57. Syntax and Lexicography

Abstract

The article gives an overview of the role of syntax in theoretical and practical lexicography. Generally speaking, the grammatical and syntactic information of a dictionary entry should indicate how to use the described word in a grammatically correct way. Issues to be addressed include the kind of syntactic information specified in dictionaries, its representation for the user, and the empirical basis and methodology for gathering this information. The first two points depend strongly on the type and purpose of the dictionary: A dictionary for professional use by translators or teachers is subject to different requirements concerning the delicacy and presentation of syntactic specifications than a learners' dictionary, and still other requirements hold for electronic dictionaries suitable for natural language processing by computers.

1. Introduction

Lexicography is concerned with the theory and practice of compiling dictionaries. The general monolingual dictionary can be described as a work of lexical reference, a documentation of the lexical repertoire of a language. In lexicography, syntactic information is relevant to at least two sorts of people: lexicographers and dictionary users. The common user of a monolingual dictionary may want to look up how to use a certain word in a grammatically correct way. User-friendliness of presentation is therefore a central issue – the user should be able to easily grasp the syntactic information. Which kind of representation is the most effective depends on the needs and the language competence of the intended user group, which can be language learners at different levels of mastery, adult native speakers, or language professionals such as translators or teachers. Delicacy and completeness of syntactic specifications as well as presupposed grammatical competence may thus vary considerably.

The lexicographer, on the other hand, should take syntactic analysis into account while compiling dictionary entries – not only in the obvious sense that the entry has to be supplied with certain grammatical specifications in accordance with the predefined entry structure, but as a tool for guiding the design of the entry. In general, it is a non-trivial question of how to convey the syntactic insights of the lexicographer to the user. A convenient presentation will clearly be less explicit and most probably less detailed; what is needed is, as Corbin (2002: 34) puts it, "la vulgarisation dictionnairique des savoirs linguistiques."

1.1. Lexicography versus grammaticography and lexicology

Lexicology and grammaticography are two fields closely related to lexicography and syntax. *Grammaticography* can be described as the "art and craft of writing grammars" (Mosel 2006). Grammars and dictionaries have in common that they are both metalinguistic descriptions compiled mostly for didactic and documentation purposes (Béjoint 1994: 28); cf. article 59. Grammars are traditionally concerned with the regularities of a language whereas dictionaries are responsible for the properties of single units. However, where exactly to draw the line between grammar and dictionary is not that clear (Béjoint 1994) – a point also emphasized by corpus-oriented lexicographers like John Sinclair:

> Recent research into the features of language corpora give us reason to believe that the fundamental distinction between grammar, on the one hand, and lexis, on the other hand, is not as fundamental as it is usually held to be and since it is a distinction that is made at the outset of the formal study of language, then it colours and distorts the whole enterprise. (Sinclair 2004: 164).

Lexicology investigates the structure of the vocabulary of a language; it examines the internal semantic structure of individual words, the relationships between them, and syntagmatic regularities such as selectional preferences and syntactic projection rules. The field of lexicology thus overlaps with theoretical lexicography (cf. Gouws 2004; Wolski 2005). Lang (1983) provides a careful comparison between the dictionary as a lexicographic product and the *lexicon* as a model component (*Modellkomponente*) of the grammar. He notes, *inter alia*, that while in lexicology, as a subdiscipline of linguistics, the lexicon is seen as part of the grammar in a more general sense, in lexicography, the dictionary is contrasted with grammar in the narrow sense. Moreover, the lexicon aims at depth of description and explicit, model-dependent representations, whereas the dictionary tries to achieve broad coverage and implicit, user-oriented entries. The notion of lexicon understood this way is a key component for theories of the syntax-semantics interface (cf. articles 32 and 35), whose goal is to explore the syntagmatic realization of semantic arguments, among others. We will see below that explanations at this level of linguistic abstraction can be helpful to the lexicographer's task of designing dictionary entries.

1.2. Overview, scope, and general terminology

The syntactic information provided by a dictionary entry is concerned with the *syntagmatic characteristics* of the entry's headword, that is, with the question of how the word, in each of its senses, combines with other words in forming phrases and sentences. This includes information about the word's *wordclass*, its *syntactic valency*, and the *collocations* the word occurs in (cf. Svensén 2009: 7). The main focus of this article is on the lexicographic treatment of syntactic valency. The terms *valency pattern* and *complementation pattern* will be used interchangeably (cf. article 1 on basic syntactic notions). A note on the notion of *word sense* and *meaning* might be in order: In lexicography, "the treatment of a word in a dictionary does not aim at specifying what the word 'really' means but at describing its meaning in a way that is suitable to the needs of the user of the dictionary" (Svensén 2009: 205). We will see below how linguistic and syntactic insights can support the lexicographer's decision on where to draw the line between the different meanings of a word.

The basic concepts and terminology of lexicography used in this article are introduced in Section 2. The goal of Section 3 is to indicate the positive role that linguistics and syntactic theory can play in lexicographic design decisions. In Section 4, we take a closer look at how syntactic information is represented in *monolingual dictionaries*. Special emphasis is put on the specification of complements, since complementation patterns are essential for constructing

phrases and sentences. In addition to the lexicographic coding of complementation patterns (Section 4.1), we will discuss methods of conveying such patterns implicitly in dictionary definitions and examples (Section 4.2). The purpose of the case studies in Section 4.3 is to exemplify the usefulness of taking a linguistically informed view of the presentation of complementation in dictionaries. After an overview of the specific issues related to presenting syntactic information in *bilingual dictionaries* (Section 5), we will return to the topic of complementation in the context of so-called *valency dictionaries* (Section 6.1), which are instances of *specialized dictionaries* (Section 6). Dictionaries of *function words*, a second type of dictionary specialized on syntactic information, are briefly discussed in Section 6.2. Section 7 discusses the role of syntactic information in *computational lexicography*, and Section 8 concludes the article with some remarks on syntactic aspects of lexicography that go beyond those concerned with the syntax of natural language.

2. Some basic lexicographic concepts

2.1. Dictionary types and dictionary users

Dictionaries can be classified in a number of ways (Kühn 1989; Hausmann 1989). The discriminating properties listed by Atkins and Rundell (2008: 24–25) include language (monolingual, bilingual, multilingual), coverage (general language, specific areas of language, sublanguages, etc.), size, medium (print vs. electronic), user group (linguists, translators, literate adults, language learners, etc.), and intended use (decoding vs. encoding). As to the last distinction, *decoding* refers to the process of understanding the meaning of a word, whereas *encoding* means using a word correctly. In the context of the present article, whose focus is on syntax, the following types of dictionaries are particularly relevant: dictionaries intended for encoding, that is, monolingual learners' dictionaries and active bilingual dictionaries, and dictionaries specialized on syntagmatic information or grammatical words.

A key factor in dictionary design is the intended user. With regard to user skills and needs, there is a stark contrast between learners' dictionaries and dictionaries for the expert. Syntagmatic information for non-experts, who are the overwhelming majority of dictionary users, must be conveyed in non-technical terms, preferably without presupposing any acquaintance with grammatical notions. The linguistic expert, on the other hand, prefers descriptions that are as detailed and explicit as possible. In addition to the learner and the expert, we may also count the computer as a potential user profiting from syntactic specifications in the dictionary. More precisely, a natural language processing system may take advantage of the lexical data specified in a dictionary, if they are available in machine-readable form. The requirements concerning precision and formalization are here rather different from those of the human user.

To keep in mind the goals of a dictionary is important for an adequate evaluation. As an example, Zgusta (2006: 115–116) mentions the Warlpiri dictionary project presented in Laughren and Nash (1983), where actants in meaning definitions are described abstractly with case labels indicating ergative and absolutive case marking respectively. Zgusta accepts an objection by Wierzbicka stating that this kind of presentation is not helpful to the average dictionary user such as a teacher or a high school student. But he points out that a learners' dictionary was not intended by the project and that an explicit and detailed description has its value for language documentation, especially with endangered languages.

2.2. Component parts of dictionaries

Dictionaries are highly structured objects (Hausmann and Wiegand 1989). The *macrostructure* of a dictionary determines the types of entries included in the dictionary and the arrangement of the headwords or lemmas (e.g. in alphabetical order); the *microstructure* characterizes the lexicographic information within a lemma and its internal organization (Wiegand 1989a; 1989b). The microstructure specifies the way in which the different senses or *lexical units* of the headword are arranged within the entry, and it comprises information on the form, meaning and use of the lemma. Formal information may include details about spelling, pronunciation, inflection, and also about syntax and grammar, which will be discussed in more detail in Section 4.

Explaining the meanings of a word can be regarded as the central function of the general monolingual dictionary. In lexicography, meaning explications are known as *definitions* (Wiegand 1989c). Atkins and Rundell (2008: 407) speak of a "misnomer", because *definition* stands for the unrealistic ideal of necessary and sufficient conditions. The traditional model leans on the Aristotelian notion of analytic definition by *genus proximum*, the immediate superordinate word, and *differentia specifica*, i.e., distinguishing features. Defining by synonyms is another traditional strategy widely used in dictionaries. *Contextual* or *full sentence definitions* (Hanks 1987) are a more recent device, where the *definiendum* is embedded in the defining sentence, typically as part of the *if*-clause of an *if-then* sentence (cf. Section 4.2).

Information on the use of a headword may include textual *examples*, either authentic, adapted or constructed, in which the word occurs. *Usage notes*, by contrast, provide the user with additional helpful hints such as metaphorical interpretations of the headword. As will be discussed in Section 4.2, examples and definitions can be employed to some degree to convey syntagmatic information about the headword.

2.3. The lexicographic process

Atkins (1992: 7–8) characterizes the process of monolingual dictionary building as consisting of two main stages: *analysis* and *synthesis*; see Atkins and Rundell (2008) for a detailed exposition; different but related aspects of the lexicographic process are discussed in Wiegand (1998b: sect. 1.5) and Müller-Spitzer (2007). In the first stage, the lexicographer analyzes a word, tries to identify its senses, and records linguistic facts about the word in a systematic way. The rationale is to gather as much details as possible and to store them in a pre-dictionary database. The analysis process calls for a "high degree of linguistic knowledge and awareness" (Atkins 1992). In the synthesis stage, dictionary entries are compiled on the basis of facts collected in the database. It is this stage where decisions on the macro- and microstructure as well as user skills become important. The same lexical database can thus serve as a basis for constructing dictionaries of rather different appearance. For bilingual dictionaries, synthesis is preceded by a *transfer* stage, in which the database is partially translated into the target language.

A careful treatment of syntactic information is necessary at all stages. In the analysis stage, all relevant syntactic facts about a word are recorded in a structured scheme to be stored in the database. The lexicographer has to describe the syntactic constructions in which the word occurs with sufficient detail and linguistic expertise. All constructions are to be furnished with examples, and the examples should be provided with syntactic annotations that instantiate the construction. In the entry-compilation stage, on the other hand, the lexicographer has to decide on how to present the syntactic information in a way suitable to the user and on the amount of information the user should be supplied with, e.g., concerning

the set of recorded syntactic patterns. Such a two-step process may offer a solution to the aforementioned problem that syntactic information needs to be explicit for the expert, including the lexicographer, but ought to be appropriately disguised for the non-expert.

2.4. Pointers to the literature

The following list of suggestions for further reading, which is necessarily very brief and highly selective, provides some first entry points to the vast field of lexicography. Overview articles on lexicography are Kirkness (2004) and Hanks (2003), the latter from a computational linguistics perspective. A selected list of German and English textbooks are Herbst and Klotz (2003), Engelberg and Lemnitzer (2009), Béjoint (1994), Landau (2001), Atkins and Rundell (2008), and Svensén (2009), a useful collection of important articles is Fontenelle (2008). Major periodicals on the topic are *The International Journal of Lexicography* (Oxford University Press) and *Lexicographica, International Annual for Lexicography* (Niemeyer/de Gruyter). An influential book series is *Lexicographica, Series Maior*. The three volume set on dictionaries by Hausmann et al. (1989, 1990, 1991) exhaustively describes the state of the art at that time; a forth, supplementary volume covering more recent developments has just appeared (Gouws et al. 2013). A major conference is the EURALEX International Congress organized biennially by the European Association for Lexicography (http://www.euralex.org/).

3. Lexicography and linguistics

Scholars such as Apresjan, Atkins, Corbin, Helbig and Zgusta, among others, have repeatedly expressed the opinion that linguistic research can be useful to practical dictionary making, especially with regard to its *systematicity*. In order to bridge the gap between lexicography and linguistic theory, Apresjan (1992, 2000, 2002) has proposed a number of "principles of systematic lexicography." One of his principles calls for using "integrated linguistic descriptions, with perfectly coordinated dictionary and grammar." The lexicographer could clearly profit from such an integrated linguistic framework at the analysis stage of the lexicographic process.

How to convert the linguistic descriptions into presentations accessible by the normal dictionary user is an issue to be solved at the synthesis stage. Corbin (2002: 32) regards this as one of the problems for the transmission of linguistic theory to lexicographic practice. The second problem is the lexicographers' access to linguistic insights, which Corbin sees as considerably hindered by the wide variety of linguistic theories at disposal:

> L'accès des lexicographes aux savoirs linguistiques qui pourraient leur être utiles dans leur pratique n'est pas chose aisée. La linguistique n'est pas aujourd'hui une discipline unifiée dans ses fondements et dans ses méthodes, qui proposerait, dans divers secteurs, un ensemble de résultats stabilisés.
>
> [It is not an easy task for lexicographers to access the linguistic knowledge that could be useful for their practical work. Today, linguistics is not a unified discipline concerning its foundations and methods and does not provide a set of stable results in its various branches.]

Adopting a linguistic framework for lexicographic descriptions, as demanded by Apresjan, is thus a non-trivial task. The most natural choice for the lexicographer is to consult an established descriptive grammar of the language in question. However, using such a grammar for lexicographic purposes can be problematic on two grounds: The grammar may not show the necessary level of linguistic sophistication since it targets primarily high school students and teachers. For example, the grammar may lack a systematic treatment of complementation and argument alternation, which is a prerequisite for a syntactically informed analysis of the

corpus data. On the other hand, the grammar may presuppose too much linguistic knowledge to be of use at the synthesis stage when the needs of language learners are to be met.

There is a certain tension between a linguistically informed analysis and the type of analysis put forward by corpus-oriented lexicographers, for which reservations about theoretical assumptions are programmatic: "If (…) the objective is to observe and record behaviour and make generalisations based on the observations, a means of recording structures must be devised which depends as little as possible on a theory. The more superficial, the better" (Sinclair 1987b: 107). However, finding the right generalizations on the basis of surface patterns goes along with a more abstract level of analysis such as the identification of dependencies (Hunston 2004: 108). So, even if linguistic theory may provide analyses only for a limited subset of the data found in corpora, it seems advisable to take them into account as valuable generalizations which can serve as a starting point for the lexicographer.

Another of Apresjan's principles of systematic lexicography says that "all salient lexical classes should be fully taken into account and uniformly described in a dictionary in all of their linguistically relevant properties." He gives the example of distinguishing between factive and putative mental state verbs, i.e., between verbs such as *to know*, *to understand*, *to guess* on the one hand, and those like *to think*, *to believe*, and *to consider* on the other hand. These verbs show a number of characteristic syntactic properties indicating their respective classes. For instance, factives, in contrast to putatives, can govern embedded questions – compare *She knew how to do it* with **She believed how to do it.* In this way, "two well-defined and consistently organized lexico-semantic classes emerge. To make them accessible to certain rules of grammar and other sufficiently general linguistic rules we have to posit two distinct lexicographic types which should be uniformly described throughout the dictionary" (Apresjan 2002). That is, the distinction between factives and putatives should be systematically taken into account in the organization of the respective entries in the dictionary.

Apresjan's proposal is similar to the program sketched by Atkins, Kegl, and Levin (1988), who investigate the alternation behavior of a verb as a useful probe to identify verb senses and verb classes (see also Levin 1991, 1993). Atkins, Kegl, and Levin (1988) present a case study on verbs like *bake*, *cook* etc. These verbs participate in the *causative-inchoative* (or *object-to-subject*) alternation and the *unexpressed* (or *indefinite*) *object* alternation, besides others. The first alternation is exemplified by the pair *John cooked the broccoli* and *The broccoli cooked*, with *broccoli* serving as the direct object of the causative variant and as the subject of the inchoative variant. The second alternation is shown by the pair *John cooked lunch* and *John cooked*, where the object remains implicit in the second variant. The two alternations are associated with different senses of *cook*: the causative-inchoative alternation with a change-of-state interpretation, the unexpressed object alternation with a creation interpretation. The resulting distinction of senses in the dictionary entry has positive consequences in the monolingual as well as in the bilingual case. In the monolingual entry, the two intransitive uses are clearly separated, in the bilingual entry, the two senses can be associated with different translation equivalents, e.g. French *(faire) cuire* vs. *préparer*, *faire*, *cuisiner*; cf. Atkins (2002).

4. Syntactic information in monolingual dictionaries

The general monolingual dictionary for native speakers is primarily used for decoding, i.e., for looking up the meaning of a word. Dictionaries of this type provide grammatical information only to a limited extent because the user is expected to have internalized the rules of his or her mother tongue. It is for the same reason that native speakers preferably consult *onomasiological* dictionaries for encoding since finding the right word is their main concern.

The macrostructure of onomasiological (or meaning-to-word) dictionaries is based on the meaning of lexical units. Dictionaries of this type subsume dictionaries of synonyms and thesauri, where grammatical information is traditionally confined to general wordclass labels at best.

The situation is different for learners' dictionaries, which are the topic of *pedagogical* lexicography. Learners' dictionaries are consulted for encoding to a much greater extent than dictionaries for the native speaker. Encoding requires becoming acquainted with the syntagmatic behavior of a word in sufficient detail. The presentation of this information in the dictionary must meet the learner's abilities, where little grammatical knowledge can be assumed, in general. User-friendliness is thus an important factor in pedagogical lexicography since "learners want to find information quickly and be able to grasp it immediately once they find it" (Rundell 1998: 330). In view of the apparent trade-off between accessibility and accuracy of grammatical descriptions, clarity is meanwhile favored over delicacy and completeness (see Section 4.1). Matching the user's needs and reference skills has therefore become a driving force in pedagogical lexicography. At the same time, there are a growing number of empirical studies on the utility of grammatical information in learners' dictionaries. For example, Dziemianko (2006) presents a carefully designed user study on the utility of information about verb syntax that takes into account various methods of presentation (see also Bogaards and van der Kloot 2001, 2002).

The main focus of general dictionaries is on lexical (or content or open-class) words, that is, on nouns, verbs, adjectives, and adverbs. The lexicographic treatment of grammatical (or function or closed-class) words such as prepositions, conjunctions, pronouns, auxiliaries, and determiners is more in dispute. Dictionaries for native speakers often do not deal with the syntactic properties of function words in much detail since, as mentioned above, the user is expected to have some basic knowledge of the respective language, and mastering the use of function words is considered part of general grammatical competence. Learners' dictionaries usually provide more elaborate descriptions of grammatical words, though without much information about syntactic constructions. Interestingly, Coffey (2006) criticizes the treatment of grammatical words in current advanced learners' dictionaries of English as unnecessarily detailed. He argues that elaborate sense distinctions do not necessarily meet the learner's needs, and, furthermore, questions the usefulness of including very elementary facts in the entry because this kind of knowledge is trivial to the advanced learner.

Irrespective of such strictly user-oriented considerations, there is also the "duty of documentation" in monolingual reference dictionaries, which typically come in several volumes. Lang (1989) discusses the description of conjunctions as an example of function words in general; see Schaeder (1985) on prepositions and Wolski (1989a) on modal particles. Lang's main points are in full compliance with the principles introduced in Section 3: The descriptions in the entry should follow grammatical insights; syntactic constructions and their constraints should be part of the entry; and building the entry should consist of two stages, first, recording the relevant facts and, second, designing the final entry presentation.

The treatment of light verbs is a particularly interesting challenge, both for grammar and lexicography. Halfway auxiliary, halfway tied in collocations, the meaning of a light verb is bound up with its complement. Hanks, Urbschat, and Gehweiler (2006) suggest a new kind of dictionary entry for such verbs which is based on extensive corpus analysis. By comparison, the proposal of Polenz (1989) puts more emphasis on an explicit description of the meaning component carried by the light verb.

Syntactic specifications in the general monolingual dictionary are often restricted to grammatical categories (wordclasses) and subcategories such as *gradable adjective* and

transitive verb, possibly extended by information about positional restrictions, prepositional and clausal complements, or the formation of passives. The use of categories in dictionaries is not without problems. Cowie (1989: 588) gives the example of nominal modifiers in noun compounds which are classified as adjectives, Apresjan (2002) that of numerals classified as adjectives. In order to clarify and systematize the grammatical notions used in a dictionary, it has been repeatedly suggested to provide the dictionary with a *dictionary grammar* (Bergenholtz 1984, 2002; Mugdan 1989; Lemmens and Wekker 1991), that is, to include a separate grammar section in the dictionary. The dictionary grammar should be part of, or at least be compatible with a descriptive grammar of the natural language in question – in compliance with Apresjan's principle of integrated linguistic descriptions. According to Mugdan (1989: 743), there is no reason not to employ modern grammatical frameworks for this purpose, since traditional grammar is neither linguistically adequate nor necessarily familiar to the average dictionary user. Matching the abilities of the user is again an essential factor, as acknowledged by all of the above-mentioned authors; see e.g. Lemmens and Wekker (1991: 5–10) for a proposal of what a user-friendly dictionary grammar could look like. A number of general recommendations regarding the content and structure of a dictionary grammar in learners' dictionaries can be found in Tarp (2008: 246–247). Among them are the recommendations that dictionary grammars "must be structured like production grammar books" and that they "must be integrated into the rest of the dictionary via a system of references."

Complementation may be regarded as the syntactic phenomenon most relevant to lexicography, especially if the focus is on encoding. Complementation patterns constitute the basic schemes for constructing phrases and sentences. The following sections describe how complementation information is represented in dictionaries. Most of the dictionaries discussed are learners' dictionaries, where usability is a key issue. Theoretically more advanced descriptions of complementation are provided by *valency dictionaries* to be discussed in Section 6.1. These dictionaries have limited coverage (numbering at most in the hundreds) and assume considerable linguistic expertise on the part of the user.

4.1. Complementation codes and patterns

It depends to a certain degree on the lexicographic tradition of the respective language how complementation information is presented in a dictionary (cf. Section 4.4). A good part of this section will be confined to English pedagogical lexicography, for which the coding of complementation information has been an object of thorough investigation and continuous revision during the last few decades (e.g. Lemmens and Wekker 1986; Aarts 1991; McCorduck 1993; Herbst 1996; Rundell 1998; Cowie 1999; Dziemianko 2006).

Herbst (1996: 329–330) identifies the following types of coding systems (see also Herbst and Klotz 2003: 78–82; Dziemianko 2006: sect. 1.3.1): opaque coding systems, which are neither transparent nor mnemotechnically organized; mnemotechnically organized systems, whose codes are not transparent in that their meaning cannot be transparently deduced from their form; transparent coding systems, whose codes are compositionally built from basic grammatical labels; and systems of pattern illustrations, which employ neither codes nor labels. This ordering reflects the evolution that coding has undergone in subsequent revisions of English learners' dictionaries. The dictionary entry for the verb *promise* in (1) shows the use of the opaque, non-transparent coding system in the third edition of the *Oxford Advanced Learner's Dictionary* (*OALD3*) from the 1970s.

(1) **promise** *vt, vi* **1** [VP6A, 7A, 9, 11, 12A, 13A, 17] make a promise(**1**) to: *They ~d an immediate reply. He ~d (me) to be here/that he would be here at 6 o'clock.* (...) (*OALD3* 1974)

The coding system of *OALD3* was already an improvement over that of the second edition in that similar complementation types bear adjacent code numbers (Cowie 1998: 264). Mnemotechnically organized coding systems are a first step towards transparent codes. Transparency is still rather limited for the mnemonic system employed in the first edition of the *Longman Dictionary of Contemporary English* (*LDOCE1*), see entry (2) (e.g., T3 stands for "transitive verb with a *to*-infinitive"), while the system of *OALD4*, exemplified by entry (3), is easier to access for the user.

(2) **promise 1** [T1,3,5a,b;V3;D1,5a;I∅] to make a promise to do or give (something) or that (something) will be done: *Do you promise secrecy?* (...) (*LDOCE1* 1978)

(3) **promise 1** [I, Tn, Tf, Dn·n, Dn·pr, Dn·f] ~**sth (to sb)** make a promise (to sb); assure (sb) that one will give or do or not do sth: *I can't promise, but I'll do my best. He has promised a thorough investigation into the affair.* (...) (*OALD4* 1989)

The code Tf stands for "Transitive verb + finite *that* clause" and Dn·pr for "Double-transitive verb + noun + prepositional phrase". Further code examples are Tnt for "Transitive verb + noun + to-infinitive" (e.g., *want sb to do sth*) and Cn·t for "Complex-transitive verb + noun + to-infinitive" (e.g. *persuade sb to do sth*), where a *complex-transitive verb* is defined as a verb "followed by a direct object and a complement, an element which provides more information about the direct object" (Cowie 1989a: 1555; the terminology is that of Quirk et al. 1985). Fully transparent codes go a step further in that they employ only standard grammatical labels and a small set of function words for code construction. For instance, the *OALD4* code Tnt is replaced by the transparent code "VN *to* inf" in *OALD7*. The *OALD7* entry for *promise* is shown in (4).

(4) **promise** verb **1** ~ **sth (to sb)** | ~ **sb sth** to tell sb that you will definitely do or not do sth, or that sth will definitely happen: [V **to** inf] *The college principal promised to look into the matter.* (...) [V] *They arrived at 7.30 as they had promised.* [VN] *The government has promised a full investigation into the disaster.* (...) [V (**that**)] *The brochure promised (that) the local food would be superb.* [VN (**that**)] *You promised me (that) you'd be home early tonight.* [VN, VNN] *He promised the money to his grandchildren. He promised his grandchildren the money.* (...) (*OALD7* 2005)

The entry also illustrates an improvement of presentation concerning the distribution of complementation information within the entry's microstructure: Complementation patterns are interspersed with examples, that is, there is a direct alignment of patterns and examples instead of a full list of codes at the beginning of the entry as it was common in earlier editions. A different strategy has been pursued by the COBUILD dictionaries, where transparent complementation codes appear in an extra column. However, the extra-column convention has been abandoned in the latest, sixth edition of that dictionary in favor of in-line labelling.

As mentioned at the beginning of Section 4, the presentation of syntax and grammar plays only a minor role in dictionaries for native speakers. The entry for *promise* shown in (5) is taken from the second edition of the *Oxford Dictionary of English* (*ODE2*).

(5) **promise verb 1** [reporting verb] assure someone that one will definitely do something or that something will happen: [with infinitive] *he promised to forward my mail* | [with clause] *she made him promise that he wouldn't do it again* | (...) [with two obj] *he promised her the job.* (...) (*ODE2* 2005)

Although this dictionary is "exceptional in providing a more detailed level of grammatical information" compared to other native speaker dictionaries (Atkins and Rundell 2008: 400), the syntagmatic specifications are clearly less detailed and explicit than in the learners' dictionaries seen before.

Pattern illustrations characterize complementation patterns without recourse to grammatical labels by spelling them out in terms of the headword and suitable proforms such as *someone*, *something*, etc. The *LDOCE4* entry shown in (6) exemplifies this kind of presentation. Note that already (4) comprises two pattern illustrations at the beginning of the entry, although without relating them to the pattern codes and examples in the rest of the entry.

(6) **promise** v [I,T] **1** to tell someone that you will definitely do or provide something or that something will happen: *Last night the headmaster promised a full investigation.* **promise to do sth** *She's promised to do all she can to help.* **promise (that)** *Hurry up – we promised we wouldn't be late.* **promise sb (that)** *You promised me the car would be ready on Monday.* (…) **promise sth to sb** *I've promised that book to Ian, I'm afraid.* **promise sb sth** *The company promised us a bonus this year.* (…) *He reappeared two hours later,* ***as promised****.* (…) (*LDOCE4* 2003)

French and German pedagogical lexicography have a tradition of pattern illustrations, too (see also Section 4.4). In French lexicography, notably Jean Dubois has systematically employed syntagmatic patterns for specifying complementation and as a basis for sense distinctions in the dictionary. The contrast between *affecter qqch à qqn* ('assign') and *affecter qqn* ('affect sb') gives a simple illustration of this idea (Dubois 1981: 244). In German pedagogical lexicography, the notions *Strukturformel*, *Konstruktionsformel*, *syntaktisches Gebrauchsmuster*, and *Satzbauplan* are prevalent, which owe a good part to previous research on valency dictionaries (Section 6.1); cf., e.g., Bergenholtz and Mogensen (1998); Gouws (1998); Schafroth (2002); Dentschewa (2006). Pattern illustrations for verbs in general monolingual dictionaries are mostly given in infinitival form, i.e., without a subject. The *PONS Großwörterbuch Deutsch als Fremdsprache* (*PGwDaF*) is one of the few exceptions in that its pattern illustrations take finite form with filled subject position (e.g., *jmd. wendet sich an jmdn.* instead of *sich an jmdn. wenden*). Finite clause patterns illustrate the constructional properties of the verb in a more transparent way than infinitival ones, though at the price of having to decide on a finite verb form.

Pattern illustrations have "the obvious advantage of not requiring the user to know any grammatical terminology at all" (Herbst 1996: 329). On the negative side, they can "lead to a certain amount of confusion with respect to dynamic and stative verbs and human or inanimate objects." To what extent, for instance, is *He wanted to be left alone* covered by the pattern *want to do sth*? In addition, pattern illustrations can blur distinctions respected by more technical codes, though such a simplification may be acceptable from the viewpoint of maximal transparency:

> [W]hat most current coding systems have in common is that they assume very little grammatical knowledge on the part of users, and they aim to satisfy users' needs in this department without requiring them to consult explanatory tables and charts. There is a trade-off here, in which a certain delicacy of description is sacrificed to the need for maximum clarity. (Rundell 1998: 329)

For example, *persuade sb to do sth* and *want sb to do sth* show the same surface pattern structure but behave differently with respect to passivization. In the *OALD4* coding system this difference is at least partially captured by the respective codes Cn·t and Tn·t.

The transparent complementation codes used in entry (4) are built of *formal* or *phrase-type* categories such as verb, nominal phrase, infinitival clause etc. *Functional* categories such

as (direct or indirect) object or adjunct, i.e., categories that characterize constituents by their sentence function, have also been employed in complementation codes. For example, *COBUILD1* uses V+O instead of *OALD7*'s VN, where O means "object". Functional labels have been discarded in later editions of the COBUILD dictionaries. Herbst (1996: 331) welcomes the elimination of functional categories "because of the many analytical problems they involve." Similarly, Colleman (2005) argues for preferring formal over functional labels because the former are more theory-neutral than the latter. As an example he mentions English double object constructions as in *She gave the boy the candy*, in which the status of the constituent *the boy* is not agreed upon between different syntactic theories with regard to assigning the labels *direct object* and *indirect object*. Another of his arguments is that functional labels are often too unspecific: For some transitive verbs, direct objects can be realized by nominal and clausal complements while others take nominal complements only, and clausal complements can be further restricted to finite or infinitival ones. Nevertheless, Colleman concedes that functional descriptions are necessary in some cases. For instance, formal labels do not allow one to distinguish between *He felt the cold air* and *He felt such a fool*. Most current English learners' dictionaries code the latter case by the functional label *linking verb*, that is, the respective lexical unit is categorized as a copular verb. In contrast, Colleman suggests a functional label *subject complement* for the complement of a copular verb. Aarts (1991: 577) holds a more rigid position in that he proposes codes which "should contain category symbols only, not symbols denoting sentence functions" and which "should represent surface syntactic structures" while "underlying differences between structures can be ignored." In this system, both of the above example sentences for *feel* would be subsumed under the code V+n and the only distinction presented to the user is the label *no passive* attached to the copular verb.

The basic categories *transitive* and *intransitive* of traditional grammar are dispensable in light of elaborate coding systems. The usefulness of this distinction has been called into question anyway by many authors. For example, Bergenholtz (1984: 34) notes that the label *transitive verb* is used rather inconsistently across German dictionaries. Herbst (1996: p. 331) finds it a wise decision to dispense with the labels *transitive* and *intransitive* because many verbs would have to be labelled both *intransitive* and *transitive*, and *transitive* covers divalent as well as trivalent verbs. Remarkably, the labels *transitive* and *intransitive* are still in use in *LDOCE4*. In fact, they are often the only explicit grammatical descriptions in the entry – witness (6), which even contains conflated labels of the sort criticized by Cowie (1989b: 588). The more fine-grained subdivision into transitive, ditransitive, and complex-transitive verbs introduced in Quirk et al. (1985) has found its way into *OALD4*; cf. (3). The verb label *ergative* used in the COBUILD dictionaries is also worth mentioning in this context: verbs categorized that way participate in the object-to-subject alternation mentioned in Section 3, that is, have systematically related transitive and intransitive usages. A further problem is that verbs with prepositional complement traditionally count as intransitive, on a par with verbs lacking any complement. French lexicography has resolved this issue by a subdivision of transitivity into direct and indirect transitivity, the latter covering prepositional verbs (Dubois 1983: 88).

4.2. Syntagmatic information in definitions and examples

Besides complementation codes or patterns, there is an increasing tendency in pedagogical dictionaries to employ definitions and examples as a means for conveying syntagmatic information to the user (Rundell 1998). For "even when codes are ignored, verbal illustrations are what dictionary users should always be able to safely fall back on" (Dziemianko 2006: 19).

In traditional-style definitions, lexicographers have developed various conventions to ensure that the subcategorization properties of the definiendum are properly reflected by

those of the definiens. For instance, the definiens of an intransitive verb should also be intransitive, which means that the definiens is either an intransitive verb or a transitive verb complemented with an object (Landau 2001: 174). Ilson (1985: 164–167) shows how the incompleteness of transitive verbs, or other relational definienda like prepositions, can be reflected by similarly incomplete definientia. One of his examples is *assist*, defined as *to give usu. supplementary support or aid to* in *Webster's Ninth New Collegiate Dictionary*. Ilson furthermore indicates that verbs with clausal complements can be treated the same way if the definiens has compatible subcategorization properties: The definition of transitive *hope*, taken from the same dictionary, is *to expect with desire*, and both verbs can take a *that*-clause. However, as noted by Dziemianko (2006: 29), this example is problematic since the dictionary user might mistakenly conclude that *hope*, like *expect*, can take a nominal object too.

Current dictionaries are less concerned with the requirement that the definiens has the same subcategorization properties as the definiendum and is thus substitutable for the latter. In the following example, taken from the second edition of the *Macmillan English Dictionary for Advanced Learners* (*MEDAL2*), the definition does not provide many hints about the correct syntagmatic usage of *hope*:

(7) **hope** verb [I/T] to want and expect something to happen or be true: **+(that)** *I just hope she's pleasant to him on his birthday.* **+for** *It wouldn't be sensible to hope for immediate success.* (…) (*MEDAL2* 2007)

The user has to resort to the complementation patterns +(that) and +for, and the examples given there, in order to find out how the object of *hope* can be realized syntagmatically. Moreover, the entry says nothing about whether nominal complements are admissible or not, because the labels I and T could be respectively due to the prepositional and the clausal complement. In fact, as the entry of *expect* given in (8) reveals, it is only the *absence* of an appropriate example in (7) that allows one to conclude that *hope* cannot take a nominal object:

(8) **expect** verb [T] to think that something will happen: *We're expecting good weather at the weekend.* (…) **+(that)** *Investors expect that the rate of inflation will rise.* (…) (*MEDAL2* 2007)

Full sentence definitions are an influential lexicographic convention developed during the COBUILD project (Hanks 1987). They are typically formulated as conditionals with the definiendum embedded in the premise. The left-hand side of a full sentence definition thus reflects the syntactic patterns in which the definiendum occurs:

(9) If you **hope** that something is true, or you **hope** for something to happen, you want it to be true or to happen and usually believe that it is possible or likely. (*COBUILD1* 1987)

Dziemianko (2006: 38) concludes that "full sentence definitions do not require much effort of the dictionary user looking for information on verb syntax in entries." However, not all full sentence definitions are equally helpful in this respect. As noted by Tarp (2008: 235), the definition of the verb *anticipate* in *COBUILD4* begins with *If you anticipate an event, you realize in advance that it may happen*, whose left-hand side gives no information about clausal complements at all. Rundell (2006) takes a balanced position towards full sentence definitions. He recommends using them, for instance, if a transitive verb occurs mostly in the passive or if an adjective has a narrow range of complements. On the other hand, he prefers a more conventional, economic style of definition in more straightforward cases, because full sentence definitions can get rather lengthy.

In learners' dictionaries, any statement about the syntactic behavior of a word should

be backed up by an example (Atkins and Rundell 2008: 454). The advent of corpus-based lexicography in the 1980s came along with a strong commitment to authentic examples. Meanwhile, there seems to be consensus that "the primary function of the corpus is as a source of *evidence* rather than as a source of examples" (Atkins and Rundell 2008: 458). Hence, "in a dictionary designed for learners, there is no incompatibility in supporting a corpus-driven description with examples that reflect the recurrent patternings in the corpus within an accessible and intelligible format" (Atkins and Rundell 2008: 458). Similarly, Dziemianko (2006: 28): "The consciously pedagogical orientation of examples, evident also in the earliest learners' dictionaries, thus remains a distinctive feature of the corpus-based learners' dictionaries published today."

4.3. Case studies on complementation

It has been argued in Section 3 that linguistic analysis can be useful for guiding the design decisions of the lexicographer. In the following, several example entries are discussed from this perspective. The entries are taken from monolingual (learners') dictionaries of French, English and German. The examples considered all have to do with clausal complementation in one way or another.

Corbin (2002: 29–30) gives an example for French, where an adequate syntactic analysis on the side of the lexicographer matters for the quality of the lexical entry. He discusses the use of the French verb *décider* followed by *de*. He points out that an adequate dictionary entry for *decider* should list *décider de* + infinitive as a *verbe transitif direct* that takes a clausal complement, on a par with *décider que*, whereas *décider de* + noun phrase should count as a *verbe transitif indirect*. The syntactic insight here is that *de* acts as a complementizer in the first case and as a preposition in the second. Corbin's requirement is clearly satisfied by the entry shown in (10), which is taken from the *Dictionnaire de Français* (*DDF*).

(10) **décider** v.t. **1.** (…) **Décider qqch**, **de** *(+ inf.)*, **que** *(+ ind.* ou *cond.)*, **décider si**, **qui**, **quand**, etc. *(+ ind.)*, se prononcer pour qqch, déterminer ce qu'on doit faire: *Le gouvernement a décidé l'indemnisation des sinistrés (…). J'ai décidé de tenter ma chance.* (SYN. **résoudre**). (…) v.t. ind. (…) **1. Décider de qqch**, se prononcer sur qqch, prendre parti à ce sujet. (…) (*DDF 1987*)

Corbin contrasts this linguistically coherent entry structure with the treatment of *decider* in the *Nouveau Petit Robert 2000*, shown in (11), where all uses with *de* are listed in the *verbe transitif indirect* section.

(11) **DÉCIDER I.** V. tr. dir. (…) **2.** (…) Arrêter, déterminer (ce qu'on doit faire); prendre la décision de. (…) DÉCIDER QUE. *Il décide qu'il n'ira pas travailler.* (…) **II.** V. tr. ind. DÉCIDER DE QQCH. (…) Disposer en maître par son action ou son jugement. (…) DÉCIDER DE (et l'inf.): prendre la résolution, la détermination de. (…) *Décidons de nous retrouver à huit heures.* (…) (*NPR 2000*)

He regards (11) as "défendable du point de vue de la commodité de consultation, mais linguistiquement inconséquent et peut-être sous-informé" [justifiable with regard to look-up convenience but linguistically inconsistent and perhaps under-informed]. This lack of linguistic precision or awareness leads to an unwelcome definitional redundancy: *decider de* + infinitive is circumscribed as *prendre la résolution, la détermination de*, which essentially repeats the explication *prendre la décision de* of the *verbe transitif direct* section.

Our next example is concerned with control verbs in English (cf. articles 14 and 38). Prototypical subject and object control verbs are *promise* and *persuade*, respectively. The argument missing in the infinitival complement of a subject control verb coincides with the

argument expressed by the subject of the matrix clause, and an analogous condition holds for object control verbs and the object of the matrix clause. The relevant sections of the *LDOCE4* entries for *promise* and *persuade* are shown respectively in (6) and (12).

(12) **persuade** v [T] **1** to make someone decide to do something, especially by giving them reasons why they should do it, or asking them many times to do it: **persuade sb to do sth** *I finally managed to persuade her to go out for a drink with me.* (...) (*LDOCE4* 2003)

There is, of course, no mentioning of *control* in the entries, nor is the non-linguist expected to be familiar with that notion. The question is rather whether the correct usage of the control construction is conveyed to the user. The infinitival clause pattern is present in both entries. The information about subject and object control, on the other hand, is only accessible from the definitions, that is, from *to tell someone that you will do something* and *to make someone decide to do something*, respectively. But understanding the latter definition presupposes grasping the meaning and use of *decide*, which is a control verb itself. The *LDOCE4* definition *to make a choice or judgment about something* given for *decide* does not resolve the issue. The gloss *to make a choice about what you are going to do* taken from *MEDAL2* is more helpful in this respect, since the user is told that the agent of the matrix is identical to the agent of the complement. A more explicit (though not systematic) treatment of these matters can be found in the *Dictionnaire du Français Contemporain* (*DFC*), the predecessor of the *DDF*, where the infinitival complement of *décider de* is characterized as "un infinitif ayant même sujet logique que décider." However, it seems questionable whether the notion of a logical subject is of much help to the average dictionary user.

The final example is the treatment of the prepositional verb *denken an* in two German learners' dictionaries, *Langenscheidts Großwörterbuch Deutsch als Fremdsprache* (*LGwDaF*) and the *de Gruyter Wörterbuch Deutsch als Fremdsprache* (*dGWDaF*). The relevant sections of the entries for *denken* in these dictionaries are shown in (13) and (14), respectively. The exposition adheres to the textual condensations (abbreviations, place holders, etc.; cf. Wolski 1989b) found in the book editions of the dictionaries, although such techniques will become more and more obsolete in view of CD-ROM editions and online access.

(13) **denken** ***Vi*** (...) **10** ***an j-n / etw. d.*** sich an j-n / etw. erinnern, j-n / etw. nicht vergessen: *Wie nett, dass Sie an meinen Geburtstag gedacht haben*; *Denkst du noch manchmal daran, wie schön es damals war?*; *Denk bitte daran, den Hund zu füttern!* **11** ***an j-n / sich / etw. d.*** sein Interesse, seine Gedanken auf j-n / sich / etw. (*bes.* auf j-s Bedürfnisse) konzentrieren: (...) *Du sollst mehr an deine Familie d.!* **12** (***daran***) ***d.*** + ***zu*** + *Infinitiv* die Absicht haben, etw. zu tun, etw. tun wollen (...): *Sie denkt daran, ihr Geschäft zu verkaufen*; (...) (*LGwDaF 1998*)

(14) **denken** 5. /jmd./ *an etw., jmdn.* ∼. **5.1.** 'seine Gedanken auf etw., jmdn. richten': *an die Feier, den Freund* ∼; *er denkt immer an seine Familie* ('ist immer auf ihr Wohl bedacht'); (...) **5.2.** 'jmdn., etw. im Gedächtnis behalten, nicht vergessen': *wir werden an dich* ∼*!; wir müssen daran* ∼*, den Brief einzuwerfen; hast du daran gedacht, dass wir heute ins Theater wollen?* (*dGWDaF 2000*)

There are three lexical units of *denken an* in *LGwDaF* whereas *dGWDaF* lists only two. As to complementation, all of these lexical units allow a clausal complement with the preposition *an* replaced by the obligatory correlate *daran*. However, none of the two dictionaries conveys this information in a systematic and transparent way. In *dGWDaF*, it is part of the editing strategy not to include complementation alternatives in patterns but to indicate them in examples. The dictionary user might thus mistakenly conclude that the first sense in (14) does not

license clausal complements. The situation in *LGwDaF* is not better in this respect. Only the third sense in (13) encodes a clausal complement plus correlate by a pattern, and even this specification has to be qualified since it neglects the possibility of prepositional complements. In fact, the clause in the example can easily be nominalized: *Sie denkt an den/einen Verkauf ihres Geschäfts.* A linguistically more sensible analysis of the usages of *denken an* could clearly improve the quality of the entries in both dictionaries.

It goes without saying that there are many more complementation issues in the dictionary worth analyzing from a theoretical perspective. A good example is the interaction between derivation and complementation in general, and between complementation of deverbal nouns and verb complementation in particular.

4.4. Further notes on lexicographic traditions

The following notes are limited to French, English, and German lexicography; see Hausmann et al. (1990) and Gouws et al. (2013) for more information about developments in the lexicography of these and other languages.

Modern French lexicography has a strong tradition in following linguistic principles (Schafroth and Zöfgen 1998). Cowie (1989b: 590) attributes this fact to the direct involvement of linguists in the design and compilation of monolingual French dictionaries. A prominent example is the *DFC* edited by Jean Dubois and published in the mid-sixties. In the *DFC*, syntax plays a major role both for pedagogical and linguistic reasons (Cowie 1989b: 590). Complementation is systematically described by syntagmatic patterns, which also serve as a basis for sense distinctions. The *DFC* thus reflects the concept of distributional analysis in the tradition of Zellig Harris (cf. Rey 1990: 1834). The *Grand dictionnaire encyclopédique Larousse*, edited by Dubois in the early 1980s, has benefited from a collaboration with Maurice Gross (Corbin 2002: 15), whose lexicon-grammar approach (Gross 1994) is based on Harris' structuralist ideas as well. Theoretical considerations have also influenced the making of the *Robert méthodique* in the early 1980s, which puts into practice the functionalist and lexicalist positions of Josette Rey-Debove (Rey 1990: 1834). The influence of linguistics on French lexicography has meanwhile declined (Corbin 2002), and French pedagogical lexicography is even said to have failed in view of the present publishing situation (Schafroth and Zöfgen 1998: 16; see also Corbin 2008; Leroyer, Binon, and Verlinde 2009).

The systematic use of verb patterns in English pedagogical lexicography goes back to the work of H. E. Palmer and A. S. Hornby in the 1930s (Cowie 1989b, 1998, 1999). Both introduced an extensive set of alphanumerical codes for specifying complementation patterns. Starting in the 1980s, there has been a tendency towards more transparent, user-friendly descriptions of syntagmatic information, even in face of a slight reduction of accuracy (cf. Section 4.1). At about the same time, the corpus-revolution set in, most notably represented by *COBUILD1*. It seems fair to say that, at present, British lexicography is leading in the production of high-quality learners' dictionaries that are both user-friendly and rich in syntagmatic information. The corpus-orientation is exemplary and the innovation cycles have been impressive during the last two decades. The future will show whether the type of presentation realized in *LDOCE4* and *MEDAL2* with its strong emphasis on pattern illustrations and its very limited set of explicit syntactic indicators is the last word on the subject. After all, the "description of syntactic behaviour is far from complete, and better ways of presenting that description can still be discovered" (Rundell 2007b: 17–18).

The development of post-war German lexicography until 1990 is thoroughly described in Wiegand (1990). While German lexicography, compared to English, has a rich tradition in producing valency dictionaries (cf. Section 6.1), comprehensive learners' dictionaries have not

been available until fairly recently. The publication of *LGwDaF* in 1993 can be seen as the advent of German pedagogical dictionaries (Schafroth 2002: 57) – not counting dictionaries of basic vocabulary. A second learners' dictionary, the *dGWDaF*, appeared in 2000, and in the meantime, other dictionary publishers took up the challenge. Most of the German learners' dictionaries present syntagmatic information by pattern illustrations and examples; witness (13) and (14). While *LGwDaF* uses the traditional categories *transitive* and *intransitive*, *dGWDaF* abandons this distinction – a decision welcomed by Schafroth (2002: 62). In *PGwDaF*, by comparison, transitivity and intransitivity are indicated by *mit OBJ* and *ohne OBJ*, which is disputable because the user still has to keep in mind that *mit OBJ* covers only accusative objects (Dentschewa 2006: 125). A detailed metalexicographic analysis of *LGwDaF* and *dGWDaF* can be found in Wiegand (1998a) and Wiegand (2002), respectively, including an in-depth investigation of grammatical and syntactic information; see also Wiegand (2003, 2005) for a similarly thorough analysis of the latest edition of the German reference dictionary *Duden – Das große Wörterbuch der deutschen Sprache in zehn Bänden* (*GWDS*). Bergenholtz (2002: 43) has expressed some reservations about the flourishing field of German metalexicography that shows up in these investigations, given its low impact on actual dictionary making. And Tarp (2008: 241) states that "[u]ntil now no German learner's dictionary has found a satisfactory solution to the difficult question of how to treat syntactic data lexicographically."

5. Bilingual lexicography

The topic of syntactic information in bilingual lexicography will be covered only briefly (cf. Herbst 1985; Kromann, Riiber, and Rosbach 1991a, 1991b; Tarp 2005, 2008; Bassola 2006; and Atkins and Rundell 2008: chap. 11 and 12 for more information). In a bilingual dictionary, each lexical unit of the *source language*, i.e. a headword in one of its senses, is associated with a *translation equivalent*, i.e. a word of the *target language* in one of its senses. A *unidirectional* or *monofunctional* bilingual dictionary is one with fixed source and target language; a *bidirectional* or *bifunctional* dictionary comprises two unidirectional parts with reverse directions. Further distinctions can be drawn: A unidirectional dictionary is called an *active* or encoding dictionary if its purpose is to support the encoding of expressions in a foreign language, that is, if the dictionary's source language is the language of the user. A *passive* or decoding dictionary, by contrast, presumes that the dictionary's target language is the user's language. This distinction affects the user's needs concerning the type and distribution of grammatical information since this sort of information is mainly needed on the side of the foreign language. It follows that "[i]n active bilingual dictionaries it is first and foremost the equivalents that need to be supplied with grammatical information; in passive dictionaries, it is the lemmata" (Kromann, Riiber, and Rosbach 1991b: 2723). Commercial bilingual dictionaries often aim at two language groups and therefore will have to serve encoding as well as decoding. This means that the grammatical information in an entry is to a large part redundant for speakers of either one of the two languages (Atkins and Rundell 2008: 43).

The treatment of grammatical information in bilingual dictionaries is complicated by various factors: Karl (1991) discusses the problem of using grammatical and lexical categories in bilingual dictionaries when different languages come along with different category systems. Moreover, any account of syntagmatic information in bilingual dictionaries has to cope with all sorts of cross-language divergences known from contrastive grammar and valency studies. A concise overview of divergence classes relevant to lexicography is given in Heid (1997: chap. 6). Examples of divergence classes are syntactic divergence – *enter the house* (En.) vs. *entrar en la casa* (Sp.), thematic divergence – *jmd an den Termin erinnern* (Ge.) vs. *rappeler la date à qqn*

(Fr.), and head switching – *gern tun* (Ge.) vs. *like to do* (En.).

The presentation of syntactic information in bilingual dictionaries is generally less sophisticated than in monolingual learners' dictionaries (Salerno 1999; Klotz 2001). For example, the transitive/intransitive distinction is still widely in use as an organizational principle of the entry structure of verbs. In addition to the problems mentioned at the end of Section 4.1, this distinction can lead to a considerable duplication of information in the bilingual entry (Herbst and Klotz 2003: 180–182; Atkins and Rundell 2008: 496). For if the transitive and the intransitive uses of a verb are listed separately, irrespective of their semantic relatedness, their translation equivalents have to be listed separately as well, even if they are in effect identical. Typical examples for this phenomenon are verbs like *cook* and *eat* that participate in the unexpressed object alternation. As to pattern illustrations in bilingual dictionaries, the finite form with subject appears to be more appropriate than the infinitival form, because finite patterns allow one to describe divergences that involve the subject as, e.g., in *qqn manque qqch* (Fr.) vs. *etw. misslingt jmdm.* (Ge.).

Kromann, Riiber, and Rosbach (1991a: 2774) propose a number of general guidelines for specifying grammatical constructions in the bilingual dictionary. First, the user's needs and competence have to be taken into account: "The less foreign-language competence the user has, the greater the need for the specifications of constructions in the bilingual dictionary." Second, the divergences determined by the language pair call for special attention: "[T]he divergent constructions in the respective languages must be given priority in the bilingual dictionary for the language pair in question. Grammatical and idiosyncratic constructions which are not predictable in translation between the language pair in question must be included in the bilingual dictionary concerned" (Kromann, Riiber, and Rosbach 1991a: 2772). Third, the intended function of the dictionary (active vs. passive, mono- vs. bidirectional) must be respected. Forth, a dictionary grammar should be included. As to the third point, it should be added that the active/passive distinction has meanwhile been criticized as insufficient. According to Tarp (2005, 2008), the user's communicative and cognitive situation must be described in much more detail in order to come up with an adequate typology of dictionary functions.

6. Specialized dictionaries

There are essentially two types of dictionaries specialized on syntactic information: dictionaries of function words (Section 6.2) and dictionaries of syntagmatic constructions for lexical words. Zöfgen (1989: 1002) subdivides dictionaries of syntagmatic constructions (*Konstruktionswörterbücher*) into traditional, distributional, and valency based approaches. Traditional approaches describe morphosyntactic properties of dependent (governed) elements; they are usually limited to case marking and prepositional objects. The concept of valency, by contrast, emphasizes the ability of a lexical unit to impose requirements on its surrounding constituents, including the subject and clausal or participle complements. As long as the focus is on syntactic properties, valency based approaches resemble distributional accounts to some extent (Zöfgen 1989: 1002). This affinity dissolves if the goal is to explain valency on semantic grounds, because, in this case, the semantic properties of the valency bearing unit become of central importance.

6.1. Valency dictionaries

The following discussion will mainly be confined to monolingual German and English dictionaries. Schumacher (2006a) provides a good overview of valency dictionaries for

German; Busse (2006) covers other languages with a focus on Romance languages; contrastive valency dictionaries are reviewed in Schumacher (2006b); and valency dictionaries available on the internet are the topic of Heid (2006).

The first valency dictionary of German verbs was the *Wörterbuch zur Valenz und Distribution deutscher Verben* by Helbig and Schenkel (1969). In this dictionary, complements are described syntactically by a transparent coding system with formal categories (e.g., pSa stands for *präpositionales Substantiv im Akkusativ*) and semantically by coarse-grained categories such as *human* and *abstract*. Sommerfeldt and Schreiber (1974, 1977) extend this methodology to the valency of adjectives and nouns. A second early exemplar is *Kleines Valenzlexikon deutscher Verben* (*KVL*) by Engel and Schumacher (1976), which is restricted to syntactic valency. It employs a non-mnemonic coding system for constructional patterns (*Satzmuster*, *Satzbaupläne*) that are based on a dependency grammar approach (Engel and Schumacher 1976: chap. 2; Schumacher 2006a: 1399). A theoretically more ambitious project is *Verben in Feldern* (*ViF*) by Ballweg et al. (1986); see also Ballweg et al. (1981). *ViF*'s underlying model draws on ideas from categorial grammar and generative semantics (Ballweg et al. 1981: chap. 3; Schumacher 2006a: 1401). The semantic orientation of *ViF* is reflected by its onomasiological macrostructure where verb entries are organized into semantic fields.

The compilation of these dictionaries, which are limited to several hundred headwords, has been motivated with reference to teaching German as a foreign language (*Deutsch als Fremdsprache*). The first two dictionaries are supposed to serve teachers as well as learners, while the linguistically more advanced *ViF* aims at teachers only. However, the usefulness of valency dictionaries for language teaching has been repeatedly called into question by Zöfgen, Wiegand, and others. Zöfgen (1989: 1007) observes a growing evidence "daß die einseitig linguistisch argumentierende Valenzlexikographie zunehmend der Versuchung erliegt, ihre eigenen Anforderungen zum alleinigen Maßstab zu machen und mit Benutzerbedürfnissen gleichzusetzen" [that valency lexicography, with its strong focus on linguistic arguments, tends to take its own requirements as a standard and to identify them with user needs]. Wiegand (1990: 2173–2174) expresses similar doubts as to whether the intended user has sufficient linguistic expertise to benefit from dictionaries of this type. Zöfgen (1989: 1007) therefore argues for a more user-oriented presentation and is even inclined to consider pedagogical dictionaries as competitive to linguistically motivated ones in terms of precision and conciseness.

The situation today has improved insofar as there are two recent valency dictionaries available, one for German and one for English, which both aim at combining linguistic theory with user-friendliness. The first one is *VALBU – Valenzwörterbuch deutscher Verben* by Schumacher et al. (2004), the second one is *A Valency Dictionary of English* (*VDE*) by Herbst et al. (2004). *VALBU* builds partly on the ideas that underlie *KVL* and *ViF*, but uses only a minimal amount of technical vocabulary to describe the valency of verbs syntactically and semantically; cf. Schumacher (2006a: 1406–1408) for a brief introduction to *VALBU*'s basic features. For example, the prepositional verb *denken an* we looked at in Section 4.3 has three main senses in *VALBU*. The constructional patterns associated with these units are uniformly described by the transparent code "NomE PräpE", with NomE and PräpE being short for *Nominativergänzung* ('nominative complement') and *Präpositivergänzung*. As to PräpE, the dictionary grammar included in *VALBU* tells us that a *Präpositivergänzung* can be realized by a prepositional phrase, but also by a clausal complement, possibly in combination with a correlate; details are to be specified in the respective lexical entries. In the case of *denken an*, the first sense is glossed *seine Überlegungen oder Gedanken auf jemanden/etwas richten*. The list of syntactic realizations for PräpE comprises a prepositional phrase with *an* plus accusative as well as a number of

clausal complements with obligatory correlate *daran*: *dass*-clause, infinitival clause with *zu*, *w*-question, and a complement that takes the form of a main clause as in *Denke daran, der Teufel steckt im Detail!* (without noting that this indirect speech construction is restricted to the imperative). All possible realizations are illustrated by example sentences, most of which are taken from corpora. The complementation patterns of the other two senses of *denken an* are specified in a similar vein. Taken together, the three lexical units cover about one full two-column page of the dictionary. Compared to the entries in (13) and (14) taken from learners' dictionaries, the *VALBU* entry for *denken an* is clearly superior with respect to precision and explicitness of syntactic information.

The 638 verbs covered by *VALBU* were selected with regard to the requirements of the *Zertifikat Deutsch*, which corresponds to the competence level B1 (lower intermediate learners) of the Common European Framework of Reference for Languages. *VALBU*'s primary target group are non-native teachers of German; further potential users are advanced learners (Schumacher et al. 2004: 20). The pretended user situation is, however, not without problems. It seems questionable whether the high level of detail in *VALBU* is of much help with teaching lower intermediate learners. Advanced learners and language professionals, on the other hand, can profit from the large amount of information provided by the dictionary, but may regard its limitation to several hundred words as a significant disadvantage to everyday use.

Similarly to *VALBU*, *VDE* is targeted toward non-native teachers, advanced learners, and language professionals (Herbst et al. 2004: vii). *VDE* is the first valency dictionary for English, notably compiled at a German university. In addition to 511 verbs, it includes 274 nouns and 544 adjectives. The verbs were chosen on the basis of frequency and complexity of their valency structure; for adjectives and nouns, the presence of a valency pattern was a key criterion for inclusion. Valency information is described in two ways: by an inventory of syntactic realizations per argument position and by an exhaustive list of complementation patterns, accompanied by corpus examples (cf. Herbst 2007). *VDE* uses an elaborate though transparent coding system with formal labels. For instance, the pattern "+ N_P + to N", which occurs in entries like *deliver* and *promise*, says that, in an active sentence, the verb can be followed by a noun phrase and a prepositional phrase with *to*; the index P in N_P indicates that the respective complement can take the subject position of a passive sentence (e.g., *the car was delivered/promised to John*). Although *VDE* strives for a user-friendly presentation, the sheer amount of information may complicate access even for the lexicographically versed reader: "The coding of the linguistic information that organizes and accompanies the examples that fill this book demands a seriously motivated reader and quite a bit of work" (Fillmore 2009: 56).

Let us take a closer look at the *VDE* entry for the verb *promise*, which served as a running example in Section 4.1. The entry contains ten complementation patterns, including the following three:

(15) a. + (that)-$CL_{P(it)}$ *Chancellor Kohl promises that the new Germany (...)*
b. + N_P + (that)-CL *In a televised speech, he promised East Germans they would not (...)*
c. + N_P + to-INF *She'd promised Beryl to keep an eye on him.*

The index P(it) in (15-a) allows for extraposition with *it* if the finite complement occurs as subject of a passive sentence. The lack of such an index in pattern (15-b) indicates that the finite complement cannot be subject of a passive sentence, whether extraposed or not, if the promisee is expressed by the direct object. It would thus be correct to say *East Germans were promised they would* etc. but not *It was promised East Germans they would* etc. Pattern (15-c) is particularly interesting from a linguistic point of view because it brings up again the topic of subject control (cf. Section 4.3). The attentive reader may have noticed that neither (3), (4), nor

(6) admit a control construction matching (15-c) where the promisee is explicitly mentioned. This omission in the learners' dictionaries is presumably due to low corpus frequency, which in turn might be explained in terms of constructional and discourse-related constraints as suggested by Egan (2006). A striking fact about (15-c) is that it allows passivization, because this contradicts the restriction known as Visser's Generalization (Bach 1979) according to which subject controlled sentences cannot be passivized. Since *VDE* does not give an example for the passive construction, the reader can only guess whether the index P indicates corpus evidence against Visser's Generalization, or whether it is simply a mistake.

According to Fillmore (2009: 75), *VDE* is primarily committed to complements "that appear inside the phrasal projection of the lexical item." While in verb entries, the subject is specified as well, though not as part of the valency patterns, there is no way to refer to the subject of a copula sentence or the modified noun in an adjective entry. This strategy might be acceptable from a purely syntactic perspective on valency, but it does not allow a satisfying explanation, for instance, of the semantic difference between *familiar to* and *familiar with*, since it is the thematic switch between phenomenon and experiencer in the external and internal arguments of *familiar* that marks the difference in this case (Fillmore 2009: 59). Another of Fillmore's desiderata is that valency similarities and differences between derivationally related lexical units could have been pointed out in *VDE*.

The goals of Fillmore's own approach, FrameNet (Fillmore, Johnson, and Petruck 2003), are similar to those that underlie the compilation of *VDE*: to document all valency patterns for each lexical unit on the basis of corpus evidence. A central difference is that in FrameNet, lexical units are grouped into semantic classes, each of which is associated with a *frame*, a conceptual representation of a certain type of situation or state of affairs. For example, FrameNet defines a frame *Commitment* that includes the verbs *commit*, *consent*, *promise*, *swear*, and *threaten* (in one of their senses) as well as the nouns *commitment*, *oath*, and *promise*, besides others. FrameNet's goals can be summarized as follows:

> The FrameNet project is dedicated to producing valency descriptions of frame-bearing *lexical units* (…), in both semantic and syntactic terms, and it bases this work on attestations of word usage taken from a very large digital corpus. The semantic descriptors of each valency pattern are taken from frame-specific semantic role names (…), and the syntactic terms are taken from a restricted set of grammatical function names and a detailed set of phrase types. (Fillmore 2007: 129)

FrameNet provides thus a three-layered description of valency patterns: by phrase type, by grammatical function, and by semantic role. (16) shows two (of the many) valency patterns for the verb *promise* available in the FrameNet database, each accompanied by a corpus example.

(16) a.

NP		Sfin	DNI
Ext		Dep	
Speaker		Message	Addressee
I	*promise*	*I won't even offer to help.*	

b.

	NP		NP	VPto
	Ext		Obj	Dep
	Speaker		Addressee	Message
But	*she*	*had promised*	*Peter*	*to stay.*

In (16-a), DNI is short for *definite null instantiation* and indicates a "lexically licensed zero anaphora" (Fillmore 2007: 148). Ext and Dep stand for *External* and *Dependent*; *Speaker*, *Addressee*, and *Message* belong to the core semantic roles of the *Commitment* frame. As of the time of this writing, FrameNet is an ongoing project. Its potential benefits for valency lexicography as described in Heid (2006) and Fillmore (2007) are undeniable. However, in

order to become usable as a dictionary for teachers, or even learners, progress on several fronts is necessary: a broader coverage of word senses, a more reliable annotation of corpus examples, and a more intelligible way of presenting the valency information to the non-expert.

6.2. Dictionaries of function words

An overview of dictionaries of function words in different languages is beyond the scope of this article. For German, one can mention Schröder (1986) on prepositions, Helbig (1988) on particles, Buscha (1989) on conjunctions, and Helbig and Helbig (1990) on modals. Since function words are a heterogeneous class, their lexicographic treatment in specialized dictionaries differs considerably. For example, Schröder (1986: 243–245) covers the grammatical aspects of prepositions on only three pages by indicating the case they govern and their position with respect to the dependent noun phrase. The main part of the dictionary is concerned with a feature-based identification of the different senses a preposition can have. Conjunctions and other clausal connectives, in comparison, have much more intricate syntactic properties. It is thus indicative that Pasch et al. (2003: p. XV) locate the subject matter of their voluminous *Handbuch der deutschen Konnektoren* between lexicography and grammaticography. The descriptions of this handbook are partly available online at the web portal GRAMMIS of the Institut für Deutsche Sprache (Strecker 2005), which also provides syntagmatic information about prepositions.

7. Computational lexicography

In Hanks (2003: 49), two meanings of the term *computational lexicography* are distinguished: "Using computational techniques to compile new dictionaries", and "[r]estructuring and exploiting human dictionaries for computational purposes".

7.1. Lexicography and corpus analysis

At the analysis stage of the lexicographic process described in Section 2.3, the lexicographer systematically records, among other things, the syntagmatic constructions in which a word occurs, and decides on complementation patterns and sense distinctions. The resulting pre-dictionary profile of the word is maintained in a database; see Atkins and Rundell (2008: sect. 9.2.5) for an overview of the kind of grammatical information to be stored. Nowadays, this task is conducted with massive computational support. A word's syntagmatic behavior can be studied in detail by powerful corpus analysis tools such as the Sketch Engine of Kilgarriff et al. (2004), which allows one to extract concordances and to measure the salience scores of collocations and the like. Despite these advancements, one should keep in mind that "[t]he advent of electronic corpora and media can make the lexicographers' work better, but not necessarily easier" (Kirkness 2004: 56). Hanks (2003: 58) points out that corpus evidence must be treated with caution. Frequency alone is not a sufficient criterion because it cannot always preclude the idiosyncrasies of a single author. Another problem is the "failure-to-find fallacy". A pattern may exist in the language even it is not found in the corpus. In general, "lexicographers should carefully decide which language sample(s) they want to be working on" (Heid 2008: 134), that is, they should be particularly sensitive to questions of corpus authenticity and representativity.

Heid (2008: 138–139) draws a distinction between *corpus-driven* and *corpus-based* approaches to corpus lexicography. In the first case, the lexicographer avoids "as much as possible the a priori projection of linguistic categorizations" and relies "essentially

on the observation of distributional facts identified." In the second case, projections or annotations resulting from computational linguistic preprocessing are accepted as a basis for lexicographic analysis. The wide variety of preprocessing options includes lemmatizing, part-of-speech tagging, noun phrase chunking, shallow (syntactic or semantic) parsing, or even deep (syntactic or semantic) parsing. The more linguistic annotation can be conducted automatically, the less has to be decided intellectually by the lexicographer. However, it also holds that the more ambitious the automated annotation, the more error-prone it is likely to be. Alternatively, the lexicographer can resort to corpora that have been annotated manually. Notably treebanks, i.e., syntactically analyzed corpora, are of great interest to the lexicographic process, but they are naturally limited in size because of the time and effort involved in the manual treatment.

FrameNet, seen as a corpus annotation project, provides both a syntactic and a semantic annotation layer. It has been argued that the FrameNet corpus can be useful to lexicographic analysis (Atkins 2002; Atkins, Fillmore, and Johnson 2003; Atkins, Rundell, and Sato 2003; Atkins and Rundell 2008: sect. 5.4). The verb *cook* discussed in Section 3 may serve as an example. It is associated with three FrameNet frames: *Apply_heat*, *Absorb_heat*, and *Cooking_creation*. The first two frames belong to the change-of-state sense of *cook* that participates in the causative-inchoative alternation; *Apply_heat* covers the causative and *Absorb_heat* the inchoative use; these two frames are interrelated by the *is_causative_of* frame-to-frame relation. The *Cooking_creation* frame corresponds to the creation sense of *cook* that participates in the unexpressed object alternation. Since FrameNet annotates complements by frame-specific semantic roles, the annotation makes explicit to the lexicographer which of the intransitive uses of *cook* has a subject that carries the same role as that of the transitive use, and which does not. A related attempt towards providing corpora with a (shallow) syntactic and semantic annotation layer for lexicographic purposes is the *Corpus Pattern Analysis* approach of Hanks and Pustejovsky (2005).

Given a morphosyntactically analyzed corpus, it is relatively straightforward to extract subcategorization patterns from it – which means, in a sense, to automatize part of the lexicographic process. Senses of words are then distinguished insofar as they are already distinguished in the annotated corpus. Manning (1993) is an early example of this type of approach, Korhonen, Krymolowski, and Bricoe (2006) a more recent one. Both have in common that the syntactic analysis of the corpus is generated on the basis of probabilistic processing; see Schulte im Walde (2009) for an overview of this line of research. Unsurprisingly, the resulting lexicons are not intended for human use but as input to natural language processing (NLP) systems. Note that the FrameNet lexicon can be regarded as automatically acquired from an analyzed corpus too, since "the valency patterns are automatically derived from the annotations" (Fillmore 2007: 129); see also Spohr et al. (2007). The difference is that the corpus has been analyzed manually in this case.

7.2. Electronic dictionaries

Most dictionaries compiled for human use are nowadays available in electronic form, in one way or another, and are accessible via CD-ROM or the internet. From a user's perspective, this does not necessarily imply significant changes compared to the print edition besides a new retrieval system and certain improvements in the layout (e.g., the avoidance of textual condensation). Truly innovative features and a fully integrated hypermedia access structure are still the exception (de Schryver 2003). As far as the presentation of syntagmatic information is concerned, the challenges of matching the user's needs and reference skills remain basically the same as those discussed in Sections 4 and 5. Nevertheless, a hypermedia

dictionary system could be much more flexible than its printed counterpart if it would allow the user to decide on how explicit and detailed the lexical information should be presented to her or him. Moreover, the ideal system would come along with an integrated grammar component and a corpus query facility. De Schryver (2003: 189–190) lists a handful of promising research projects such as the web-based language learning system ELDIT (Abel and Weber 2005) that are working towards more adaptive hypermedia dictionaries.

As soon as standard dictionaries were available in machine-readable form, computational linguists became interested in exploiting them for natural language processing (NLP) purposes, since building a wide-coverage lexical resource for NLP is an expensive and time-consuming undertaking. For example, Boguraev et al. (1987) describe an approach to automatically transform the syntactic information of *LDOCE1* into a format suitable for NLP. Other research initiatives, such as the ACQUILEX project (Copestake et al. 1993), took a similar direction, but with an emphasis on using dictionary definitions as a source for knowledge acquisition; see also Wilks et al. (1996). With regard to the latter aspect, Ide and Véronis (1994) give a rather sceptical summary of what has been achieved.

As to the exploitation of syntactic information, one could suspect that the emphasis on usability and the resulting move from codes to descriptions in normal prose is rather unwelcome to those who want to use this sort of information in NLP applications. Indeed, Rundell (2007b) mentions in passing that he "was almost lynched at a computational linguistics conference (…) when the word got around that [he] was 'the man who removed the codes from *LDOCE*'." Zgusta (1988) arrives at a similar conclusion concerning the diverging needs of humans and machines:

> If the *COBUILD* style proves attractive and if monolingual dictionaries for human users generally follow this style, we shall have the interesting situation in which dictionaries constructed for the human user will take into consideration human abilities and will therefore allow themselves to be less exact and less explicit, whereas dictionaries constructed for machine use will not be able to allow themselves such licenses. In this way a situation may develop in which dictionaries for computational use will have to be more strictly constructed than the user-friendly dictionaries for human users.

However, Zgusta's argument is not compelling. For if the distinction between analysis and synthesis in the lexicographic process is taken seriously, and if the pre-dictionary database is carefully designed and maintained, then it is not the final dictionary product computational linguists should be after, but the lexical database itself.

Valency dictionaries are more on the database side of the foregoing distinction since it is their concern to describe the valency of a word as completely as possible. Accordingly, Heid (2007: 378) comes to the conclusion that *VDE* "shows considerable affinity with NLP, even though is was not conceived with the use by automatic systems in mind. But the presence of a clear descriptive programme, its richness in details and its reproducible internal structure contribute to its multifunctionality." Heid (2007) furthermore reports on an experiment to enhance the lexicon of a Lexical Functional Grammar (LFG) system for English with data from *VDE*.

The lexicon-grammar of Gross (1994), in its electronic form, can be regarded as a lexical database that describes the syntagmatic environment of several thousand French verbs. Gardent et al. (2005, 2006) outline how to transform these data into a subcategorization lexicon suitable for NLP applications. It is part of Gross' program to group verbs into classes on the basis of their common distributional properties. This idea shows some resemblance to the alternation based approach that underlies VerbNet (Kipper, Dang, and Palmer 2000), a lexical database of English verb classes that builds on Levin (1993). Especially the corpus-based

induction of verb classes pursued by Kipper et al. (2006) resembles Gross' program to some extent. Crouch and King (2005) describe an attempt to enrich the above-mentioned LFG lexicon by the valency patterns of VerbNet, amongst others.

COMLEX (Grishman, Macleod, and Meyers 1994) is one of the few electronic dictionaries available that have been specifically compiled for supporting NLP applications without any specific grammatical framework in mind. COMLEX has been used to automatically supplement the lexicon of the English Resource Grammar, a broad-coverage grammar of English in the Head-Driven Phrase Structure Grammar (HPSG) framework that is part of the Linguistic Grammars Online (LingGO) project (Copestake and Flickinger 2000). Other computational dictionaries specifically developed for NLP applications are described in Hartrumpf, Helbig, and Osswald (2003) and McShane, Nirenburg, and Beale (2005), both of which are embedded in NLP systems for deep semantic analysis.

8. Further syntactic aspects of lexicography

Syntax, up to now, has referred to the syntax of the natural languages dictionaries are about. There are further meanings of this term which are relevant to lexicography. A first example is the *syntax of definitions* in dictionary entries, which is not concerned with the syntax of natural language proper but with a regimented, controlled sublanguage: "Scraps of sublanguage (…) may well be found in unexpected places, as for example in the language of dictionary definitions" (Sinclair 1996). In this context, syntax serves as a normative device that specifies what definitions must look like, i.e., their basic vocabulary and the set of admissible constructions.

Another, more technical notion of syntax is concerned with the microstructure of a lexical entry, i.e., with questions of how the entry's informational components are arranged. Used in this way, the syntax of a lexical entry is a topic for metalexicographic analysis and has been extensively studied by Wiegand (1989a, 1989b). Today, in the electronic age, there is an additional structural, and thus, in a sense, syntactic level relevant to dictionary design: the specification of lexical data as an abstract data structure. From this perspective, microstructure is more a concept of presentation than of representation (see also Müller-Spitzer 2006: 91). Lexical data structures can be specified in different ways and at different levels of abstraction. The prevalent methods are XML schemas, entity-relationship models, and the like. Another option is to lean on the Lexical Markup Framework (LMF) (Francopoulo et al. 2006), a generic conceptual model for dictionaries that is formally specified by means of the Unified Modelling Language (UML) and is currently being developed under the auspices of the International Organization for Standardization (ISO).

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