# Chapter 10
# The Syntactic Interface

*Lofty designs must close in like effects.*
Robert Browning, "A Grammarian's Funeral"

This book began by stating some uncontroversial assumptions in the form of the rule-to-rule condition and the competence hypothesis, deducing the even more widely accepted Constituent Condition on rules of competence grammar. The Introduction also endorsed the methodological priority of investigating competence syntax over performance mechanisms. Having noted the difficulties presented by coordination and intonation in relation to the Constituent Condition on Rules, part I of the book went on to advance an alternative combinatory view of competence grammar under which these apparently paradoxical constructions were seen to conform to that condition after all. After putting the theory through its syntactic paces in part II, the progression has been brought full circle in part III by deriving some consequences for the theory of performance under a "strict" version of the competence hypothesis.

## 10.1 Competence

The competence theory that was developed along the way is conveniently viewed in terms of a third and final version of the by-now familiar Y-diagram in figure 10.1, which combines figures 4.1 and 5.3, again including mnemonic exemplars of the constructs characteristic of each module of the theory. According to this theory, lexical items and derived constituents (including sentences) pair a phonological representation with a syntactic category (identifying type and directionality only) and an interpretation. Chapter 5 showed that the interpretations of the principal constituents of the sentence correspond to the information structural components called theme and rheme. These in turn combine by function application or "β-normalization" to yield fairly standard quantified predicate-argument structures or Logical Forms. Predicate-argument structures preserve fairly traditional relations of dominance and command. In par-

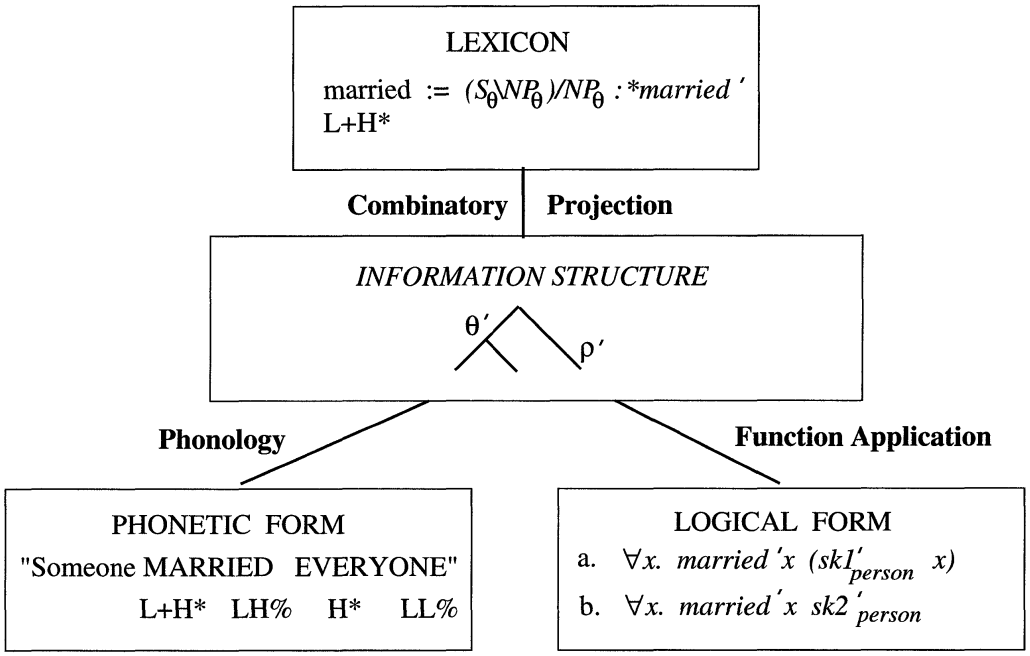


**Figure 10.1**
Architecture of Combinatory Categorial Grammar III

ticular, they embody the obliqueness hierarchy on grammatical relations over arguments. The order of combination that is defined by the syntactic category need not conform to the obliqueness hierarchy, and in VSO and SVO languages cannot conform to it.

Traditional notions of command and dominance have nothing to do with derivation in this sense. Instead, derivations capture directly the notion of constituency relevant to relativization, coordination, and phrasal intonation, without the invocation of empty syntactic categories or syntactic operations of "movement," "deletion," "copying," or "restructuring," distinct from those implicit in the automatic construction of the appropriate Logical Form. This notion of structure should be identified with Information Structure, rather than traditional Surface Structure. Although it is convenient to represent Information Structures as trees, they do not constitute a level of representation in the theory. In contrast to Logical Form and the associated predicate-argument structural domain of the binding theory, no rule or relation is predicated over such structures.

The responsibility of the combinatory rules is to "project" both components of the lexical categories, synchronously and in lockstep, onto the corresponding constituent components of the derivation.[1] The types of the constituents

that they yield are considerably more diverse than those implicated in traditional Surface Structures or GB S-Structures. They provide the input to rules of coordination, parentheticalization, and extraction, all of which are thereby brought under the Constituent Condition on Rules. They also provide the input to purely local phonological processes, such as vowel harmony or *liaison* and the Rhythm Rule (Selkirk 1984), which directly map information-structural constituents onto Phonetic Form proper.

There is no conflict between such a view of surface constituency and more traditional theories of grammar. In categorial terms, such theories can be seen as predominantly concerned with predicate-argument structure and hence with elements of semantic interpretation or Logical Form, rather than syntax proper. To the extent that such theories provide a systematic account of the relation between interpretations in this sense and syntactic categories, they provide what amounts to a theory of the categorial lexicon—a component of the present theory that continues to be lacking in this and preceding discussions of CCG.

By contrast, the normalized Logical Form or quantified predicate-argument structure, which is the exclusive domain of the binding theory, provides the input to such systems as reference and the binding of pronouns. It is presumably at this level that the effects associated with "weak crossover" and "subjacency" make themselves felt. Although we may find it convenient to think about these processes in terms of a further structural level of Logical Form, such a representation is not in principle necessary, for the reasons discussed by Montague (1970), and in fact this level is eschewed in other versions of Categorial Grammar. In chapter 4, I discussed how such systems should capture ambiguities of quantifier scope without movement at LF or the equivalent, drawing on work by VanLehn (1978), Webber (1978, 1983), Reinhart (1991, 1997), Park (1995, 1996), Winter (1997), and Schlenker (to appear).

The question of how well the theory generalizes to more parametrically diverse languages than English and its Germanic relatives, and in particular to languages with freer word order and those that use morphological markers of Information Structure rather than intonational ones, goes beyond the scope of the present book. However, Kang (1988), Segond (1990), Foster (1990) Nishida (1996), Hoffman (1995a,b, 1996, 1998), Bozsahin (1998), Komagata (1997b, 1999), Baldridge (1998, 1999), and Trechsel (to appear) offer CCG analyses for the grammar and Information Structure of Korean, French, Spanish, Old Spanish, Turkish, Japanese, Tagalog and Tzotzil.

## 10.2 Acquisition

The explanatory adequacy of the theory will also depend on its compatibility with a reasonable account of language acquisition. This question also lies beyond the scope of the present book, and the following remarks are restricted to the briefest of preliminary sketches. (See Briscoe 1997, forthcoming, Osborne and Briscoe (1997), and Watkinson and Manandhar 1999 for specific proposals for acquiring categorial grammars in the face of noise and situational ambiguity, and see Kanazawa 1998 on the computational complexity of the problem.)

The considerations discussed in chapters 1 and 8 suggest that language acquisition mainly reduces to the problem of learning the categorial lexicon and the language-specific instances of the combinatory rule types that are involved. Lexical learning must in the earliest stages depend upon the child's having access to mental representations of the concepts underlying words, in a form more or less equivalent to the lexical Logical Forms assumed here, perhaps along lines suggested in Pinker 1979, Fisher et al. 1994, Steedman 1994, and Siskind 1995, 1996. Under the assumptions inherent in the Principle of Categorial Type Transparency, the semantic type of such concepts defines the syntactic type in every respect except directionality. The Principle of Head Categorial Uniqueness ensures that in most cases the child need have access only to combinatory rules of functional application in order to deduce the latter property, and hence the lexical category or categories of each word. The tendency of languages toward consistency in head-complement orders suggests that this search is constrained accordingly.

As far as the combinatory rules go, it seems likely that the repertoire of semantic combinators is fixed as composition, substitution and (possibly as a lexical rule) type-raising over the categories that are actually encountered in the grammar acquired so far. Once some lexical categories are known, the child is therefore immediately in a position to master constructions like relatives by inducing the particular instances of combinatory rules that the grammar includes—principally those of the composition family— and the categories to which they apply, working on the basis of the lexical categories learned in the manner sketched above and contextually available compound concepts, perhaps along lines sketched in Steedman 1996a. (The fact that lexical learning generalizes in this way is an important reason why natural languages should adhere as closely as possible to the Principle of Head Categorial Uniqueness.) The simplest way to do this would be to include only the most specific instance of a combinatory rule that supports a combination that yields the concept in

question. However, such an assumption raises the same questions of inductive generalization and stability in the face of noise and ambiguity that arise in other frameworks.

The most serious problem that this account faces arises from the inclusion of exceptions to the Principle of Head Categorial Uniqueness, such as the subject extraction category stipulated in chapter 4 at example (20) for verbs like *think*. When children who are acquiring English encounter subject extraction, they have three options. They might wrongly assume that the grammar of English includes the rule of crossed composition that was rejected in chapter 4—in which case they will begin to overgenerate wildly. Or they might rightly assume that this counts as a different construction headed by *think*, specified by a separate lexical entry, but wrongly assume that this lexical entry conforms to the Principle of Head Categorial Uniqueness—in which case they will begin to overgenerate sentences like **I think fell the horse*. Or they might correctly further assume that this lexical entry is independent, violating the Uniqueness principle.

One way to ensure that the child makes the right choice, despite the penalty associated with violating this principle, is to stipulate that categories that are not induced via an application-only derivation of the kind described earlier, but (like this one) are first encountered under extraction, are assigned the most conservative category that will allow the sentence—that is, one confined to antecedent government, an assumption analogous to Baker's (1979) proposal for conservative acquisition of dative shift.[2] (Similar remarks may apply to acquisition of the antecedent government–restricted combinatory rules for phenomena like Heavy NP shift, discussed in chapters 4 and 6.) Such a procedure seems to be one that could only be safely applied in the last stages of fine-tuning a stable grammar based on a sizable corpus. Stromswold's (1995) results showing that complement subject extraction is one of the last constructions to be acquired in English (see section 4.2.1) are consistent with this procedure.[3]

## 10.3 Performance

The architecture schematized in figure 10.1 embodies the strongest possible relation between Surface Structure or derivation, Intonation Structure and Information Structure. The evidence for it is entirely based on linguistic argumentation, and it must in the first place be judged on those grounds. Nevertheless, this property of the theory has significant implications for processing

under the strict competence hypothesis. The fact that syntactic constituency subsumes intonational constituency in the sense discussed in chapter 5 implies that modular processors that use both sources of information at once should be easier to devise. Such an architecture may reasonably be expected to simplify the problem of resolving local structural ambiguity in both domains.

However, we have noted that a considerable amount of nondeterminism remains in the grammar, for both spoken and written language. Although this nondeterminism can be kept within polynomial complexity bounds using techniques discussed in chapter 9, the associativity implicit in functional composition means that the average-case complexity potentially remains serious. The properties of the grammar are consistent with the suggestion that the basis for the oracle that renders the process as a whole deterministic is the incremental availability of semantic interpretations (possibly compiled in the form of related head-dependency probabilities of the kind discussed by Collins (1998).)

The generalized notion of constituency that is engendered by the combinatory rules ensures that many leftmost substrings are potentially constituents with interpretations, subject of course to the limitations of the grammar and any further information that may be available from intonation. Such a theory of grammar may therefore have the added advantage of parsimony, in being compatible with such a processor without compromising the strict competence hypothesis.

Indeed, we can stand this argument on its head. If we believe that the parser has to know about interpretations corresponding to strings like *The flowers sent for* . . . , and we identify such interpretations with the notion of abstraction, then advocates of more traditional notions of constituency must ask themselves why their grammar does *not* accord such useful and accessible semantic concepts the status of grammatical constituents.

The claim is strengthened by the observation that the residual nondeterminism in the grammar of intonation, arising in part from the widespread presence of unmarked themes, as discussed in connection with example (55) in chapter 5, is confined precisely to those occasions on which the topic or theme is believed by the speaker to be entirely known to all parties, and to be recoverable by comparing the interpretation of a (usually leftmost) substring with the contextual open proposition or theme. It would be surprising if the mechanism for disambiguating written language were very different from its ancestor in the processor for spoken language.

It is of course unlikely that we will ever know enough about the biological constraints to evaluate the assumptions on which the "strict" version of the

competence hypothesis is based with any certainty. In the absence of such certainty, we must beware of falling into the error of evolutionary Panglossism. However, it is appropriate to speculate a little further upon the implications of the Strict Competence Hypothesis for the theory as a whole, for the following reason.

Competence grammar and performance mechanism originally evolved as components of a single biological system. The methodological priority of competence that has been continually endorsed in the present work is no more than a research strategy. Any claim about competence grammar is ultimately a claim about the entire computational package. As soon as our linguistic theories have attained the level of descriptive adequacy, they will have to be judged not merely on their purity and parsimony as theories of competence, but on their explanatory value as part of a psychologically and biologically credible performance system. Chapter 9 noted that all theories will require *something* more, in the form of a language-independent mechanism for resolving local ambiguity, or grammatical nondeterminism, together with a language-independent algorithm and automaton. But if a theory of competence requires much more than that, or if that mechanism in turn implicates a notion of structure that is not covered by the competence grammar, then those assumptions will weigh against it. If there is another descriptively adequate theory that requires fewer such assumptions, perhaps even no further assumptions beyond the mechanism for resolving nondeterminism and the minimal bottom-up algorithm, by virtue of having a different notion of surface syntax, then the scales may tilt in its favor.

None of the current theories of grammar, including the present one, have yet attained the full descriptive adequacy that would allow us to weigh them in the balance in this way. But if it is true that the principal responsibility for local ambiguity resolution lies with word-by-word incremental interpretation (or with correspondingly fine-grain probabilistic evaluation), then any theory that does not make assumptions similar to those of CCG concerning constituency in the competence grammar will, as we saw in chapter 9, have to make some strikingly similar structures available to the processor, complete with interpretations. Such additional assumptions could not by definition be inconsistent with the pure competence theory itself. However, they compromise the Strict Competence Hypothesis. To the extent that a combinatory grammar can achieve the same result without any additional assumptions, and to the extent that it is descriptively correct to include identical structures and interpretations in the competence grammar of coordination and intonation, the combinatory theory may then be preferred as an explanatory account.

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# Notes

## Chapter 1

1. The HOLD-register analysis of *wh*-movement was in part anticipated in earlier work by Thorne, Bratley and Dewar (1968), who called their register *.

2. Wood (1993) provides a useful review of theories by Lambek (1958), Ades and Steedman (1982), Bach (1979), Dowty (1979), Steedman (1987), Oehrle (1988), Hepple (1990), Jacobson (1990, 1992b), Szabolcsi (1989, 1992), and Wood (1988), although my colleagues should not be assumed to endorse all the assumptions of the version that is outlined here. The present proposal is more distantly related to a number of other generalizations of the early categorial systems of Ajdukiewicz, Bach, Bar-Hillel, Dowty, Lambek, Geach, Lewis, Montague, van Benthem, Cresswell, and von Stechow, to many of which the conclusions of this book also apply. In particular, Oehrle (1987), Moortgat (1988a), and Morrill (1994) explicitly relate Lambek-style categorial grammars to prosody.

3. Marr expressed some doubt about whether natural language is in fact a modular system, apparently because he was aware of the way knowledge and inference interact with language understanding. I will argue against this conclusion in chapter 9.

## Chapter 2

1. This claim should not be taken as denying that such learning can be usefully thought of in terms of supervised machine learning techniques, or as excluding the possibility that the substrate of such conceptual representations may be associative or probabilistic.

2. The "Standard Theory" presented in Chomsky 1965 did not explicitly recognize any level of Logical Form distinct from Deep Structure. However, had it done so, it would have had to derive it from Deep Structure. The fact that later "Extended," "Revised Extended," and "Principles and Parameters" or "Government-Binding (GB)" versions of Chomsky's theory derived Logical Form from a level called "S-Structure" should not be allowed to confuse the point. S-Structure is not the same as Surface Structure, as will become clear when this level is discussed in more detail below. The rather different view of Logical Form sketched in Chomsky 1971 is discussed in chapter 5.

3. There are a number of well-known exceptions to this generalization, which I will