# The Generative Lexicon

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# 3 ■ The Logical Problem of Polysemy

In chapter 2, I reviewed the basic components of knowledge necessary for lexical description. In this chapter, I turn to the problem of lexical ambiguity. **A** proper treatment of the description of the semantics of lexical items in the language should permit us to adequately describe the behavior of ambiguity as well as the lexical selection process in the grammar. If done correctly, this should simplify both the grammatical and semantic description of the language. I explore two dimensions of the problem of lexical ambiguity and then discuss the simplest lexical model that is able to account for these phenomena.

## 3.1. Varieties of Sense Extension

It is certainly true that many words in a language have more than one meaning, a propert y usually called polysemy. But the ways in which words carry multiple meanings can vary. For example, Weinreich (1964) distinguishes two types of ambiguity, the first of which he calls *con trastiv e ambiguity.* This is seen where a lexical item accidently carries two distinct and unrelated meanings (i.e., homonymy). Examples of this are shown in (1)-(5) below.

(1) a. Mary walked along the bank of the river.
b. HarborBank is t he richest bank in the city.

(2) a. Drop me a line when you are in Boston.
b. We built a fence alon g the property line.

(3) a. First we leave the gate, then we taxi down the runway.
b. John saw the taxi down the street.

(4) a. The discussion turned on t he feasibility of t he scheme.
b. The bull turned on the matador.

(5) a. The judge asked the defendant to approach the bar.
b. The defendant was in the pub at the bar.

In the examples above, for whatev er reason, the underlined items have more that one lexical sense. Whether these senses are historically re lated or accidents of orthographic and phonological blending, is largely

irrelevant for purposes of lexicon construction and the synchronic study of meaning.

The other type of ambiguity Weinreich refers to, illustrated in (6) (10) below, involves lexical senses which are manifestations of the same basic meaning of the word as it occurs in different contexts.

(6) a. The bank raised its interest rates yesterday.
b. The store is next to the newly constructed bank.

(7) a. John crawled through the window.
b. The window is closed.

(8) a. Mary painted the door.
b. Mary walked through the door.

(9) a. The farm will fail unless we receive the subsidy promised.
b. To farm this land would be both foolish and without reward.

(10) a. If the store is open, check the price of coffee.
b. Zac tried to open his mouth for the dentist .

Following Weinreich's usage, I will refer to these sense distinctions as *complementary polysemies.* Somehow, our model of lexical meaning must be able to account for how the word for bank can refer to both an institution and a building, how the word for window can refer to both an aperture and a physical object, and how stative predicates can also refer to ca usat ive acts. In the examples above, there are two types of sense complementarity: (a) category preserving , and (b) category changing. I will define *logical polysemy* as a complementary ambiguity where there is no change in lexical category, and the multiple senses of the word have overlapping, dependent, or shared meanings. Hence, complemen tary polysemy is a slightly broader term than logical polysemy, since the former also describes how cross-categorial senses are related , for ex ample with the use of *hammer* as both a noun and a verb.

In the next section I discuss the nature of contrastive ambiguity in more depth, and examine what factors in the grammar and what types of knowledge seem to be at play in the disambiguation process for this type of polysemy.

## 3.2. Contrastive Ambiguity

Making use of the distinction mentioned above, it quickly becomes clear that most work to date on ambiguity has dealt with contrastive am biguity, the essentially arbitrary association of multiple senses with a single word; furthermore, if it has dealt with complementary polysemy at all, it has been cross-categorial ambiguity alone, usually treated as a subspecies of contrastive senses. In some sense this is not surprising, since given the current representational techniques and strategies for dif ferentiating word senses, there would appear to be no reason to make a logical distinction between these types of ambiguity. This strategy, which I will call *sense enumeration lexicons (SELs),* appears at first to adequately handle the sense differentiation for both ambiguity types.

Let us see what factors are at play in the disambiguation process for lexical items that have contrastive senses. Consider first, the ambiguities in sentence (11), presented in Waltz and Pollack (1987).

(11) John shot a few bucks.

In this sentence both the verb *shoot* and the noun *buck* are contrastively ambiguous, and this sentence asserts either that John was successful on a hunting trip or that he spent some money gambling. This example illustrates what could be called *pragmatically constrained disambigua tion,* since comprehension of such an utterance is performed in a specific context of who John is and what activity he was involved in. Notice that lexical disambiguation does not occur independently for one lexical item, but rather, once the context or domain for one item has been chosen or identified, the ambiguity of the other items is also constrained. We will see that , while this is a property of contrastive ambiguity, it does not characterize sense narrowing in logical polysemy.

Consider next the sentence in (12) below, discussed in Hirst (1987, 1988).

(12) Nadia's plane taxied to the terminal.

Both the nouns *plane* and *terminal* are ambiguous.[1] Here *plane* has at least two senses, (1) as an aircraft and (2) as a tool used in carpen try. The noun *terminal* also has two senses, as (1) a computer terminal and (2) as a building at an airport, train station, or bus station. The

computational concern in the disambiguation of such lexical items is the question of how to arrive at the appropriate word sense within a given sentence, given particular strategies for contextual and pragmatic priming.

Another example discussed in Hirst (1988) and similar examples dis cussed in Lascarides and Asher (1993) involve sentences such as (13) below, and (14) mentioned in the previous section:

(13) Ross was escorted from the bar to the dock.

(14) a. The judge asked the defendant to approach the bar.
b. The defendant was in the pub at the bar.

For a sentence such as (14a), although it is possible that a judge could be at a drinking esta blishment and furthermore could refer to the indi vidual as a defendant at this locati on, this is unlikely, given the normal use of these terms. Hence, what is at play in these cases is an intuitive notion of *priming* and *context setting* that is providing for the disam biguation of the lexical items in the sentence by virtue of the discourse within which the sentence appears. From a theoretical perspective, the major problems posed by contrastive ambiguity involve issues of dis course inferencing and the correct integration of contextual information into processing.

Finally, there are some cases of contrastive ambiguity that do not require context and pragmatic information for disambiguation, so much as the disambiguation that comes by virtue of the predication relation in the sentence. For example, in (15) below, the appropriate sense for the noun *club* is arrived at by virtue of sortal knowledge of the NP appearing in the inverted subject position (cf. Hirst, 1988).

(15) a. Nadia's favorite club is the five-iron.
b. Nadia's favorite club is The Carlton.

Because of the way the appropriate sense is identified in this example, I will refer to this as a case of *sortally constrained disambiguation.*

There are, of course, many finer distinctions to make in the nature of contrastive ambiguity, as well as the in the strategies and information sources that help disambiguate senses. My concern here, however, is to compare this type of ambiguity with complementary polysemy, and to explore what lexical representation is adequate for expressing such sense distinctions.

## 3.3. Complementary Polysemy

Unlike the cases of ambiguity discussed in the previous section, com plementary polysemy seems to entail a very different type of relation between senses. The sentences given in the first section above involv ing the nouns *door* and *window,* for example, are part of a larger set of al te rnat ions called *Figure-Ground Reversals,* which include a large class of nouns in the language, such as *fireplace, pipe, room, gat e,* etc. The ambiguity in such nouns involves the two senses of ' aperture' and 'physical object' used to frame this aperture. This sense alternation is just one of many nominal alternations that can be described as logical polysemies, where the noun seems to have systematically related senses. These include:

*(16)* Count/Mass alternations; *lamb.*
a. The lamb is running in the field.
b. John ate lamb for breakfast.

*(17)* Container/Containee alternations; *bottle.*
a. Mary broke the bottle.
b. The baby finished the bottle.

*(18)* Figure/Ground Reversals; *door, window*.
a. The window is rotting.
b. Mary crawled through the window.

*(19)* Product/Producer alternation; *newspap er , Honda* .
a. The newspaper fired its editor.
b. John spilled coffee on the newspaper.

*(20)* Plant/Food alternat ions; *fig , apple.*
a. Mary ate a fig for lunch.
b. Mary watered the figs in the garden.

*(21)* Process/Result alternation; *examination, merger.*
a. The company's merger with Honda will begin next fall.
b. The merger will produce cars.

*(22)* Place/People alternation; *cit y , New York.*
a. John traveled to New York.
b. New York kicked the mayor out of office.

Like the contextually determined disambiguation we encountered with the case of the noun *club* in the previous section, the correct sense within a logical polysemy is identified only by virtue of the context around it.

What distinguishes the senses **in a** logical polysemy from the con trastive cases we have discussed is the manner in which the senses are related. The biggest difference is that, while contextual priming and discourse setting helps disambiguate contrastive senses, it seems irrele vant to the issue of determining the sense of a logically polysemous noun. That is, while contrastive senses are contradictory in nature (that is, one sense is available only if every other sense is not available), complemen tary senses seem to have a much weaker shadowing effect. Both senses of a logically polysemous noun seem relevant for the interpretation of the noun in the context, but one sense seems 'focused' for purposes of a particular context. All of the pairs above seem to exhibit this logical relation between the senses of the noun.

Complementary polysemy is also seen in other categories as well. For example, adjectives such as *good* have multiple meanings, depending on what they are modifying.[2]

(23) a. a good car
b. a good meal
c. a good knife

In some sense, the adjective *good* is merely a positive evaluation of the nominal head it is modifying. Unlike the nominal polysemies above, however, there does not seem to be an alternation or focusing effect, but rather a functional dependency on the head being modified. Such ad jective senses seem better classified as complementary polysemies rather than contrastive senses, although it is not clear what the exact relation is between these senses beyond a positive judgment. I return to this question in chapters 7 and 10 below.

Logical polysemy can also be seen as relating the multiple complement types that verbs select for, as in the sentences below.

(24) a. Mary began to read the novel.
b. Mary began reading the novel.
c. Mary began the novel.

Verbs such as *begin* are polysemous in that they must be able to select for a multiple number of syntactic and semantic contexts, such as Verb

Phrase, Gerundive Phrase, or Noun Phrase. To a large extent, the verb itself retains the same meaning, varying slightly depending on the type of complement it selects. Hence, this would appear to be a legitimate example of logical polysemy.

Other related senses which could possibly be viewed as polysemies take us further into the area of verbal alternations more broadly defined, such as the inchoative/causative alternation, seen below in (25) and (26).

(25) a. The bottle broke.
b. John broke the bottle.

(26) a. The window opened suddenly.
b. Mary opened the window suddenly.

These differ from the contrastive ambiguity cases presented in the pre vious section in several respects . Not only are the senses related in a well-defined way, but it is fairly uncontroversial that one sense (that in (25a) and (26a)) is actually entailed by the other sense. Thus, even such verbal alternations as these can be seen as logical polysemies as well.

These are but a few of the types of complementary polysemy that languages allow. The purpose of this discussion has been merely to introduce the distinctions in ambiguity types, and not to exhaustively study the nature of these polysemies themselves, something that is ad dressed in subsequent chapters. In the next section, I present the most elementary model for lexical semantics that would adequately describe the sense distinctions just discussed.

## 3.4. An Elementary Lexical Semantic Theory

Given the preliminary discussion of polysemy from the previous section, I present the simplest model of lexical design possible, and one which is widely assumed **in** both computational and theoretical linguistics. As I mentioned earlier, the form that a lexicon takes influences the over all design and structure of the grammar. The major part of semantic research until fairly recently has been on logical form and the mapping from a sentence-level syntactic representation to a logical representation language. Hence, it is not surprising that many assumptions regarding lexical meaning are based on models that are 10-20 years old.

Let us outline the problem in order to present the elementary model more clearly. Assuming that the core problem for natural language semantics is one of assigning the correct semantic interpretation to any string in the language, we would hope that the mapping between word forms and semantic forms can proceed in a well-defined and possibly deterministic process. The most direct way to account for the polysemies described in the previous section is to allow the lexicon to have multiple listings of words, each annotated with a separate meaning or lexical sense. This is certainly the simplest means of encoding sense variation in a lexical form, and furthermore has the smallest effect on the nature of the semantic operations **in** the grammar. Let us define such a dictionary as a *Sense Enumeration Lexicon (SEL},* and characterize it directly as follows:

> **A** lexicon *L* is a *Sense Enumeration Lexicon* if and only if for every word win *L,* having multiple senses $s_1, \ldots, s_n$ as soc.iated with that word, then the lexical entries expressing these senses are stored as $\{w_{s1}, \cdots, Wsn\}$.

Given this view of lexical sense organizat ion, the fact that a word-form is ambiguous does not seem to compromise or complicate the compositional process of how words combine in the interpretation of a sentence.

For example, the two contrastive senses of the word *bank* as used above could be listed in a straightforward fashion as in (27) and (28) below, using a fairly standard lexical data structure of category type (CAT), and a basic specification of the genus term (GE NUS) , which locates the concept within the taxonomic structure of the dictionary.[3]

(27) **bank1**
CAT = **count-11oun**
GENUS = **flnanciaLinstitution**

[ **b ank2**
CAT = **counLnoun**
GENUS = **shore**

(28)

[

Assuming that selectional requirements for verbs are defined from the same set of features (or types) as the genus terms themselves, then dis ambiguation would appear to be merely the process of correctly match ing the features of functor and arguments from the available set of lexical entries (cf. Hirst, 1987). For example, a verb such as *lend* might select,

**in** one of its senses (for it will certainly have many senses in an SEL), for financiaLinstitution *as* subject, shown below:

(29) The bank will lend the money to the customer.

(30)
CAT = **verb**
SEM = R_o(01, 02 , 0a)
1

[ ARGSTR = [ ARGl = **np !+financiaLinstitution)**
ARG2 = **np +money)**
ARG3 = **np +human)**

From the point of view of linguistic theory, this is a perfectly reasonable model for lexical design, since, as long as the structural and semantic requirements are satisfied , there is no reason to change or enrich the compositional mechanisms making use of this lexical knowledge.[4]

A similar approach applied to verbs would allow variation in comple ment selection to be represented *as* distinct senses, related through a sharing of the lexical sign itself. This is the strategy adopted in most current linguistic fram eworks, in some fashion or ot her.[5] Informally, such an approach assumes each lexical item to be uniquely selective for a particular syntactic environment, as illustrated below for the verb *begin.* The semantics of ea ch form, shown below simply as a relation *Ri(01, 02),* can be related to each other by a lexical redundan cy rule or meaning postulate.

(31)
**begin 1**
CAT = **verb**
SEM = R1(01,02)
ARGSTR= [ ARGl = **np**
ARG2 = **vp (+mf)**

**beg in 2** CAT **verb**

(32) SEM = *R2(81, 82)*

[ ARGSTR - ARGl = **np**
- [ ARG2 = **(+prog)**]

**begin a**
CAT = **verb**
(33) SEM = *Ra(81,02)* .
[ ARGSTR = [ ARGl = **np]**
ARG2 = **np**

Given this preliminary definition of sense enumeration lexicons, let us examine more carefully the way in which SELs are able to account for

lexical selection and ambiguity in the two classes of ambiguity discussed in the previous section. We return to the sentence in (12), repeated below.

(34) Nadia's plane taxied to the terminal.

Assuming that the contrastive senses of *plane* and *terminal* can be distinguished by appropriate features or sorts (as illustrated in (35) and (36) for *plane),* then this example is similar to the disambiguation of the

(35) **plane1**
[ CAT = **count_noun**
GENUS = **aircraft**

(36) **plane2**
[ CAT = **count_noun**
GENUS = **tool**

That is, the contrastive senses of *plane* are *sortally constrained* or differentiated, hence discourse context is not really needed to select the appropriate sense. Assuming the sortal restrictions on the predicate *taxi* shown in (37) below, the subject is therefore disambiguated by strict type selection.

(37) **taxi**
[ CAT = **verb**
SEM = *P(01)*
ARGSTR = [ ARG1 = **np [+aiccraft]]**

As mentioned above, once one contrastive sense has been fixed in a sentence, pragmatically constrained disambiguation facilitates the narrowing of other contrastive senses in subsequent processing (cf. Small, Cottrell, and Tanenhaus, 1988). Assuming that the two senses for the noun *terminal* are terminal$_1$ (computer), and terminal$_2$ (a building for an aircraft), then selection of the appropriate sense is accomplished quite straightforwardly, given that the basic predication is fixed at this point in the processing.[6]

Let us turn to the representation of complementary polysemy. We saw above that variations in verb complementation have been encoded as enumerated lexical senses since the *Aspects-Model* (cf. Chomsky, 1965), and they appear to adequately describe syntactic distribution. I

will attempt to analyze the cases of nominal polysemy discussed above in terms of SEL representations. These involved figure/ground reversals, container/containee alternations, and count/mass alternations, repeated below:

(38) a. The lamb is running in the field.
b. John ate lamb for breakfast.

(39) a. Mary broke the bottle.
b. The baby finished the bottle.

(40) a. The window is rotting.
b. Mary crawled through the window.

Traditionally these have been treated as simple cases of sense enumeration, along the lines of contrastive ambiguity. Indeed, the representations below for the complementary senses of the noun *lamb* seem as well-motivated as the listings for *plane* given in (35) and(36).

(41) CAT = **coun noun**

**lambi**
[ GENUS = **ammal**

(42) **lamb 2** ]

CAT = **mass noun**
[ GENUS= **meat**

The fact that these two senses are logically related is not captured in the two representations above, but the senses are distinguished by type, which is usually the most important consideration for compositionality. One possible modification to the SEL framework we could make, which would differentiate contrastive from complementary senses for a lexical item, would be to store complementary senses in a single entry, distinguished by sense-identification number.

**lam b** CAT = **mass_noun**

(43) SENSEi = [ GENUS = **meat** ]
[ $SENSE_2$ = [ CAT = **coun_noun]**

GENUS = **ammal**

Thus, we could restate the definition of a sense enumeration lexicon to account for this distinction in how senses are stored:

(44) A lexicon *L* is a *Sense Enumeration Lexicon* if and only if for every word *w* in *L,* having multiple senses s1, ... , $s_n$ associated with that word, then:

*(i)* if s $_{1 , \ldots , s_n}$ are contrastive senses, the lexical entries expressing these senses are stored as $W_{s1}, \cdots, W sn$.

*(ii)* if s $_{1 , \ldots , s_n}$ are complementary senses, the lexical entry express ing these senses is stored *as* $W \{ s_1, \ldots, sn\}$.

Every ambiguity is either represented by (i) or (ii) above.

This is in fact the approach taken by many researchers within both theoretical and computational traditions. The advantage of this model of lexical description is that the lexicon remains a separate and inde pendent component or source of data, or a *plug-in* module from the computational perspective. Hence, one can study properties of syntax and semantic interpretation, knowing at least that the lexicon is a fixed point of reference, interacting with other components of grammar in a predictable and well-defined way. Nevertheless, in the next chapter, I show how the sense enumerative lexicon model outlined above is inade quate for the purpose of linguistic theory. I will then outline what I think are the necessary components for an adequate semantic description of the language, as viewed from the lexicon.