Koenig

LEXICAL RELATIONS

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To Alfred and Yolande Koenig

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Introduction

1.1 Lexical Knowledge

What is the nature of the lexicon and lexical knowledge? According to an early view within modern linguistics (see Bloomfield 1933, Chomsky 1965) the lexicon consists of a theoretically uninteresting repository of idiosyncrasies— what Di Sciullo and Williams 1987 call a listeme. This view meshes well with the experience of language learners; learning a language consists in part in the memorization of idiosyncratic properties of words and morphemes. From a more theoretical perspective, linguists often distinguish between the universal aspects of language— syntax being the clearest locus of such universality— and the inescapable idiosyncratic left-overs, what lexical knowledge is about. The lexicon is, then, a place where the (theoretical) linguist's job ends. This view is unsatisfactory in at least two respects. For one thing, in more recent years, linguists have transferred more and more of the structure of grammatical systems to the lexicon and have let syntax take its lead from lexical entries (in technical terms, syntax is projected from the lexicon). As the grammatical burden has shifted progressively to words and morphemes, lexical structure has been more and more endowed with the regularity and productivity which was once the sole province of syntax. The traditional notion of the lexicon as 'a prison for the lawless' (Di Sciullo and Williams, op.cit.) does not capture those productive aspects of lexical knowledge which are not simply the result of rote memorization.

Furthermore, by letting lexical knowledge be the repository of all idiosyncrasies, we are forced into a false dichotomy— a language consists of universal principles (often conceived of as a set of parameter values in a list of innate universal properties) and a list of (lexical) idiosyncratic facts. What this dichotomy leaves out is *medium-size generalizations*— facts that are neither particular to individual lexical items, nor conse-

quences of universal properties of the human language capacity. Much of lexical knowledge resides in such medium-size properties. By construing the lexicon as an unorganized repository of idiosyncrasies, we ignore a large portion of it. To illustrate, let's consider an example from Williams 1994. Williams notes that nouns which refer to 'lower trunk wear' in English are all *pluralia tantum* (witness, 'pants', 'jeans', 'shorts', and so forth). He introduces the following informal rule to account for this fact.

(1) Ns ←: 'lower trunk wear'

Any word whose meaning can be characterized by the expression on the right hand side of the arrow must be a plural noun. Now, this rule is particular to English. French, for example, does not have such a rule; its lexicon contains 'pantalon' ('pants (sg)'), 'short' ('shorts' (sg)), and so forth. What kind of linguistic knowledge, then, does the rule in (1) illustrate? Clearly not the value of an innate parameter. There is no "pants" parameter for which English would be marked [+plural] and French [+singular]. Nor is it an idiosyncrasy of a single lexical entry or an idiomatic fact on a par with the idiomatic meaning of 'kick the bucket', as Williams points out. The "pants" rule illustrates well what I call medium-size generalizations— descriptive generalizations that are not plausibly the consequences of universal principles, however parametrized, but do not constitute idiosyncrasies of individual lexical items either. What the traditional view of the lexicon misses is not only the productive, non-idiosyncratic aspects of lexical knowledge, but also the medium-size nature of some of this knowledge.

The thrust of this book is to provide a model of lexical relations which reconciles the lexicon's idiosyncratic and productive traits. Building on work in Head-driven Phrase Structure Grammar, an organization of lexical knowledge is proposed— called the Type Underspecified Hierarchical Lexicon— which provides a unified model for partial regularities, medium-size generalizations, and truly productive processes. The intuitive ideas and tools behind this architecture are simple.

- A language's lexicon consists of a multidimensional taxonomy of word or lexeme categories.[1]
- Lexical entries are stored underspecified.
- Lexical processes reduce to category intersection.

The use of inheritance networks or underspecification to model linguistic knowledge is not new. Inheritance networks have been used

[1]Throughout this book, I use the word 'lexeme' to refer to the class of roots, stems, and words.

in Natural Language Processing systems to flexibly and efficiently encode human knowledge since at least the late 60's (see Quillian 1968, Bobrow and Webber 1980, Brachman and Schmolze 1985, among others). Furthermore, several linguistic frameworks which can be characterized as category-based, to borrow a term from Pullum and Zwicky 1991, already make extensive use of category networks in their descriptions of grammatical knowledge. It is illustrated by work in Construction Grammar (hereafter CG, Lakoff 1987 and Fillmore and Kay (Forthcoming)), Head-driven Phrase Structure Grammar (Pollard and Sag 1994) (hereafter HPSG), and Cognitive Grammar (hereafter COGGR, Langacker 1987, Langacker 1991).

Underspecification, moreover, has been widely used in (lexical) phonology since at least the mid 80's (see among others Archangeli 1984 and Kiparsky 1985, as well as Steriade 1995 for a recent survey). More recently, Lexical-Functional Grammar's (hereafter LFG) Lexical Mapping Theory makes a limited appeal to underspecification (see *inter alia* Bresnan and Kanerva 1989). But, the combination of these two tools is new and allows for a unified account of the idiosyncratic and productive aspects of lexical knowledge.

By letting lexical entries be underspecified, the model proposed in this book departs from other architectures based on the notion of a taxonomic hierarchy of categories— be they unification-based frameworks such as HPSG or strictly usage-based models, such as COGGR. In both approaches, stored entries contain (directly or indirectly) all information needed for their use in a particular sentence. By contrast, in the lexical architecture proposed in this book, lexical entries may be stored stripped of all information which varies across their syntactic contexts of occurrence. Stored entries are abstract blue-prints, so to speak. Actual words used in uttering and interpreting sentences result from intersecting these underspecified objects with various lexeme classes that fill in information left out of stored entries. Applying lexical processes simply means filling in information.[2]

[2]Two caveats are in order. Firstly, lexical entries *may* be stored underspecified; they do not have to be. The Type Underspecified Hierarchical Lexicon does not require lexical storage to be minimally redundant. What is crucial for its account of lexical productivity is that entries are allowed to be stored without some of their contextually determined information. Because Type Underspecification does not require minimal redundancy, it can account for well-known psycholinguistic results that show that the mental lexicon contains redundancies (Lukatela et al. 1980).

Secondly, in current HPSG Hierarchical Lexicons, information contained in an entry need not be directly stipulated as part of this entry's definition. Much of the information associated with entries is indirectly inferred from the properties of the superclasses to which they belong. Moreover, the stipulated information might be

Lexical knowledge, as I argue for in this book, thus differs markedly from what is traditionally assumed. It is not a mere enumeration of idiosyncratic, fully specified entries. It consists of a set of underspecified entries organized taxonomically into lexeme classes which capture generalizations that are true of (potentially open) sets of entries. The dual aspects of lexical knowledge reconcile the two views of the lexicon mentioned at the outset. The set of *minimal* entries is indeed a repository of idiosyncrasies; but the set of *lexeme classes* the lexicon broadly construed also contains explains the fact that much of the productive patterning of grammars is lexical in nature. Four major advantages, I argue, accrue to a Type Underspecified Hierarchical Lexicon (hereafter TUHL). One stems from the hierarchical organization of lexical information it borrows from HPSG's Hierarchical Lexicon. Three are specific to the TUHL architecture.

Firstly, we can directly account for lexical productivity: we do not need to use lexical rules or any other ancillary devices. We thus avoid all difficulties attached to lexical rules I discuss in chapter 2. Productivity results from category abstraction, the fundamental structuring tool of hierarchical grammars. Furthermore, by reducing rule application to independently needed notions such as category abstraction and intersection, we provide an account of rule-like behavior without relying on rules, which are often criticized by psychologists as implausible. Rules reduce to abstract lexical categories filling in information in underspecified entries. Rule application reduces to category intersection or, more generally, boolean operations on categories.

Secondly, many salient properties of morphological processes find a natural explanation once lexical processes reduce to category intersection.

Thirdly, because the account of productivity the TUHL proposes is category-based, it does not run afoul of the well-known idiosyncrasies of lexical behavior. Lexical exceptions can be modeled without added machinery: their exceptional behavior stems from the inclusion of additional information which regular (minimal) entries leave underspecified. Any added information reduces the combinatorial potential of lexemes by restricting the set of categories with which they are compatible and can therefore combine. Exceptionality thus becomes relative and is naturally measured by the amount of information we need to specify in an

partly underspecified, as when a language neutralizes particular case distinctions (see Pollard and Sag 1994, chapter 2). But lexical entries are still crucially completely specified with respect to their category membership (or type). What sets the Type Underspecified Hierarchical Lexicon apart is the presence of *type* underspecification in the definition of stored entries, as explained in detail in chapters 2 and 3.

entry. It does not require new structure or formal apparatus. Exceptionality is the limiting case of general principles of knowledge organization.

Finally, medium-size or language-specific generalizations receive an adequate model. Many lexical generalizations are to a large extent language-specific (see Wasow 1977). They do not fall in either the universal or idiosyncratic dichotomy; they are general, often productive, but cannot be reduced to a small set of parametrized universals, even when cross-linguistic patterns are discernible. Moreover, lexical processes are typically organized taxonomically; one needs to distinguish various subcases of a particular process, some more productive than others, each sharing some common structure as well as including particular properties. Because lexical productivity stems from the organization of a hierarchical lexicon, which is well suited to capturing medium-size generalizations, the TUHL architecture directly accounts for this defining property of lexical processes.

1.2 Sign-based, category-based grammars

To better understand the overall model of lexical knowledge proposed in this book, it is useful to put the proposal within the larger context of grammatical theories. At an abstract level, grammars may be viewed as transducers associating phonological strings, semantic, and contextual representations. The linguist's task is then to characterize the general architecture of these transducers as well as how native speakers acquire it. An important task of Linguistics as a Cognitive Science is thus the construction of a computational device that accounts for the set of well-formed string-meaning-context triplets. Of course, just as important as finding out their general architecture, is finding out how much these transducers can vary across languages. The general architecture of the "transducer" I assume in this book is based on four leading ideas (outlined in this section) that are shared by frameworks as diverse as Langacker's Cognitive Grammar, Lakoff or Fillmore and Kay's Construction Grammar, and Head-Driven Phrase-Structure Grammar.[3] Even though the analyses I present are stated within HPSG, they can all be translated into Construction Grammar, and most into Cognitive Grammar.

[3]Construction Grammar is best seen as a research program rather than a specific theory. Scholars who call themselves construction grammarians often differ in the specifics of their grammatical theories. See Brugman 1988b, Fillmore et al. 1988, Fillmore and Kay (Forthcoming), Goldberg 1991, Goldberg 1995, Jurafsky 1991, Jurafsky 1996, Koenig 1993, Koenig 1994, Lambrecht 1994, Lakoff 1987, Michaelis 1993, Michaelis and Lambrecht 1996, and Zwicky 1989 for recent studies within this research program.

1. Grammars are sign-based. They consist of direct associations between form and meaning. In that sense, the approach I take in this book conforms to the rule-to-rule hypothesis of Bach 1976, according to which each syntactic rule is directly paired with a semantic rule.[4] It also conforms to the idea of linguistic gestalts introduced in Lakoff 1977, another early precursor to sign-based grammars. By locally pairing semantic and syntactic information in single rules or constructions, sign-based grammars are antithetic to the "pipeline" model familiar from work in Extended Standard Theory according to which syntax and semantics proceed independently of each other and are associated globally as separate modules (see Chomsky 1981). As a consequence, cross-module mappings between form and meaning are expected: part of linguistic knowledge consists of cross-domain associations between pieces of conceptual structure, pieces of syntactic information, and pieces of phonological information (see Lakoff 1993 among others). Sign-based theories thus also differ from theories of linguistic knowledge that follow Fodor 1983's notion of informationally encapsulated modules, which precludes construction-specific cross-domain associations.

2. Grammars are richly articulated systems of categories. Consequently, no principled difference exists between the lexicon and other parts of a language's grammar. Although phrase-structure schemata may be considered more abstract than typical lexical entries, no ontological difference between the two is presumed to exist. They bear very similar kinds of properties and are modeled via the same logic, simplifying somewhat, the logic of classes. Grammars are thus "big lexicons" or "constructicons." But this single constructicon has more structure than grammars and lexicons in traditional generative studies. Whereas grammars and lexicons traditionally consist of a set of unordered rules or principles and a collection of entries, hierarchical sign-based grammars are not flat. Grammatical signs (and linguistic objects, more generally) form a system of categories within a structured inheritance network, in a manner very similar to models of other kinds of knowledge in Artificial Intelligence.[5] Because of this hierarchical organization, relationships

[4]The semantic side of signs or constructions differs among sign-based grammars. In particular, it is more inclusive in CG than typically assumed in classical model-theoretic semantics. It includes (at least) information-structure notions such as Topic or Focus (see Lambrecht 1994), pragmatic variables (see Fillmore et al. 1988), illocutionary force (see Lakoff 1987), and construal or frame-based semantics (Fillmore 1982, Fillmore 1985, Langacker 1987, Talmy 1985).

[5]I assume the strongest version of this claim— that grammatical knowledge is organized like any other kind of knowledge. Note that this question is in principle independent of whether the content of linguistic knowledge is different from other kinds of knowledge, and in particular, is the result of a particular language faculty.

between patterns are not modeled derivationally, through the transformation of one structure into another, but through the specification of the common classes to which patterns belong and through which they share a set of properties.

3. Grammars are constraint-satisfaction systems. String interpretation or production is not accomplished via derivations, but by simultaneous satisfaction of sets of constraints (intuitively speaking, by superimposing constructions or signs). This idea dates back in part to Generative Semantics and McCawley 1968, but its more general implementation is the hallmark of several modern approaches to grammatical theory, from CG to HPSG, or some versions of the Principles and Parameters approach (see Berwick 1991).

4. All grammatical facts belong to a single grammar common to both competence and performance. This claim encompasses two slightly different hypotheses. Firstly, no *a priori* distinction is recognized between a grammatical core and a grammatical periphery. Generalizations as well as true substantive universals are captured by positing more and more abstract objects; idiosyncratic patterns are simply objects low in the hierarchy of signs.[6] Secondly, the strong competence hypothesis of Bresnan and Kaplan 1982 (anticipated in the cognitive grammar of Lakoff and Thompson 1975) is assumed: grammars described by linguists as constituting native speakers' knowledge of their language are the same grammars used by speakers to interpret and produce utterances. For reasons made abundantly clear in Bresnan and Kaplan 1982, Shieber 1986, Sag 1991, and others, this last assumption leads sign-based grammarians to prefer monotonic, declarative representations of grammatical knowledge: such representations allow for an easy modeling of partial interpretations of substrings, the integration of knowledge from various sources at any point during interpretation/production, and

Claiming that the organization of linguistic knowledge parallels that of other kinds of knowledge does not commit oneself to any hypothesis as to its content.

[6] A word of caution is in order. Although universal distinctions are high in the hierarchy of linguistic objects and language-specific distinctions will be further divisions of the universal classes, determining a cut-off point above which only universal categories occur is not easy. To that extent, category hierarchies do not by themselves separate universal classifications from general, cross-linguistic frequent ones. In the specific representational scheme I adopt for this book (Typed Feature Structures), the only universals are (i) formal universals induced by the representational scheme itself; (ii) universals that follow from the particular "feature geometry" one chooses; (iii) stipulated universal principles, such as the subcategorization principle of Pollard and Sag 1994. I leave open the question of the existence of abstract, universal types as well as the relationship between such hypothetical universal types and language-specific types. See Green 1996 for some suggestions concerning universal types.

the construction of a single model of grammatical knowledge for both interpretation and production.[7]

1.3 The psychological reality of grammars

Ideally, grammars of natural languages as linguists describe them should correspond to individual speakers' internal grammars. One must therefore partly evaluate the former on how well they reflect what is known about the cognitive systems within which the latter are embedded. Most of my discussion in this book, though, does not focus on such "cognitive" issues. In fact, to "cognitively"-oriented linguists, there might seem to be very little cognition in the pages to follow. Two remarks should suffice to clarify the cognitive status of the grammatical descriptions included in this book. Firstly, the representational scheme I use to state grammatical descriptions is somewhat minimalist. I make use of very few properties of cognitive systems. I only rely upon three tools: the ability to generalize over instances, the ability to organize categories along several taxonomic schemes, and the ability to identify two (sub)structures. None of these abilities seems particularly controversial. As such, the general mechanisms underlying the grammar fragments I present are cognitively plausible. In fact, some cognitive psychologists recently have independently proposed psychological models of linguistic productivity very similar to the one proposed here (see for example Barsalou 1993 and Barsalou and Prinz 1997). Such unexpected convergence suggests the initial cognitive plausibility of the model of lexical knowledge for which I argue.

Secondly, the gist of the book lies in the description of some general properties of grammars and the logic of their organizations. It is these properties which are claimed to have a cognitive equivalent, not the representational scheme used to describe them. The formalism that I use should not therefore be directly interpreted in cognitive terms. Although I assume that the grammatical structures being formally represented are (in the best of all cases) isomorphic to the actual implementation of grammatical systems in the brain/mind, no claim is made

[7] This monotonic and declarative stance is slightly bent in those versions of CG that use default inheritance schemes, such as Lakoff 1987, Goldberg 1992. But, as George Lakoff pointed out to me (p.c.), this alteration only concerns the representation of grammatical information, not its use: once a construction is chosen in interpreting or producing an utterance, the information structure it contributes to the analysis of the string cannot be altered. Moreover, Lascarides et al. 1996's recent approach to the logic of defaults in unification grammars can be applied so as to make Lakoff's and Goldberg's theories conform to the desideratum of order-independence intimately tied to the strong competence hypothesis.

as to the actual mechanisms by which they are cognitively realized. To borrow freely from Marr 1982's terminology, what is being described is merely some of the properties of *what* is computed by the brain when interpreting or producing sentences.

To illustrate this point with an example, the classification of linguistic categories into cross-cutting inheritance hierarchies is claimed to be part of the structure of people's actual internal grammars. But the formalism used to make the idea precise does not commit us to any particular realization. What corresponds to the type hierarchy psycholinguistically or neuro-physiologically is left completely open. The only cognitive hypothesis I make is that the realization of grammars obeys the logic of types and the relations between types discussed in this book. In other words, the grammatical descriptions included in this book are merely abstract characterizations of certain properties of the "machines" ("transducers") which underly people's grammars. They are not descriptions of the machines themselves. There might be many (linguistically equivalent) ways to build a machine meeting these design requirements. The same is true of my major claim— that lexical entries are stored underspecified. This property of lexical organization is intended to reflect a property of the psychological/neurological implementation of individual speakers' grammars, but no assumption is made as to how this property is implemented.

Such a minimal cognitivism seems to be the most linguistic methodologies can hope for. As Gupta and Touretzky 1994 show, the inner workings of particular implementations of a grammatical theory can differ significantly from the mechanisms foreseen by the linguistic theory which underlies them. Given the looseness of the connection between grammatical and actual cognitive modeling, such broad cognitivism is, for the moment, the only game in town. What linguists describe are sets of properties grammars obey, which they model with a certain description language provided with a logic. What attributes of the brain/mind correspond to these properties and implement this logic— while ultimately the goal of a theory of language— is beyond the scope of linguistic methodology. This book is no exception.