty (1980) and Levinson (1991) have pointed out, may not even be part of competence grammar at all. Even apparently quantifier-bound pronouns are strikingly free of such grammatical constraints as nested dependency conditions and subject barrier effects that normally influence syntactic dependencies.

(62) a. Every man_{i} thinks that every woman_{j} believes that he_{i} has met her_{j}.
   b. Every woman_{i} thinks that she_{i} is a genius.

2.1.5 Control and Tough-Movement

Nothing in the binding theory presented so far prevents the mechanism of control from binding nonsubject pro-terms. Although the apparently universal constraint on the lexicon that forbids analogues of English control verbs subcategorizing for S/NP still needs to be explained, there is one variety of object binding that seems to be a first cousin of control in any framework, in the sense that it is predicational. Consider the following examples of “tough-movement:”

(63) a. Chapman is easy to please.
   b. Chapman tries to be easy to please.

Since tough-movement is usually regarded as an unbounded construction, I will defer discussion of the actual categories involved until section 3.4.5. However, it is reasonable to assume that the predicate-argument structure of (63a) is something like the following, in which the constant one’ stands for a dummy agent of some kind:

(64) easy’(please’(chapman’one’))

It follows that the interpretation of to be easy to please is the following:

(65) λy.easy’(please’y one’)}
If so, then the predicate-argument structure of (63b) must be something like (66), in which this object argument becomes a controlled pro-term because of the interpretation of the control verb tries, (50).

(66) \text{try(easy(please(\text{and}_c \text{chapman}_c \text{one}_c)))chapman}_c \sim

This expression does not obey Condition A as it is usually defined since the pro-term is not bound to the available less oblique argument one'. Any theory in which Condition A operates in the grammar at large must make otherwise unmotivated stipulations about this arbitrarily interpreted subject—for example, that it is expletive, or, following Chomsky (1981), that an “empty operator” binding a trace is involved—or abandon the assumption that both control and bounded anaphora are mediated by the same mechanism. On the other hand, a theory that imposes Condition A only implicitly, via the assumption that anaphors are only introduced into the grammar lexically, and does not impose any condition on their projection other than Condition C, needs no such stipulation. Similar conclusions would follow from an examination of the passive construction and sentences like Keats tries to be loved, on the assumption that passive is a morpho-lexical rule applying to verbs and affecting their first argument (see note 18).

2.2 The Combinatory Generalization

The above proposals concerning the theory of binding and control are no more than a sketch. Many questions have been left open, and the reader is referred to the work of Szabolcsi, Jacobson, Dowty, Hepple, and others already cited for alternative proposals. However, these observations may serve to show how the binding theory, and in particular Condition C, interacts with syntax beyond the domain of locality defined by the categorial lexicon. Since the only true binders are lexical, the condition as it applies to syntactic derivation entails that any syntactic combination that unifies two nodes one of which c-commands the other at predicate-argument structure yields an illegal interpretation. It is this “anti-c-command” condition that will interact with the analysis of coordination and relativization under the combinatory generalization of categorial grammars, to which we now turn.

2.2.1 Coordination

To extend categorial grammars to cope with coordination we need a rule, or rather a rule schema, of the form shown in (67). (The rule schema given here is a simplification, in that it does not represent syntactically the “prepositional” or “proclitic” character of the English conjunctions, which associate to the right, although the result of right-associativity will be seen to be reflected at the level of predicate-argument structure, when we turn to the semantics of the rule. This simplification also obscures the way in which coordination obeys the Principle of Combinatory Transparency. I also gloss over certain problems of number agreement that are evident in examples like Frankie and Johnny were lovers.)

(67) \text{Coordination } (<\Phi^a>):

\[ X \ CONJ \ X \Rightarrow_{\Phi^a} X \]

Apart from the simplification already mentioned, this is everyone’s coordination rule (e.g. Chomsky 1957, see Gazdar 1981). It captures the commonplace intuition that coordination is an operation that maps two constituents of like type onto a constituent of the same type. It gives rise to derivations like the following:

(68) Keats cooked and ate apples

\[
\begin{array}{c}
\text{NP} \quad \text{(S\text{NP})/NP} \\
\text{CONJ} \quad \text{(S\text{NP})/NP} \\
\quad \Rightarrow \quad \Phi^a \\
\quad \text{S\text{NP}} \\
\quad \Rightarrow \\
\quad \text{S}
\end{array}
\]

Because X may be any category including functor categories of any valency, the rule has to be schematized semantically over such types, as follows:

(69) \text{Coordination } (<\Phi^a>):

\[
X : g \ CONJ : b \ X : f \Rightarrow_{\Phi^a} X : \lambda b(f \ldots)(g \ldots)
\]

The annotation $\Phi^a$ on the reduction arrow in the rule is inspired by the combinatory notation of Curry and Feys (1958), to which I return below. The dots schematize over the following family of functionals combining the interpretation of the conjunction $b$ with the two argument interpretations (see Partee and Rooth 1983).
2. Of course, (2) is not the only category that the verb *eats* bears. Like many other transitives, it can also be used intransitively, as $S \backslash NP$, like *walks*. For parsing purposes, we might combine such categories into a single lexical entry, including optional arguments. However, such considerations are irrelevant to competence grammar, and I will treat such alternatives here as independent lexical categories.

3. Of course, the converse also holds. Semantic combination totally determines the form of syntactic combinatory rules, apart from details of directionality. In terms of the biological evolution of the language faculty, this is presumably the true direction of determination.


5. The idea that bounded phenomena are properties of the interpretation as defined in the lexicon is implicit in proposals by Brame (1976) and by Keenan and Foltz (1985) and Bach (1980), and in much subsequent work in Montague Grammar. It is also the idea that lies at the heart of the Lexical-Functional Grammar (LFG) account of binding and control, as in Bresnan 1982, and it has recently been extended by Pollard and Sag (1991).

6. Inputs and outputs of lexical rules are related by the $\leftrightarrow$ operator. Locating reflexivization at the level of predicate-argument structure in this way is very like the analyses of Keenan (1988), Chierchia (1989), Pollard and Sag (1992) and Reinhart and Reuland (1993). A lexical treatment of reflexivization gains some support from the existence of inherently reflexive lexical predicates like intransitive *shave*. The functor *ari* acts like a diacritic on the lower $y$ for the purposes of the binding theory developed below. I assume following Carpenter (1991) that lexical rules cannot apply recursively to the output of lexical rules, and that they cannot produce categories taking a larger number $n$ of arguments than that characteristic of the original lexicon. It appears that $n=4$ in English. Although I will not go into the question here, I assume that the nominal in *John’s criticism of himself* has a related category arising via a similar rule.

7. It might seem that a more elegant translation for such reflexivized verbs would be as in (ia), yielding (ib), in which the anaphoric argument is implicit in the function *self*.

   (i) a. $(S \backslash NP_{agr}) / NP_{+ANA_{agr}} : \lambda g . \lambda y . g \text{sees' y}$
   
   b. $(S \backslash NP_{agr}) : \lambda y . \text{self'} \text{sees' y}$

   However, anaphors can act as controllers in sentences like *Keats persuaded himself to go*, so if we want to make control explicit at predicate-argument structure, we need an explicit argument. See section 2.1.4 for further discussion. This is not to say that we could not define binding and control in other ways, say in terms of lexical entailments, as Jacobson 1992b and others do. I am indebted to Bob Carpenter for last-minute advice on this part of the analysis.

8. It follows that we predict the existence of nonpredicative PP anaphors in other languages. French reflexive se in sentences like the following seems to offer an example:

   (i) Il se donne un bonbon.

   He TO-SELF gives a sweet

   "He gives himself a sweet."

   (Compare *Il donne un bonbon à Brigitte/*Il donne Brigitte un bonbon—He gives a sweet to Brigitte/He gives Brigitte a sweet.)


10. Again, a definition directly in terms of variables in interpretations rather than normalized predicate-argument structures would be better, but would complicate the presentation.

11. I have not said how pronouns, as distinct from bound anaphors, actually get bound. I will argue below, following Dowty (1980) and Levinson (1991), that this may not be a matter of sentence grammar at all, in which case it may be possible to do without Condition B.

12. The separation of predicate-argument structure, thematic structure, or any form of LF from syntactic derivation is explicitly eschewed in most other categorial approaches, notably those in the Montague tradition of Bach and other investigators identified above. These approaches tend to use wrapping operators in syntax, to restore obliqueness to derivation. The reason for departing from this assumption will become apparent in the discussion of coordination below, and its significance is discussed in chapter 4. Under both assumptions, we are forced to assume that dative alternation verbs must have distinct semantic interpretations for alternates, here distinguished as *show₁* and *show₂*. This is not surprising in view of the fact that not all dative verbs alternate—see Oehrle 1975 for discussion.

13. Further phenomena that Hoeksema and Janda (1988) note in support of including wrap operations in the theory of grammar are passed over here. The authors themselves point out that many if not all of them are susceptible to alternative analyses in terms of alternative combinatory operations, including composition and type-raising.

14. The original specification of this convention used $\alpha S$ to similarly schematize over { $\alpha S$ }, the set containing $\alpha$ and all functions of whatever directionality into { $\alpha S$ }. This alternative may also be required.

15. The point did not of course escape Chierchia and Jacobson, who capture control and other binding phenomena in additional meaning postulates or lexical entailment rules. Jacobson has at least on occasion conjectured that all agreement may be semantic (see Dowty and Jacobson 1988).

16. The idea that control verbs involve implicit anaphors goes back at least to
Helke 1971 and Fodor 1975 and has more recently been revived in Manzini 1993.

17. The analysis has a precedent in the “auxiliaries as main verbs” analysis proposed by Ross (1969), in the LFG analysis of these phenomena (see Bresnan 1982), and in widespread recent proposals for “VP-internal” subjects in GB.

18. I assume here, following Jackendoff (1990, 68–70), that verbs like promise have the same syntactic category (VP/VP) as persuade. Although I do not offer an analysis of the passive here, I assume that the oddity of *be promised to take a bath (and the increased acceptability in interaction with passive in be promised to be allowed to take a bath) is a consequence of binding the subject of the infinitive to (and one) at the level of predicate-argument structure, where one is a dummy subject in the translation of the passive, which is distinct from any agent in a (more oblique) by phrase.

19. It was in order to capture such effects explicitly that I chose to use reflexivization rules that realize the anaphor as an explicit pro-term at predicate-argument structure. See note 7.

20. For example, pronoun binding may arise as a side effect of incremental, clause-by-clause semantic processing conducted in parallel with syntactic processing, as proposed by Kimball (1973). The anomaly of #Every man, likes him; would then arise from the necessary absence of the antecedent from the context at the point where the pronoun is encountered. Dowty (1980) suggests that the (much reduced) anomaly of #He, likes him, is Greco-Pragmatic in origin. A similar argument could presumably be made for sentences like (61).

21. Thanks to Mark Hepple for advice on the above analysis and its continuation in chapter 3.


23. Of course, we are glossing over a number of complications that arise for any theory in the notion of “like type,” and which are raised by examples like Harry is a football player and easy to please.

24. Combinatory categorial grammars can compose functor categories of indefinitely high valency, because of the inclusion of rules corresponding to the combinator B², discussed in section 2.2.2. The above assumption therefore limits the extent to which such categories can conjoin.

25. Curry (see Curry and Feys 1958, 184, fn.), notes that he called the operation B because that letter occurs prominently in the word “substitution” and because the names S and C were already spoken for. The operation is Smullyan’s (1985) Bluebird.

26. Rather than using λ-notation, we could write the semantics without the use of variables using Curry’s combinators, as Szabolcsi and Jacobson sometimes do. (See Dowty 1992 on this point.) The rule would then be written as

follows, using a combinatoric term for the interpretation of the result:

(i) X/Y : f · Y/Z : g ⇒ X/Z : Bfg

When we want to represent non-normalized interpretations (particularly when they are to be evaluated by machine), this can be an attractive alternative. However, it is hard for human readers to interpret combinatoric terms and to identify the corresponding normalized predicate-argument structures, so I avoid them here.

27. See the discussion of examples (59) and (60) concerning the significance of the pro-term and (and six) as capturing a concatenation of binding and control relations.

28. The example is somewhat clumsy but we will see later that exactly the same operation is required for relative clauses such as a flower which will show, and you will give, to this policeman.

29. To ensure monotonicity in language acquisition, we must assume that this set of argument types is determined universally, and does not change as acquisition proceeds.

30. Type-raising is indexed as (forward or backward) T in derivations, for the type-raising combinator T. This combinator was called C, by Curry and is Smullyan’s Thrush.

31. There is in fact a way of defining a single underspecified order-preserving type-raised category, discussed in Steedman 1991b.

32. This use of † is unrelated to that of Moortgat (1988), and the (distinct) use of Oehrle (1991), who uses up-arrow as a special kind of categorial slash operator, analogous to GFSG/HPSG’s interpretation of SLASH as a store, distinct from subcategorization.

33. In earlier work, including drafts of the present book, I have argued for the lexical alternative. This alternative now seems to me to be less desirable, proliferating categories and losing some of the explanatory force of the syntactic alternative, in particular in respect of phenomena associated with the Subject Condition.

34. This is not to assume that morphological case is invariably transparent to position in the obliqueness hierarchy at predicate-argument structure.

35. See the account of reflexive binding in Szabolcsi (1989), although she proposes a different non-combinatorially transparent semantics.

36. See Postal 1993 for arguments that parasitic gaps must be treated as distinct from across-the-board extraction out of coordinate structures, contra Williams 1990.

37. The name “substitution” was proposed for the combinator S in homage to Curry’s explanation (see note 25) of his choice of the name B as deriving from this word, and because S is the general form of the operation of which B is a special case. Schönfinkel (1924) called it Verschmelzung, or “fusion,” and Szabolcsi (1983, 1989) calls it “connection.” It is Smullyan’s Starling.