Lexical Semantics of Adjectives

A Microtheory of Adjectival Meaning

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Abstract. This work belongs to a family of research efforts, called microtheories and aimed at describing the static meaning of all lexical categories in several languages in the framework of the MikroKosmos project on computational semantics. The latter also involves other static microtheories describing world knowledge and syntax-semantics mapping as well as dynamic microtheories connected with the actual process of text analysis. This paper describes our approach to determining and representing adjectival meaning, compares it with the body of knowledge on adjectives in literature and presents a detailed, practically tested methodology and heuristics for the acquisition of lexical entries for adjectives. The work was based on the set of over 6,000 English and about 1,500 Spanish adjectives obtained from task-oriented corpora.

Introduction

The topic of this paper is the information about adjectival meaning which should be included in a computational lexicon. Thus, we concentrate on adjectival meaning proper and not on the peculiarities of using lexical entries for adjectives in producing computational semantic analyses. The latter topic will be part of a report about semantic analysis, including the semantic analysis of adjectival modification as one of the multiple manifestations of the phenomenon of modification in language.

The practical goal of the study has been to develop a method for describing the semantics of adjectives contained in a corpus of Spanish and English journalistic texts as part of a larger effort to develop a computational method for determining and representing the meaning of natural language texts. Some fundamental premises of this general effort must be made clear before we embark on the description of adjectives.

The first premise is that **text meaning:**

- involves both linguistic and world knowledge;
- is necessary for advanced computational-linguistic applications; and
- is extractable and formally representable.

A number of computational-linguistic schools --- corpus-based linguistics, connectionist linguistics, and those approaches which insist on the primacy of syntax --- do not share this premise. Obviously, the premise can be invalidated and the approach falsified if it can be shown that a higher-quality output is possible within an alternative approach.

The second premise is the inclusion of native speaker judgment for **verification** purposes. Unlike

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the familiar mechanism of grammaticality judgments suggested by Chomsky (1957, 1965) and universally applied in theoretical linguistics, the procedure we suggest involves the native speaker comparing the input and the output of our working model and judging whether the task the model purports to perform has been carried out well. In the case of machine translation, the source and target texts will be compared based on any of a number of evaluation scales. In other applications, such as, for instance, automatic summarization systems, other metrics will be used as appropriate. This premise satisfies the principle of verifiability and falsifiability (à la Popper 1972) of our approach.

The third premise is the **machine-tractability** of our results. Thus, we call a representation machine-tractable if there exist computer programs which can derive it from a text and generate a text from it. In many schools of linguistic, philosophical and even computational-linguistic thought this premise is not considered essential. In some others, establishing the theoretical possibility of machine tractability is deemed sufficient.

The fourth and last premise is a shift from the usual focus of theoretical linguistics on exceptional and borderline phenomena as evidence for or against a certain rule within a certain theory (such as LFG or the minimalist approach) to a large-scale principled **description of ordinary cases**, which are often presumed by theoretical linguistics to be clear and simple and which, as a norm, remain undescribed. Related research (Raskin 1990, Raskin *et al* 1994a,b) has demonstrated that massive and seminal works in post-1960 linguistic semantics has yielded just a handful of actual semantic descriptions of the meanings of particular words or sentences, and almost all of those are exceptional and borderline cases.

Assuming that pursuit of a monolithic theory of language is futile, we approach the task by developing a society of microtheories responsible for what we think are manageable components of the entire task. These components may be circumscribed based on a variety of approaches. There are microtheories devoted to language as a whole or particular languages; to parts of speech, syntactic constructions, semantic and pragmatic phenomena or any other linguistic category; to world knowledge ("ontological") phenomena underlying semantic descriptions; and to any of the processes involved in analysis and synthesis of language by computer.

Examples of microtheories include those of Spanish prepositions, of negation, of passive, of aspect, of speech acts, of reification of properties, of semantic dependency building, and many others. Our hypothesis is that it is possible to combine all these, sometimes overlapping, microtheories into a single computational system which accounts for a totality of language phenomena for which it is supposed to serve as a model. In these terms, our purpose in this research is to produce a microtheory of adjectival meaning, namely, to account for the lexical semantics of the adjectives and for the computational mechanisms of its incorporation into a general description of text meaning.

The number of microtheories, as described above, can be, of course, very high. In practice, it is necessary to determine which subset of such microtheories is the most appropriate for a particular task. At present, we do not have any formal mechanism for doing this and rely instead on such simple rules of thumb as keeping the number of microtheories and overlaps among them to a possible minimum.

The microtheory approach facilitates the incorporation of fruitful ideas found in linguistic and computational-linguistic literature on the subject of each microtheory. Most linguistic descriptions deal with fragments of the overall set of language phenomena, much like our microtheories. The

difficulty of combining two linguistic descriptions to form a coordinated single description of the union of the phenomena covered by each individual description is well known and stems from differences in the premises, formats and purpose. The microtheory approach rectifies this situation through the following procedure. First, we collect scholarship pertaining to the scope of a microtheory. Next, for each contribution, we establish its premises and purpose. If they are different from the premises and purpose of our general approach, we determine what remains of the description after these premises are replaced by ours. The remaining material is then reformulated in the metalanguage of our approach and incorporated into the overall statement of the microtheory. Next, we check whether the imported descriptions cumulatively cover the intended scope of the microtheory. If not, original research is undertaken to complete the microtheory.

The relation between our work and linguistic theory, on the one hand, and computational linguistics, on the other, should be seen, we believe, as being based on the concept of a 'theory of practice' (*albeit* not à la Bourdieu 1977), or, more specifically, of a theory for applying the findings of theoretical and descriptive linguistics to natural language processing (see Nirenburg and Raskin 1987a,b; Raskin 1987a,b). The microtheory-based methodology for accomplishing this, as described above, avoids the double pitfall of trying to transfer the findings of linguistics directly into NLP without accounting for the difference in premises and goals or, alternatively, ignoring those findings and engaging instead in wasteful reresearching and second-guessing linguistic issues and redescribing language material in an uninformed and frequently *ad hoc* fashion.

The structure of this paper reflects the microtheory development process described above. The paper focuses on the lexicon part of the microtheory. Section 1 surveys the field of adjectival semantics and identifies the major premises and descriptive results of the individual contributions. Section 2 briefly presents the premises and basic concepts of our model, the Mikrokosmos approach, and shows how the useful findings from the survey are incorporated into the microtheory of adjectival meaning. The issues thus imported and revised include:

- the basic function of the adjective,
- adjective taxonomy,
- the correlation between adjectival syntax and semantics,
- the nature of relative (denominal) adjectives,
- the order of adjectives in multi-adjective strings,
- the use of adjectives as nouns and vice versa,
- the nature of gradability scales for adjectives and degrees of comparison.

Section 3 reviews the MikroKosmos typology of adjectives and their representations. Section 4 continues from a subsection of Section 2 in the direction of the methodology, or--more accurately--the theory of the implementation of the semantic representation and lexicographic description of the adjective, again a theory of practice, as it were. It deals with the issues of:

- reducing the multiple dictionary meanings of an entry to a handful,
- the grain size of meaning presentation and the concept of variable-depth semantics,
- capturing the meaning of an adjective, i.e., the heuristics of semantic determination
- establishing the way to represent the captured meaning ontologically and lexically, i.e., the heuristics of computational lexicography.

1. The Syntax and Semantics of the Adjective in the Literature

This section contains a comprehensive survey of the work on adjectives accumulated in theoretical and traditional linguistics. According to the microtheory approach, we consider this body of knowledge "raw material" for incorporation into the microtheory of adjectival meaning. It comes from a diversity of theoretical backgrounds and premises, and is generally not machine-tractable. In this survey, we summarize the features, issues, taxonomies, and dichotomies that have been put forth in the study of adjectives. Our evaluation of these issues is left to Section 2.3. Instead of re-interpreting each survey element in our terms, we try to lay out the linguistic scholarship as it was presented in the original work. The preparatory work for the microtheory is done in this section only in the sense of grouping the surveyed work according to the issues and overcoming the idio-syncratic terminological differences --- if some two approaches deal with similar things, often un-aware of each other and using very different terminologies, we attempt to bring them together.

Our basic premises and goals differ from those of theoretical semantics, lexicography, formal semantics, structural semantics, traditional lexicology, and other reviewed approaches. Nevertheless, any extensive criticism of these approaches is outside the scope of this paper. We concentrate only on those elements which seem to be useful for building our microtheory. Through this process of selection, we discover what is important in the theoretical-linguistic accounts of adjectives and what is immaterial from the standpoint of computational applications.

1.1 Conventional Wisdom on the Adjective

Much more has been written in the current linguistic theories about verbs and nouns than on their modifiers, adjectives and adverbs. Adjectives are typically tackled only inasmuch as they are constituents of noun phrases which are arguments of verbs. Outside of the "mainstream" of contemporary linguistic research, however, there exists a sizable body of work on adjectives, typically on their properties in languages other than English.

The conventional wisdom on adjectives is that they modify nouns and that they usually denote some properties of things denoted by nouns. A French **Dictionnaire de linguistique** (1973), a very appropriate reference for conventional wisdom, defines adjectives as "words joint to the nouns to express a quality of the object, creature, or concept designated by this noun." Grevisse (1969: 285) adds "a property of being" to the list of things designated by nouns.

Lyons (1977: 438-439) "adopt[s] the conventional view, according to which the attributive adjective is the modifier of the noun with which it is combined, and the adverb is the modifier of the verb or adjective with which it is combined, in endocentric expressions." He immediately adds, however, that "[t]here are many subclasses of adverbs and some adjectives for which this statement is definitely not valid; and there are other adverbs and adjectives for which its validity is questionable. In so far as the generalization that has just been made does hold, however, it explains the traditional terms 'adjective' and 'adverb': the adjective is typically the modifier of a noun and the adverb is typically the modifier of a verb or adjective" (ibid).

1.2 Basic Syntax and Semantics of the Adjective

One immediate objection to "the conventional view" is that not all adjectives modify nouns. They do when they are used attributively (1i) but they do not (at least, not syntactically) when used predicatively (1ii):

(1) (i) This is a good book.
(ii) This book is good.

The dual attributive/predicative use is just one of the five largely syntactic features that Quirk et al. (1985: 402-403, 434-436) associate with the adjectives (2):

(2) (i) Attributiveness/predicativeness;
(ii) Modifiability by adverbs like *very*;
(iii) Staticity/Dynamicity, as illustrated by the distinction between the static *The boy is tall* and dynamic *The boy is being unreasonable*, with the construction *N is being* _____ serving as diagnostic for dynamicity;
(iv) Gradability/nongradability, as illustrated by the distinction between *good* (*better*, *worse*) and *male*,[2] with all the dynamic adjectives but not the static ones being gradable
(v) Inherence/noninherence, as illustrated by the distinction between *firm handshake* and *firm friend* and diagnosed through the nominalizability vs. nonnominalizability, respectively, of the adjective: *the firmness of the handshake*/**the firmness of the friend*.

Some similar features are distinguished by Shramm (1979: 6) for Russian qualitative (gradable, scalar) adjectives: degrees of comparison, diminution, augmentation; change of attribute over time; varying absolute meanings (a wide board is a foot wide; a wide street is 50 foot wide); occurrence with quantifying adverbs. Shramm's features are a mixture of "the lexico-grammatical meaning, the morphological properties, and the syntactic functions" (4).

Quirk and Greenbaum (1973) and Quirk *et al*. (1985) do not really ever do semantics, but their last three features (2iii-v) can be seen--and actually are presented by them (Quirk *et al*. 1985: 434-436)--as basically semantic ones, except that they are also based, in one way or another, on a syntactic property. In languages that do have adjectives the category is not so hard to define in some such syntactic terms. The difficulty is with a semantic definition, and this is where Lyons's caution came from. In languages, where there are no or practically no adjectives, their semantics is divided, usually quite unevenly, between the nouns and the verbs. Lyons argues carefully that there must be something inherent to the meaning of the category for it to behave syntactically the way it does:

> "...qualitative adjectives fall, semantically, between the most typical nouns and most typical verbs; and in particular languages they may be assimilated, grammatically, to either nouns or verbs. In Latin, for example, nouns and adjectives are much more similar from a grammatical point of view than they are in English. In Chinese, on the other hand, adjectives may be regarded as a subclass of verbs (cf. Kratochvíl, 1968: 113). The term 'adjective', as we have already seen, implies the primacy of syntactic considerations in the definition of the part-of-speech or expression-class that it denotes; and it is interesting to note that, whereas

[2] latest genetic findings about the continuity and, therefore, gradability of the gender scale notwithstanding--because, of course, natural language semantics does not reflect scientific views of reality--at least, not right away.

> the dictionary-definitions of 'noun' and 'verb' quoted above... each includes a semantic condition, the definition of 'adjective' in the same dictionary is purely syntactic ("any member of a class of words functioning as modifiers of nouns, such as 'good', 'wise', 'perfect': Urdang, 1968). Adjectives are lexemes or other expressions whose most characteristic feature is that they can occur more freely than any other open-class expressions as modifiers of nouns within nominals: hence our use of the term 'adjectivalization' for any transformational process that converts a predicative expression into a noun-modifying expression within a nominal.... The standard transformationalist view, for English and for other languages, that nominals containing attributive adjectives are derived, in general, by means of an embedding transformation has the advantage that it enables us to account for the semantic relationship between all kinds of attributive and predicative expressions in the same way; and we will accept this view. But it may be assumed that the embedding of a quality-denoting expression is more normal than the embedding of either a class-denoting or action-denoting expression. There is a connexion, therefore, between the semantic and the syntactic definition of the most typical adjectives; and we should be surprised, to say the least, if we came across a language in which quality-denoting expressions could occur in predicative, but not attributive, position, whereas the most typical nouns and the most typical verbs could occur freely in both positions" (1977: 447-448).

Jespersen attempted to capture the semantic nature of the adjectives by distinguishing them from nouns, 'substantives' in his terminology, on the general vs. specific basis. Realizing that "[a]n answer very often given [to the question of the perceived distinction between the two categories] is that substantives denote substances (persons and things), and adjectives qualities found in these things" (1929: 74) and desiring, understandably, to strengthen the distinction, he proceeds to observe that

> "on the whole, substantives are more special than adjectives, they are applicable to fewer objects than adjectives, in the parlance of logicians, the extension of a substantive is less, and its intension is greater than that of an adjective. The adjective indicates and singles out one quality, one distinguishing mark, but each substantive suggests, to whoever understands it, many distinguishing features by which he recognizes the person or thing in person" (1929: 75).

But even having said so, he has to fall back on the formal syntactic criteria, still pleading that these must be the way they are because of the semantic nature of the adjectives:

> "...we cannot make the complexity of qualities or specialization of signification a criterion by which to decide whether a certain word is a substantive or an adjective: that must be settled in each case by formal criteria varying from language to language. What has been attempted in this chapter is to find out whether or not there is anything in the nature of things or of our thinking that justifies the classification found in so many languages by which substantives are kept distinct from adjectives. We cannot, of course, expect to find any sharp or rigid line of demarcation separating the two classes in the way beloved by logicians: language-makers, that is ordinary speakers, are not very accurate thinkers [?!]. But neither are they devoid of a certain natural logic, and however blurred the outlines may sometimes be, the main general classifications expressed by grammatical forms will always be found to have some logical foundation. It is so in the case before us: substantives are broadly distinguished as having a more special signification, and adjectives as having a more general signification, because the former connote the possession of a complexity of qualities, and the latter the possession of one single quality" (1929: 81).

Wierzbicka pursues the same line of thought in a more aggressive fashion:

> "This is, then, the main thesis...: despite the appearances to the contrary, nouns do differ in meaning from adjectives, not just core nouns from core adjectives, but, probably, all nouns from all adjectives, and the two classes differ in a systematic, largely predictable manner. In suggesting that nouns differ from adjectives on semantic grounds I don't mean that nouns designate, primarily, concrete things that can be seen and touched. After all, core adjectives such as *black, white, big, small, long* or *new*, too, designate things that can be seen and touched. The real semantic difference between nouns and adjectives lies not in the range, or kind, of referents, but in the kind of semantic structure" (1988: 466).

She follows Lyons into believing that syntactic distinctions must reflect semantic ones, and while she questions Jespersen's criterion for distinguishing between the nouns and adjectives on the ground of the specificity/generality of their meanings, respectively, she ends up with a variation of his view, stopping just short of equating the nouns with natural kinds:

> "I suggest, then, that there are at least two crucial and interrelated semantic differences between nouns and adjectives. First, nouns tend to designate 'kinds of things' endowed with certain properties; whereas adjectives designate properties as such. Second, as Jespersen pointed out, a noun tends to suggest a rather large number of properties (even though its meaning cannot be reduced to those properties); an adjective, on the other hand, designates (what is seen as) a single property" (1988: 472).

Similar concerns, namely, the relations between the semantic properties of the adjectives and their usually more obvious syntactic features as well as the relations between the adjectives and the nouns they modify, are central to most of the Continental literature on the adjectives, especially in French linguistics and the linguistics of French--see, for instance, Bonnard (1960), Borodina (1963), Stephany (1969), Wheeler (1972), Conte (1973), Loux (1978), Picabia (1976, 1978), Stati (1979), Claude (1981), Riegel (1985, 1993), Martin (1986), Goes (1993).

Givón (1970, 1984) has tried to accommodate the intermediate position of the adjective between the noun and the verb by applying his principle of time-stability (cf. Quirk et al.'s staticity/dynamicity in (2iii) above), according to which nouns encode temporally stable entities, verbs encode temporally unstable entities, and adjectives are right in between, encoding both more temporally stable, noun-like entities and more temporally unstable, verb-like entities:

> "The classes of noun and verb, the two prototypical extremes on our time-stability scale, are attested in the lexicon of all languages. On the other hand, the class 'adjective' is a bit more problematic. In languages, such as English, which has the class (with its characteristic semantics, morphology, and syntactic distribution), adjectives occupy the middle of the time-stability scale. They may overlap with the least time-stable nouns, such as 'youth,' 'adult,' 'child,' 'divorcee,' 'infant.' Most commonly they embrace at least the time-stable physical properties such as size, shape, color, texture, smell or taste. Finally, they may overlap, at the other end of the scale, with the most time-stable adjectives/verbs, such as those expressed in English by the following adjectives: 'sad,' 'angry,' 'hot,' 'cold,' 'happy,' 'ill,' etc.... When adjectives are derived from nouns, they then tend to code more time-stable meanings that those coded by verb-derived adjectives.... There is a small group of underived, 'original' adjectives in English. Diachronically most of them seem to have been derived from nouns. Synchronically, they pertain to the most prototypical adjectival qualities, those of stable physical qualities such as size, shape, texture, color, taste or smell" (1984: 52-53).

The time-stability factor is bought wholesale by Frawley (1992). Thompson (1988) and Bolinger (1967a) consider it only in relation to the all-important attributive/predicative distinction discussed at length in Section 1.4 below, with the former being more time-stable and the latter less time-stable.

1.3 Adjective Taxonomies

Because in some languages, adjectives "disappear" into verbs and/or nouns, Dixon (1982) came up with a curious list of indispensable, must-have adjectives that even almost adjective-free languages, such as Chinese, Hausa, or Chinook, must somehow provide (see, however, Sarma 1991 for apparent counterexamples in Telugu and Meiteiron). These correspond, in principle, to the "underived, 'original' adjectives in English," mentioned in Section 1.2 above by Givón, and they belong to seven categories: dimension, physical property, color, human propensity, age, value, and speed. Obviously, in English, these seven categories are represented by much more numerous adjectives, thus yielding our first example(3) of a taxonomy of adjectives:

(3) "1. DIMENSION--*big*, *large*, *little*, *small*; *long*, *short*; *wide*, *narrow*; *thick*, *fat*, *thin*, and just a few more items.
2. PHYSICAL PROPERTY--*hard*, *soft*; *heavy*, *light*; *rough*, *smooth*; *hot*, *cold*; *sweet*, *sour* and many more items.
3. COLOUR--*black*, *white*, *red*, and so on.
4. HUMAN PROPENSITY--*jealous*, *happy*, *kind*, *clever*, *generous*, *gay*, *cruel*, *rude*, *proud*, *wicked*, and very many more items.
5. AGE--*new*, *young*, *old*.
6. VALUE--*good*, *bad* and a few more items (including *proper*, *perfect* and perhaps *pure*, in addition to hyponyms of *good* and *bad* such as *excellent*, *fine*, *delicious*, *atrocious*, *poor*, etc.).
7. SPEED--*fast*, *quick*, *slow* and just a few more items" (Dixon 1982: 16).

Frawley's (1992: 447-480) taxonomy of "properties" (4) is loosely based on Dixon's (3) but is presented even more unevenly, with some favored types discussed at much length and others barely mentioned (cf. Raskin 1994):

(4)

Value:		*good: bad*
Human Propensity:	• Mental state	
		jealous, happy, loyal, ashamed
	• Physical state	
		weak, sore, thirsty, robust
	• Behavior	
		wild, argumentative, funny, interruptive
Physical Property:	• Sense (related to taste, smell, etc.)	
	• Consistency	
		hard, soft, flexible
	• Texture	
		rough, smooth, scaly
	• Temperature	
	• Edibility	
		ripe, raw, cooked
	• Substantiality	
		hollow, full, thick
	• Configuration	
		sharp, broken, whole
Color:	• Hue	
Age:	[No detail]	
Quantity:	[Standard quantifier lore in much detail]	
Possession:	[Only mentioned]	

Several other taxonomies of adjectives have been proposed. Most of them, like Dixon's and Frawley's (3-4), provide for qualitative (scalar, gradable) adjectives only. In a curious exception, Warren (1984) has a mixed-bag approach, which does not distinguish between the qualitative and relational (non-scalar, non-gradable, denominal) adjectives but adds the frequency data to the somewhat vaguely defined types of adjectives. Okada (1990) returns to the scalars, distinguishing seven structural types of Japanese adjectives and classifying them semantically into emotion, sense, location, direction, shape, quality, quantity, light, color, heat, force and energy, voice and sound, appearance and disappearance, start/end/stop, continuation (*faint*?), state (*dull*?) abstract, and others.

Aarts (1976: 34) offers three "higher-level primary features," static (+STA), physical (+/-PH), and dimensional (+/-DIM), which "describe only three categories of adjectives: +STA, +PH, +DIM; +STA, +PH, -DIM; +STA, -PH--that is physical dimensional and non-dimensional and non-physical." These three categories, in turn, introduce a bunch of "low primary features" (5):

(5)

Dimensional: horizontal, vertical, quantity, general size, time, duration, frequency, iteration.
Non-dimensional: substance, solidity, liquidity, gaseousness, texture, luminosity, humidity, temperature, color, weight, smell, taste, vision, touch, sound, musical sound, weather, fixity, property, content, corp. cond. (*hungry*), corp. func. (*blind*), velocity, activity.
Non-physical: emotion, attitude, intellect, truth, communication, manner, evaluation, degree, modality.

Nobody goes further than Shramm (1979) in laying out a painstaking, multi-level taxonomy of

Russian qualitative (scalar) adjectives, which he divides at the top level into empirical and rational. Here is his somewhat streamlined taxonomy (6) for the easier, empirical scalars only (1979: 24-33); a similar structure is available for the rational ones (1979: 33-43), but the categories there are, understandably, much less reliably defined:

(6)

Empirical A:
A I: sight-related
- 1. Surface (including color)
  - a. Surface and environment
    - 1. Light reflection (*light*/*dark*)
    - 2. Absence/presence of colors and their number
    - 3. Color terms
      - 1. Non-human color
      - 2. Human color
      - 3. Animal color
    - 4. Degrees of light
    - 5. Light reflection properties of matter
  - b. No light effect
    - 1. Smoothness
    - 2. Covered by smth. or not
    - 3. Effect of fire or heat
    - 4. Mechanical effect
    - 5. Texture
- 2. Composition, shape, texture
  - a. Shape
    - 1. Inanimate
    - 2. Animate
      - 1. Fat
      - 2. Normal/Abnormal
      - 3. Shape of body parts
      - 4. Same, with quantifier (*hairy*)
  - b. Size
    - 1. Linear
    - 2. Complex/quantitative size as seen:
      - 1. Big/Little
      - 2. Capacity of a container
  - c. Composition
    - 1. Homogeneous parts
    - 2. Mutual location of homogeneous parts
    - 3. Nature/texture of homogeneous parts
  - d. Mechanical impact
  - e. External interaction with other objects
    (*full*, *empty*, *free* (e.g. *compartment*))
- 3. Spatial
  - a. Static
    - 1. Orientation in space
      - 1. Related to vertical or horizontal
      - 2. Related to another object
  - b. Dynamic/motion
    - 1. Motion/non-motion
    - 2. Nature of motion
    - 3. Surface of liquid

A II: hearing-related
- 1. Properties of sounds
  - a. Volume
  - b. Pitch
  - c. Timbre (*hoarse*, *metallic*)
  - d. Variability
  - e. Sound quantity (multivoiced)
  - f. Human speech (*lispy*)
- 2. Properties of the sound of an object
  - a. Presence/absence of sounds
  - b. Timbre (hoarse harmonica)
  - c. Volume (*loud* (e.g. *rooster*))
  - d. Human speech as property of a person
    (*lispy* (e.g. *daughter*))

A III: olfactory

1. Properties of a smell
2. Various smells

A IV: taste-related
1. Taste-related properties
2. Changes of taste (*rotten* (e.g. *egg*), *pickled* (e.g. *cucumbers*))

A V: tactile
1. Temperature
2. Humidity
3. Surface

A VI: muscular tension
1. Weight
2. Pressure (brittle. hard)

A VII: complex sensory (several senses)

While Shramm's taxonomy (6), published in Russian, is largely unfamiliar to students of adjectives, Vendler's one is probably the one most cited in the literature. Very much in the spirit of the time, Vendler (1963, 1968) attempts a classification of (scalar) adjectives on purely transformational (à la Harris, not Chomsky) principles (1963: 449-460). The first type, A_1, allows the "A N--N *is* A" transformation, as in "*red rose--rose is red*." This is what others call the predicating type, the adjectives which can be used predicatively. A_2: A N--N *is* A *for an* N (more accurately: A N--A *for an* N), e.g. *small elephant--small for an elephant*, are the measuring adjectives. A3: A N--N [V] D (again, more accurately, A N--[V] D), e.g. *beautiful dancer--dances beautifully*; the square brackets around the verb refer to a situation, in which the verb is not as obviously produced as in the case of *dance*r--*dance*, for instance, *fast car--runs fast*. A_4: A N--N *is* A *to* V, e.g., *comfortable chair--chair is comfortable to sit on*.

A_5's "ascribe the adjective to the subject with respect to a whole sentence sharing the same subject:

John is stupid to take this job
It is stupid of John to take this job" (*ibid*: 458)

A_6's are *possible* or *impossible* and others similar to them: they cannot be used attributively but keep the identity of the subject: *It is possible for you to work* ("possible for you," "you work"). A_7's allow the change of subject*: It is useful for me that you work*. And, finally, according to Vendler, A_8's do not tolerate relative predication "N *is* A *for* N: *true, false, probable, improbable, certain, uncertain*, e.g. $^{?}$*The statement is true for me*.

While the intuitive-type taxonomies listed before Vendler's are all vulnerable to charges of arbitrariness and of the non-justifiability of the distinctions, Vendler's taxonomy, based on a clear principle, can be questioned only on two grounds; first, by refusing to accept his thesis, affirmed without any justification as something that goes without saying, that a syntactically clear distinction necessarily renders semantically significant categorizes some further discussion of this thesis in Section 2.3 below); and, second, by finding fault with his syntactic diagnostics. Nobody has, apparently, attempted the former, even though the eight classes are intuitively unclear and though several of them can be treated as complementary-distributive variants of the same class, precisely on the basis of his transformations: for instance A_3 and A_4 as the variants of the same "functional" class or A_5 through A_8 as the variants of his "whole-sentence" adjectives. But Taylor (1992), a cognitive linguist, accuses Vendler's transformations of illegitimacy with regard to their status at the later stages of transformational grammar, a status Vendler never claimed for them because, as we mentioned earlier, his transformations are Harrisean, in the first place, and not at all Chomskian (the Chomskian and post-Chomskian transformational work on adjectives is scant--see, however, Lakoff 1966, Ross 1969, Babby 1971, 1973, Postal 1972, Berman 1973, 1974, Sussex 1974, Picabia 1978, Bernstein 1995, Seymour 1995).

None of the taxonomies above have been tested on the basis of practical use because they have never, to our knowledge, been used in any practical application. For our microtheory, all these taxonomies have at least a potential heuristic value, either positive or negative. Each distinction suggests the following type of decision point for the ontologist and/or lexicographer: consider introducing an ontological feature reflecting this distinction. We will also see later, again in Section 2.3, that the major ontological distinction underlying our taxonomy and crucial for our approach has never gained much currency in the literature.

1.4 Predicating and Nonpredicating Adjectives

The central issue of adjective syntax--and semantics--is the distinction between the predicating and nonpredicating adjectives, which can also be seen as the distinction between qualitative (scalar, gradable) adjectives, on the one hand, and relational (non-scalar, non-gradable) adjectives, on the other, notwithstanding the existence of a class of mixed relational/qualitative adjectives (see Section 1.5 below).

The view of this distinction as predicating/nonpredicating is, of course, purely syntactic and thus much more manageable. Levi (1978--see also 1973, 1975) is perhaps the most definitive source on the dichotomy. While most adjectives can appear both in the attributive position, i.e., modifying a noun (in English, prenominally, cf. *red rose*), and in the predicative position (as in *the rose is red*), some adjectives are used exclusively attributively. Thus, none of the adjectives in (7) (Levi's (1.3)--1978: 2) can be used predicatively at all (8i -- Levi's (2.1) -- 1978: 15) or without a change in meaning (8ii -- Levi's (2.2) -- 1978: 15).

(7)		
	electric clock	musical clock
	electric shock	musical criticism
	electrical engineering	musical interlude
	electrical conductor	musical comedy
	electrical outlet	musical talent

Thus, for instance, in *a criminal lawyer*, *criminal* means "dealing with crimes (committed by others)," but *in a lawyer who is criminal*, it means "who commits a crime" (see more on these meaning shifters in Section 1.6 below).

(8)					
(i)	a.	a rural policeman	b.	*a policeman who is rural
		a chemical engineer		*an engineer who is chemical
		a corporate lawyer		*a lawyer who is corporate
		a dental appointment		*an appointment which is dental
		a linguistic scholar		*a scholar who is linguistic
(ii)	a.	a provincial governor	b.	a governor who is provincial
		a criminal lawyer		a lawyer who is criminal
		a logical fallacy		a fallacy which is logical
		a constitutional amendment		an amendment which is constitutional
		dramatic criticism		criticism which is dramatic

Levi's purpose is to prove that such adjectives are transformationally derived from the nouns to which they are morphologically related. Additionally, she puts forward six features that the non-

predicating adjectives share with the nouns (1978: 18-29):

(9) (i) Nondegreeness
(ii) Nonconjunction of nonpredicating and predicating adjectives
(iii) Quantification
(iv) Semantic features
(v) Case relations
(vi) Nonnominalization

(9i) is the observation that nonpredicating adjectives cannot have degree modifiers, such as **very urban riots* or **more urban riots* (Levi 1978: 19); in other words, that they are not gradable. Nonpredicating adjectives constitute one of three classes suggested by Bartning (1976: 112-113; 1976/1980). Following Lees (1960: 180-181), she introduces a distinction among (a) 'binary oppositions,' more commonly known as 'complementary antonyms' (Raskin and Weiser 1987: 116), such as *dead/alive*; (b) 'multiple oppositions,' such as *linguistic/economic/mathematical/etc., research*; and (c) 'polar oppositions,' more commonly known as 'gradable antonyms' (ibid), such as *cold (colder, coldest)*/*hot (hotter, hottest)*.

Gradability is seen as such an essential property of adjectives that many writers include it in their definition of the category, as Quirk *et al*. (1985) did, without accounting for those legitimate members of the category which are nongradable. In fact, the membership of the nonpredicating adjectives in the category is often questioned precisely because of their nongradability. Thus, Bally (1944: 96-97) firmly established in French scholarship a view that relational (nonpredicating) adjectives give up many features of regular adjectives, primarily, gradability, and this has been accepted by a group of contemporary scholars, who call the nonpredicating, nongradable adjectives "pseudo-adjectives' (see, for instance, Maurel 1993, Mélis-Puchulu 1991).

(9ii) is the assertion that a predicating adjective and a nonpredicating adjective cannot be conjoined with the help of the conjunction *and*, for instance, (10i) (cf. Levi 1978: 23) or (10ii) (Miller and Fellbaum 1991: 209), and the reason for that is, according to Levi, the different syntactic origin/nature of the adjectives, which blocks the operation of conjoining nonlike entities. Many nonpredicating adjectives may, however, be used predicatively in a different meaning, and then, of course, the *and* conjunction with another predicating adjective is reenabled, for instance, (11i) or (11ii).

(10) (i) **a rude and mechanical engineer*
(ii) **the tall and corporate lawyer*
(11) (i) His response was rude and mechanical.
(ii) She was shocked by his rude and mechanical response.

(9iii-v) seem to be accurate but marginal observations that nonpredicating adjectives may share quantification, semantic classes, and thematic roles with the nouns they derive from. The quantification observation (9iii) seems especially brittle because it can be expressed only in such adjective prefixes as *bi-*, *tri-*, *mono-*, *poly-*, *uni-*, *multi-*, and to quote Dixon, perhaps a few more. The connection between some such adjective, e.g. *polythematic*, and a quantifier plus noun phrase, probably *many themes*, seems untested and superfluous.

Similarly, in (9iv), Levi's (1978: 25) semantic classes (12) are plausible enough, though they are in reality syntactic and the features def and common are too similar. The connection between the nonpredicating adjectives and the nouns they are derived from is reasonably clear, however, so the

fact that the adjectives inherit much of the noun meaning does not come as a shocking surprise, and the fact that these features of the adjectives are shared by the related nouns seems less significant.

(12)

+def: *Markovian, Mexican*	-def: *national, feline*
+concrete: *aquatic, lunar*	-concrete: *dramatic, linguistical*
+animate: *senatorial, Chomskian*	-animate: *rural, electric*
+human: *Markovian, presidential*	-human: *Bostonian, bovine*
+masc: *paternal, masculine*	+fem: *maternal, feminine*
+common: *financial, monthly*	-common: *Persian, Chomskian*

Similarly, the (9v) observation on the adjectives inheriting, in a sense, the thematic roles (cases, as per Levi 1978: 27) from the originating noun is both true and trivial (13):

(13) agentive: *presidential refusal, editorial comment*
objective: *constitutional amendment, oceanic study*
locative: *marginal note, marine life*
dative [genitive?]/possessive: *feminine intuition, occupational hazard*
instrumental: *manual labor, solar generator*

The primary reason (9iii-v) are more or less superfluous is that these nominal properties are not actually useful for describing adjectives. They affect the syntactic behavior of nouns in important ways. With adjectives, they may at most marginally influence the rare use of oblique constructions, such as prepositional phrases, as adjective modifiers. Miller and Fellbaum (1991: 209) are right when, crediting Levi (1978) for the criteria for distinguishing the nonpredicating adjectives, they disregard these three criteria.

(9vi) is a statement about the nonnominalization of nonpredicating adjectives. It provides an important diagnostic test for predicativeness/nonpredicativeness: only the former adjectives can be nominalized, as in (14i) vs. (15i) or (14ii) vs. (15ii) (cf. Levi 1978: 29, Miller and Fellbaum 1991: 209, Bartning 1976: 112ff, Dell 1970: 189ff, and, of course, Quirk *et al*. 1985: 436 again).

(14) (i) the rudeness of the engineer
(ii) the politeness of the lawyer
(15) (i) *the mechanicalness of the engineer
(ii) *the corporateness of the lawyer

The nonpredicating/predicating distinction has been dealt with by various schools of linguistic thought, and it was taken to the extreme by the Montegovian tradition, where the nonpredicating and predicating adjectives were assigned to two different syntactic categories (Montague 1974: 211ff): attributive adjectives make common nouns out of common nouns (CN/CN); predicative adjectives are one-place predicates (t//e). Siegel (1976a,b, 1979), the main Montegovian voice on adjectives, discusses the ambiguity of *beautiful* in (16) as that between the absolute meaning (17i) and relative meaning (17ii):

(16) Olga is a beautiful dancer
(17) (i) Olga is beautiful and Olga is a dancer
(ii) Olga is beautiful as a dancer (dances beautifully)

The absolute meaning is also known as ‘intersective’ and the relative meaning as ‘nonintersective’

(Siegel 1976a: v). The distinction is, of course, synonymous with the predicating/nonpredicating distinction: the relative, nonintersective meaning cannot be derived from/related to the predicative use of the adjective: if Olga dances beautifully, it is not the case that Olga must be beautiful--but for the absolute, intersective meaning, it is certainly the case that Olga is both beautiful and a dancer. Siegel also claims (1976a: vii-viii) that absolute adjectives are verb-like, and in those languages which do not have adjectives, the absolute adjective meanings are expressed by verbs; similarly, the relative adjective semantics is expressed by nouns. In Russian, whose adjectives provide most material for her research (1976a: 16-46, 1976b; cf. Nirenburg, 1980: 31-33), the absolute meanings can be expressed both by short, predicative and long, attributive forms of the same adjective, while the relative meanings can be expressed only by long forms, that is, exclusively nonpredicatively (this claim of hers needs some considerable fine-tuning, better examples, and a number of disclaimers).

Absolute meanings are also extensional because they modify the referent: in the absolute meaning, Olga, the referent of (16) in the intersective meaning (17i), is beautiful--it is one of her properties. The relative meanings are intensional because they modify the reference, not the referent, and Olga in the (17ii) meaning is not necessarily beautiful, but beauty is rather a modification of the reference *dances*. Larson (1995--see also Larson 1983 and Larson and Segal 1995; see also Lewis 1972, an early and influential paper on natural language meaning in terms of extensionality/intensionality) elaborates on this aspect of the Montegovian view of the adjective by arguing that, in (18i), *veteran* is intensional because it is not a property of Marya's and does not automatically extend to (18ii), which does not follow from (18i), while *aged* in (19i) is extensional, it is established as a property of Marya's, and it does extend to (19ii), which does follow from (19i). *Veteran*, in the meaning it is used in (18), is, of course, nonpredicative (20I) and *aged* in (19) is predicative (20ii).

(18) (i) Marya is a veteran lutenist.
(ii) Marya is a veteran guitarist.
(19) (i) Marya is an aged lutenist.
(ii) Marya is an aged guitarist.
(20) (i) *Marya is veteran.
(ii) Marya is aged.

Curiously and, apparently, unbeknownst to the Montegovians, a similar view of the extensionality vs. intensionality of these two meanings of the same adjective was also expressed by Bally (1944: 77-78) with regard to (21), where the adjective *présidentiel* is extensional in (21i) because it refers to somebody in reality (the actual president) there, and intensional in (21ii), where no actual president is referred to (see also Maurel 1993: 24), except that it appears that the Montegovians would characterize these meanings in exactly the opposite way with regard to their extensionality/intensionality:

(21) (i) Le voyage présidentiel s'est bien déroulé (=le voyage du président)
(ii) Il a adopté un ton présidentiel (=un ton de président)

The extensionality/intensionality distinction seems to overlap somewhat with Givón's idea of time stability, cited earlier (1984: 52-53), which places the adjective between the time-stable nouns and the time-unstable verbs. Applied to the predicating/nonpredicating distinction, it would make the former type of adjectives less time-stable and, therefore, more verb-like and the latter type more time-stable and more noun-like. Jamrozik (1989), following Picabia (1976), finds a modicum of support for this point of view, emphasizing the time-instability of the evaluative predicatives.

Spanish provides some evidence of the grammaticalization of the time-stability factor in the distinction of two copula verbs, the more time-stable *ser*, rendering its predicatives accordingly more time-stable, and the less time-stable *estar*--see, for instance, Clements (1989), who argues against a more simplistic picture presented by Lujan (1980). Bolinger's (1967a: 4) position seems to support Givón's view: in (22i), the property expressed in predicative form conveys a more temporary circumstance (see also Frawley 1992: 441 fn. 2), as if the drink were "readied for the occasion," while (22ii), he believes, conveys a more stable property.

(22) (i) This whiskey is straight
(ii) This is straight whiskey

Frawley (1992: 440-441, especially 441, fn. 2) treats Thompson's (1988) account of the predicative/attributive distinction as highly compatible with this position, but, in fact, she questions rather directly the applicability of the time-stability factor to the distinction. Interested in the role the adjective plays in discourse across various languages, she discovered in her English corpus of 308 adjectives that 79% of all usages "predicate[d] a property of an established discourse referent" (1988: 174), either by being predicative or by being attributive to a non-informative predicate noun, and that the remaining 21% "introduced a new discourse referent" (ibid), always in attributive form. She did establish the obvious correlation of the former type of usage with the verbs and the latter with the nouns and claimed that this discourse-based, given-new distinction predicted better which adjectives would disappear into the verb category and which into the nouns in adjective-deprived languages than Givón's time-stability factor did.

Parsons (1990) covers, roughly, the same territory as the Montegovians, but from the positions of logical semantics--see also Parsons (1972, 1980, 1985), Damerau (1975), Kamp (1975), Klein (1980, 1981), Åqvist (1979), Hoepelman (1983), Iwańska (1995), for fairly representative formal-semantic approaches to adjectives in general and the attributive/predicative distinction in particular. Interestingly, both of these logical approaches easily extend their view on the adjectives to the phenomenon of modification in general--see, for instance, Stalnaker and Thomason (1973), Bartsch (1976), Cresswell (1985), Davidson (1985), Parsons (1972, 1980, 1985). The idea that the relation of modification that holds between noun as head and adjective as modifier is a particular case of the general relation of modification which holds between words of a higher rank and words of a lower 'rank' (nouns and adjectives, verbs and adverbs, and adjectives and adverbs) can be found in the more traditional schools of linguistic thought as well--see, for instance, Hjelmslev (1928), Jespersen (1929), Lyons (1977), van Schooneveld (1969), Howden (1979). We will adopt this position as well.

1.5 Relative Adjectives

It was Bally, again, who contributed seriously to the more traditional treatment of the predicativeness/nonpredicativeness distinction in the French scholarship. There, the distinction is referred to in terms of the relational, or relative, or denominal, adjectives for the nonpredicating category and the qualitative adjectives for the predicating (and gradable) ones--see, for instance, Bally (1944, especially, 96-97 and 207), Arnauld and Lancelot (1660), Marchand (1966), Kalik (1967), Ljung (1970), Bartning (1976, 1976/1980), Picabia (1976), Tamba-Mecz (1980), Hietbrinck (1985), Bosredon (1988), Leitzke (1989), Mélis-Puchulu (1991, 1993), Bartning and Noailly (1993), Maurel (1993). The same terms, 'relative' and 'qualitative,' are standard in Russian and many other language-specific grammars--see, for instance, Vinogradov (1947), Pavlov (1960), Grechko (1962), Trofimov (1972), Katlinskaya (1977), Vol'f (1978), Shramm (1979), Kim (1986). This tradition

does accept as a dogma what Levi so painstakingly proves, namely that "relative adjectives [are] derivatives of nouns" (Bally 1944: 207).

It is easy to understand why the French, Russian, and other Continental scholars have paid more attention to the relative adjectives than their colleagues dealing with English: there are rather few truly relative adjectives in English, and the term is basically unfamiliar to English grammarians because much, if not most of what relative adjectives do in other languages is done in English by nouns preceding other nouns (see also Section 1.9 below). Unlike in the Continental and many other languages, the English morphology does not provide most adjectives with a specific morphological profile, distinct from that of the nouns, and that makes this syntactic arrangement possible.

In spite of all of this attention to the relative adjectives outside of the realm of English grammar, the nature and typology of the relations between their meanings and those of the nouns they are derived from remain rather unclear. Maurel (1993: 23-24), looking for something more specific than Mélis-Puchulu's (1991: 37) defining statement in (23) and attempting to define some more specific relations, such as (24i) or (24ii), discovers that these leave many other cases uncovered, and so he settles on (25), which is even less informative than (23). (RA is, of course, 'relative adjective,' and N is the noun it is derived from.)

(23) *artériel* /*arterial*/: that which is related to *artère* /*artery*/
(24) (i) [meaning of] RA = 'typical of N'
(ii) [meaning of] RA = 'whose part N is remarkable for its dimensions, its number'
(25) [meaning of] RA = the adjective corresponding to N

1.6 Relative/Qualitative Adjectives

Even if most of what is known about the relative adjectives is negative properties (nonpredicating, nongradable, nonnominalizable) a considerable amount of attention has been paid to those adjectives which can function both as relative and qualitative, thus alternating between the nonpredicating and predicating syntactic behavior and changing their meaning in the process (see (8ii) in Section 1.4 above). Quirk *et al*. (1985: 435-436) characterized this meaning shift as that from the "inherent" meaning of the ambiguous adjective to the "noninherent" one. A reasonable interpretation of inherence/noninherence on the basis of their example (see (2v) in Section 1.2 above) is the shift from a physical property to an extended or metaphorical nonphysical one--at the very least, this is apparently the largest and most obvious case of this dichotomy (and, not so incidentally, the main, if only implicit tenet of Lakoff and Johnson 1980).

For the Montegovians (Siegel 1976a, Larson 1995--see examples (16)-(20)), the shift from the predicating use to the non-predicating use is the shift from the extensional meaning to the intensional one, and they are aware of a number of adjectives which admit both and thus are extensionally/intensionally ambiguous, exactly as *beautiful* is in (16)-(17). Considerations like these made a Russian scholar question the very distinction between the relative and qualitative adjectives (Trofimov 1972). Taylor (1992: 1) applies the cognitive-grammar Langacker-type (1987) analysis to the adjective *old* (cf. Bouillon and Viegas's 1994 analysis of the French adjective *vieux* and its relation to the Spanish *viejo* and *antiguo*), which, according to him, has one absolute (intersective, predicating) and three synthetic (nonintersective. nonpredicating) meanings, as shown in (26i-iv),

respectively.

(26) (i) old man (age: absolute)
(ii) old friend ('of long standing': synthetic 1)
(iii) old girlfriend ('former': synthetic 2)
(iv) old regime ('no longer existing': synthetic 3)

While all of the above works deal with the shifting adjectives more or less in passing, Bartning and Noailly (1993: 27) is devoted specifically to "these [denominal or relational] adjectives [which], parallel to their relational interpretation, give way to a qualitative analysis, with, in some cases, a clear binary distinction between the two different usages, and, in others, a continuum of the sense, which renders the description very delicate." The work is based on Bartning (1976, 1976/1980), which postulated the existence of the "PA [pseudoadjective] doubles, thus introducing this class of adjectives with a mixed status: sometimes relational and at other times qualitative" (Bartning 1976: 270). Bartning and Noailly's analysis (*op.cit*: 28-31) of five specific French adjectives of this mixed status, *maternel*, *sympathique*, *sulphureux*, *civil*, and *populaire* (see (27i-v), respectively), remains one of the few examples of somewhat detailed semantic analysis of actual adjectival material in the literature, but it is, unfortunately, limited to a search for historical evidence and attribution of the emergence of the qualitative meaning out of the original relational meaning. (27) is a presentation of what it would have looked like if presented synchronically.

(27)	Relational, Nonpredicating	Qualitative, Predicating
(i)	langue maternelle	soin maternel
(ii)	poudre sympathique	qualité sympathique
(iii)	bouillon sulphureux	charme sulphureux
(iv)	mariage civil	ton civil
(v)	republique populaire	chançonnier populaire

1.7 Adjective Order

The distinction between the relative and qualitative adjective, time-stability, and inherence/noninherence are some of the factors that have been used at various times to try and explain the pretty rigid order among multiple adjectives modifying the same noun, an order that, in English, makes (28i), but not (28ii-vi), well formed.

(28) (i) good old wooden house
(ii) *good wooden old house
(iii) *old good wooden house
(iv) *old wooden good house
(v) *wooden good old house
(vi) *wooden old good house

Dixon (1982: 24) adds the eighth category of 'logic' adjectives to his seven-category taxonomy in (3) in Section 1.3 above and produces a rigid rule for the order of adjectives in English (29) (cf. Frawley 1992: 482, fig. 10.6):

(29) Logic > Value > Dimension > Physical Property > Speed > Human Propensity > Age > Color

Apparently, (29) leaves out relative adjectives because it accounts only for the qualitative ones in (28), but it does account for such long--and rare--sequences as (30) (cf. Frawley 1992: 482, ex. 42a):

(30) five good long smooth old brown [wooden] tables

Quirk and Greenbaum (1973) and Quirk *et al*. (1985: 437) believe that the more inherent the adjective meaning the closer the adjective's position to the noun. Hoepelman (1983) attempts to deal with the adjective order on formal-logical grounds. Vendler (1968) relies, of course, on the order of transformations deriving the nominal phrase for the order of adjectives (121-134); and Katz (1972: 766) goes even further than Vendler, saying, somewhat cryptically, that: "[i]t is clear on other grounds that the ordering of adjectives is a semantically irrelevant syntactic feature... [because] the only syntactic properties that are semantically relevant are those which determine the grammatical relations within a sentence."

In a sense, Seiler (1978), who attempts to explain the adjective order in terms of the scope of the modifiers in their relation to the domain they modify, synthesizes both the syntactic considerations of Vendler and Katz and the formal-logic motivation of Hoepelman. Hetzron (1978), on the other hand, seems closer to Quirk and Greenbaum (1973) and Quirk *et al.* (1985) and Bache (1978). The latter tries to account for the order of adjectives in terms of the subjectivity and objectivity of the meanings expressed by them: evaluative adjectives, which are the most subjective, take a more remote place than such objective meanings as size or color.

Frawley (1992: 483-486) finds evidence that the hypotheses proposed for English do not really hold well for other languages. There are additional problems in other languages as well. Thus, French, for which the postposition of the adjective is usual and unmarked, can use adjectives prepositively as well, and this marked word order may change the meaning of the transposed adjective, formalize the style, or add an evaluative nuance (cf. Bally 1944: 232, 234). Whaley (1995) provides similar observations about the pre- and postnominal positions of the adjective in Hellenistic Greek. The appositional use of adjectives, possible in English and many other languages, often with oblique modifiers to the adjective, is yet another word-order aspect of its use (Giatigny 1966, Forsgren 1993, Bernstein 1995).

While we have discussed all the principal approaches to the issue of adjective order that are of some significance to us, there is a vast literature on the subject. Most of it does not question the importance of the issue and, thus, often leaves it unclear what exactly can be gained by expanding our knowledge of it at a seemingly significant expense--see Bache 1978, Danks and Gluckberg 1971, Danks and Schwenk 1972, Ferris 1993, Goyvaerts 1968, Lord 1970, Martin 1969a,b, and 1970, Ney 1981, Sproat and Shih 1988, Waugh 1976. Besides Quirk et al (1985), such grammar compendiums as Dirven (1989: Chapter III) and Halliday (1985: Chapter 6) as well as numerous others touch on adjective order as well.

1.8 Qualitative (Gradable) Adjectives: Degrees of Comparison, Scales

As the example of Dixon's position on adjective order in (29) illustrates, scholars often ignore relative adjectives in their writings on the category (cf. Lewis 1972: 10), especially in English, where relative adjectives are so few. In general, much more has been written, in and on any language, about qualitative (gradable, scalar, predicating) adjectives *per se*. Two issues definitely stand out

in the literature: the degrees of comparison of the gradable adjectives is the dominant one; the concept of the scale is the other issue, and it will prove to be more pertinent to our work.

A sticky issue for some formal semanticists (see, for instance, Hoepelman 1983), the degrees of comparison have been looked at, somewhat inconclusively, from the point of view of their relations with presuppositions (Kiefer 1978) and classified at length on quasi-logical principles (Rusiecki 1985). The morphology and syntax of comparative adjectives are typically researched more than their semantics--see, for instance, Lees (1961), Bolinger (1967b, 1972), Grundt (1970), Ultan (1972), Bresnan (1973), Hankamer (1973), Gnutzman (1974), Boguslawski (1975), Cygan (1975), Topolinska (1975), Entich (1975), Kamp (1975), Rivara 1975, Post 1981, Klein 1982, Pinkham 1982, Noailly 1993).

The meaning of the positive, noncomparative adjective, such as *good* and *big*, in its relation to its comparative degree has been puzzled over--at least since Sapir wrote in a seminal essay, "It is very important to realize that psychologically all comparatives are primary in relation to their corresponding absolutes ('positives')" (1944: 125). Lyons forcefully supports this thesis: "Rather less obvious is the fact that the use of a gradable antonym always involves grading, implicitly if not explicitly. This was stressed by Sapir (1944), who seems to have been the first linguist to employ the term 'grading' in this sense" (Lyons 1977: 273-274), and, Lyons points out, "[t]he point Sapir was making is well known to logicians and goes back at least as far as Aristotle (cf. Categories 56)" (*op.cit*: 274, fn. 4). This thesis suggests the analysis of a positive adjective *tall* in (31i) as (31ii):

(31) (i) John is a tall man.
(ii) John is taller than an average man.

Following Sapir again, Lyons (1977: 270-272) makes a popular distinction between two major kinds of scales involved in the meaning of the gradable adjectives: the continuous scale, such as *good*/*bad*, corresponding to the gradable antonyms, that he calls the "contraries," and the discreet, bipolar scale, such as *dead*/*alive*, corresponding to the complementary antonyms that he calls the "contradictories"--cf. the discussion in Section 1.4 above of Levi's (9ii) and the references there as well as Kiefer (1978), Gross *et al*. (1989). Scales have been often mentioned, at least casually, in the literature on adjectives--see, for instance, Aarts (1976, especially 41-42), Rivara (1993). They play an important part in Miller's and his associates' view of the adjectives as dominated by antonym pairs and their synonyms, a vision that lies in the foundation of their valuable online resource WordNet--see, for instance, Miller *et al*. (1988), Charles and Miller (1989), Gross *et al*. (1989), Miller and Fellbaum (1991), Beckwith *et al*. (1991).

An interesting property of some scales is their asymmetry--see Sapir (1944: 132-133), Bierwisch (1967). Rusiecki's (1985: 7) example of asymmetry is the *dry*/*wet* scale, with the *dry* end of it bound, as it were, and the *wet* end open: one can get wetter and wetter and one cannot achieve absolute wetness but one can achieve absolute dryness[3]. Somewhat related to the asymmetry is the category of the markedness/unmarkedness of antonyms--see, for instance, Bierwisch (1967), Givón (1984), Rusiecki (1985), Miller and Fellbaum (1991). Thus, in the *long*/*short* pair of gradable antonyms, *long* is unmarked (and *short* is marked) by the fact, according to Miller and Fellbaum (1991: 212-213)--and Bierwisch (1967)--that one can say (32i) but not (32ii)--at least, not in the same meaning:

[3] Again, more so in language than in reality.

(32) (i) The train was ten cars long.
(ii) *The train was ten cars short

Givón (1984: 73) establishes a similar relationship between the unmarked *tall* and marked *short* with the help of a pair of specific questions and suitable answers (33i-ii) (his 42a,b) to those questions. Here again, the unmarked member of the opposition may be used in a situation when the object in question can be characterized both in terms of that member and in terms of its opposite, while the marked member in the question can only solicit a confirmation or a modification of itself in the response.

(33) (i) Question (positive): How tall is she?
(i) Very tall.
(ii) Very short.
(ii) Question (negative): How short is she?
(i) ?Very tall.
(ii) Very short.

Following van Schooneveld (1969) and Waugh (1977) into a different approach to the same phenomenon, Howden (1979: 79-80) claims about the French synonyms *neuf/nouveau /new/* that "*neuf* is the unmarked member of the opposition *neuf*/*nouveau* in that, while both convey the notion of recentness, *nouveau* is marked, in addition, for a feature which communicates the presupposition of a point of comparison," as in (34) (op.cit.: 85--cf. Wey 1848).

(34) J'ai une nouvelle voiture, mais elle n'est pas neuve. /I have a new (to me) car, but it is not new (it is a used car)./

1.9 Substantivization and Adjectivization

Yet another connection between the nouns and adjectives has been given some attention, namely, the traffic between the two categories. In English, of course, a noun before another noun is easily used as an adjective. An adjective can lose the modified noun and this way turn into a noun itself, for instance, the second occurrence of *tough* in (34a).

(34a) When the going gets tough, the tough get going

In other languages, because of their morphology, such traffic is less possible. In French, for instance, a noun cannot be used adjectivally without a preposition, but an adjective can still be substantivized--see, for instance, Bally (1909: 305); Howden (1979), Landheer and Szirmai (1988), Noailly (1993).

1.10 Semantic and Computational Treatment of Adjectives: New Trends

The literature on adjectives shows a predictable scarcity of systematic semantic analyses or lexicographic descriptions of adjectives. The quantifier adjectives, being the closest natural language comes to formal logic, have been privileged in this respect--see, for instance, Jackendoff (1983), McCawley (1988: 594-630), Chierchia and McConnell-Ginet (1990: 406-430), Swart (1991), Frawley (1992: 464-480). The second luckiest category is adjectives of measure, especially spatial, and, to a lesser degree, temporal, which are also seen as being more logically structured (see Bier-

wisch 1967, 1989, Greimas 1966, Teller 1969, Zhurinskiy 1971, Dowty 1972, Siegel 1976a: 107-149 and 1979, Spang-Hanssen 1990, Spejewski 1995, and others).

Obviously, the semantic analysis of adjectives shares many problems with the semantic analysis of anything in natural language. One specific problem, noted by very few scholars, is what Marx (1983--see also Marx 1977 and Szalay and Deese 1978) refers to as the "plasticity" of adjectival meaning, namely that the same adjective can emphasize a different property of a noun in a different context. Lahav (1989), working loosely in the Keenan and Faltz (1985) paradigm, presents the same property as the non-compositionality of adjectives. If, he argues, red birds, red houses, and red books mean all different kinds of redness--and they do--how can one derive the meaning of an Adj N combination compositionally from the meaning of the adjective and the noun? In other words, each noun, he believes, influences the meaning of the adjective. Katz (1972: 752), analyzing the meaning of *good*, is virtually the only author to have come up with a specific, even if definitely not complete account of how this works. Certain classes of nouns, he asserts, offer specific properties for *good* to work on:

> "[t]he respects in which evaluations of things can be made differ with differences in the other semantic features of the words that refer to those things." (Artifact) permits evaluation of uses; (Component of a system) functions; (Role) duties; (Ornamentation) purposes; (Food) pleasurability and healthfulness; there are many others."

This situation, in which semantic analyses and lexicographic descriptions of adjectives (and other categories) are rare, is bound to change rapidly. As computational semantics moves to large-scale systems serving non-toy domains, the need for large lexicons with entries of all lexical categories in them is becoming increasingly acute, and the attention of computational semanticists and lexicographers is turning more towards such previously neglected or avoided categories as the adjectives. Recently, there have appeared some first indications of this attention--see, for instance, Smadja (1991), Beckwith *et al*. (1991), Bouillon and Viegas (1994), Justeson and Katz (1991, 1995), Pustejovsky (1995: 20-23). This research is a step in the same direction.

2. The Ontology-Based Semantics and Lexicology of the Adjective

In this section, we briefly review the basis of our approach to adjectival meaning, illustrate it on the example of an adjectival lexicon entry, and discuss the issues we raised in the literature on adjectives, as surveyed above.

2.1 The Ontological Approach

As stated in the introduction, our work on adjectives forms a microtheory used by the MikroKosmos semantic analyzer. The architecture of MikroKosmos is described in Onyshkevych and Nirenburg (1994), Beale et al. (1995). The MikroKosmos project is a component of a knowledge-based machine translation system (see Nirenburg *et al*. 1992). The purpose and result of the MikroKosmos analysis process is a rendering of the source language text into an interlingua text. The interlingua language is called the 'text meaning representation' (TMR) language, and the TMR of a text is its representation in this particular type of interlingua. TMRs are realized in a frame-based language, where frame names typically refer to instances of ontological concepts and slots are usually filled with values of properties of those concepts. An ontology is, thus, a necessary prerequisite for building a TMR language.

"An ontology for NLP purposes is a body of knowledge about the world (or a domain) that a) is a

repository of primitive symbols used in meaning representation; b) organizes these symbols in a tangled subsumption hierarchy; and c) further interconnects these symbols using a rich system of semantic and discourse-pragmatic relations defined among the concepts" (Mahesh and Nirenburg 1995: 1). The function of the ontology is to supply "world knowledge to lexical, syntactic, and semantic processes" (ibid).

The lexicon in MikroKosmos "mediates between the TMR and ontology" (Onyshkevych and Nirenburg 1994: 2). Lexicon entries for most open-class lexical items represent word and phrase senses, which can be either directly mapped into ontological concepts or derived by locally (that is, in the lexicon entry itself) modifying constraints on property values of concepts used to specify the meaning of the given lexical item. In the following section, we illustrate the structure of those parts of the lexicon entry in MikroKosmos which bear on the description of adjectival meaning.

2.2 The Ontological Approach to the Meaning of a Typical Adjective

Let us select a simple, typical case of the English adjective for the purposes of illustration. Such an adjective would be a scalar retaining its meaning in both the attributive and predicative use. Our microtheory associates its meaning with a region on a scale which is defined as the range of an ontological property. The contribution that the adjective makes to the construction of a semantic dependency structure (TMR) typically consists of inserting its meaning (a property-value pair) as a slot in a frame representing the meaning of the noun which this adjective syntactically modifies.

Thus, in *big house*, *big* will assign a high value as the filler of the property slot SIZE of the frame for the meaning of *house*. Similarly, in *red house*, *red* will be the filler of the COLOR property slot for the meaning of *house*. The range of SIZE in (35) is a numerical and continuous scale, while the range of COLOR in (36) is literal and discrete.

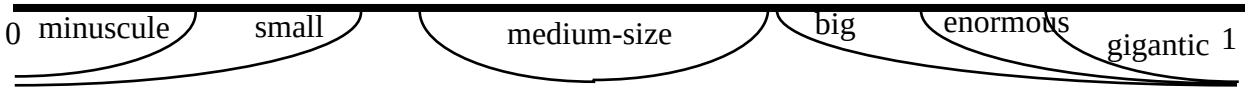
(35)

(36)

SIZE is a SCALAR-PHYSICAL-OBJECT-ATTRIBUTE, with the term 'scalar' used here, as it is customarily, in the sense of 'gradable.' *Big* is, of course, our typical adjective; *red* may be less typical, but it is certainly common, and it is convenient to look at them both together: two for the price of one, as it were. What makes *red* less typical is that its scale is not gradable: COLOR is just a PHYSICAL-OBJECT-ATTRIBUTE, missing the SCALAR attribution, because its scale consists of a finite number of discreet and incomparable entities. Both scales are presented here as properties of physical objects (the concepts are, of course, not ambiguous while the English words *size* and *color* are), which constitute its domain.

Each numerical scale can be measured in actual measuring units, such as LINEAR-SIZE in feet, yards, or millimeters, or TIME in seconds. But often natural language expressions do not refer to absolute magnitudes but rather to abstract relative ones, as in the case of *big*. We assume a 0 to 1 numerical range for such abstract scales. For abstract references to size, the fillers in English can be as shown in (37):

(37)



Big will, then, get something like a '> 0.75' value on the SIZE scale (38) and *red* the 'red' value on the COLOR scale. These values are a crucial part of the lexical mapping (LEX-MAP) included in the semantics (SEM-STRUC) "zone" of their lexical entries. Equally crucial is the syntactic-semantic mapping between the syntactic-structure (SYN-STRUC) and SEM-STRUC zones with the help of special variables (many zones which are actually present in the entries for these adjectives in the MikroKosmos lexicon are omitted from (38)-(39)).

(38) (big
(big-Adj1
(CAT adj)

```
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                ((1 2) (size-attribute
                                        (domain (value ^$var1)
                                                (sem physical-object))
                                        (range    (value (> 0.75))
                                                (relaxable-to (value (> 0.6)))))))))
```

(39)

```
(red
        (red-Adj1
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                ((1 2) (color-attribute
                                        (domain (value ^$var1)
                                                (sem physical-object))
                                        (range    (value    red)))))))))
```

In both (38) and (39), there are two subcategorization patterns, marked 1 and 2, listed in SYN-STRUC. The former pattern corresponds to the attributive use of the two adjectives: the noun they modify is assigned the variable $var1, and the adjective itself the variable $var0 in the modifier position. The latter pattern presents the noun, bound to $var1, in the subject position and the adjective in the predicative position. In the SEM-STRUC zone, instead of variables which are bound to syntactic elements, the meanings of the elements referred to by these variables (and marked by a caret, '^') are used. Thus, ^$var1 reads as "the meaning of the element to which the variable $var1 is bound." Among the constraints listed in the SEM-STRUC zone of an entry, are selectional restrictions (the noun must be a physical object) and relaxation information, which is used for treatment of unexpected ('ill-formed') input during processing.

Thus, an entry like (38) should be read as follows:

- the first line is the head of the superentry for the adjective *big* (in our terminology, an 'entry' is a specification of a single sense, while the 'superentry' is the set of such entries);
- the second line assigns a sense number to the entry within its superentry;
- next, the adjective is assigned to its lexical category;
- the first subcategorization pattern in the SYN-STRUC zone describes the Adj-N construction; the second subcategorization pattern describes the N-Copula-Adj construction;
- the LEX-MAP part of the SEM-STRUC zone defines the lexical semantics of the adjective by assigning it to the class of SIZE adjectives; stating that it is applicable to physical objects and that its meaning is a high-value range on the SIZE scale/property.

In the case of continuous scales, like SIZE, the acquisition of adjectives for the lexicon is greatly facilitated, as all the adjectives of a class served by this scale need only an appropriate range assigned to them, all the rest of the information in the semantic part of the entry being the same.

2.3 The Ontological Approach to Issues in the Syntax and Semantics of Adjectives

Our analysis of adjectives for the MikroKosmos microtheory shows that the taxonomies and the issues important for adjective meaning representation are quite different from the taxonomies and issues debated in the literature. One reason may be that the literature on adjectives is uniformly uninformed by any practical task which would involve the representation and description of adjective meaning. In the rest of this section, we review the issues discussed in Section 1 in the light of the needs of our microtheory. We intend to demonstrate that many of the issues which dominate the literature on adjectives are less significant for adjective meaning determination and representation.

Both adjectives in the examples of the previous section are scalars. The scalar/non-scalar distinction turns out to be more essential than some other distinctions discussed in Section 1 above. Because most scalars are used both attributively and predicatively and because, as shown in (38) and (39), the semantic representation is the same for both usages, this all-important distinction of Section 1 (especially, Section 1.4) plays a minor role in our approach. In other words, differences in the shape of the SEM-STRUC zones of lexicon entries for adjectives are more important for us than differences in syntactic subcategorization patterns, as encoded in the SYN-STRUC zone of the entries.

The concepts of time-stability and dynamicity/staticity of the properties expressed by adjectives and, accordingly, their relations with nominal and verbal entities and meanings (see Section 1.2 above) take a new identity as well. The purely temporal aspect in MikroKosmos is recorded with the meaning of the entire proposition, and adjective entries are not marked for it. Some temporal adjectives, of the kind that Levi presents as derived from adverbs rather than nouns (40--her (1.9) in Levi 1978: 7), are analyzed in a completely different manner because they do not really modify semantically the nouns they modify syntactically--in other words, the temporal meaning of the adjective characterizes the proposition. Thus, *occasional visitor* (40iii) is analyzed as a rhetorical paraphrase of *visit occasionally*. In general, it is very important for MikroKosmos that syntactic dependency by no means predetermines semantic dependency.

(40) (i) former roommate
(ii) early riser
(iii) occasional visitor
(iv) eventual compromise

More interestingly, the issue of the relations between adjectives, on the one hand, and nouns and verbs, on the other, assumes several dimensions. First, there are obviously, adjectives which derive their meanings from nouns. Their entries are, then, essentially noun entries adapted for adjectival use (see Sections 3.3 and 3.4). Similarly, there is a much larger class of event-related adjectives, and their entries are also essentially verb entries adapted for adjectival use (see Section 3.3). The denominal nature of some adjectives is very well-known in literature; the deverbal nature of a large adjective class is not, except perhaps for occasional brief asides on the participles, which constitute a small portion of this class--provided that one decides to include them in it.

In fact, the most crucial taxonomic distinction within the lexical category of adjectives for our approach is the ontology-based distinctions among the:

- **scalar** adjectives, whose meanings are based on property ontological concepts;
- **denominal** adjectives, whose meanings are based on object ontological concepts; and
- **deverbal** adjectives, whose meanings are based on process ontological concepts.

Just about everything pertaining to these three types of adjectives is different:

- their lexical entries look different;
- their meanings are related to different types of other entries
- different types of acquisition methodologies and rules have to be used to generate their entries.

One aspect in which these three types of adjectives do not differ much is their syntax. Our approach fails to confirm the *sine qua non* of much contemporary semantic research, stemming primarily from Chomsky's linguistics but introduced into the study of adjectives early and somewhat independently by Vendler (1963, 1968--see earlier discussion in Section 1.3), that a difference in the syntactic behavior of an adjective automatically assures a significant semantic distinction. The assumption that syntax determines semantics persists, for instance, in Pustejovsky's (1995: 21) claim about the distinctions in the meanings of adjectives like *eager* and *easy* in terms of their well-known syntactic distinction.[4]

While this assumption is intended to be self-evident and informs many contemporary works in, for instance, lexical semantics, we find no support for it either in terms of the acquisition of the entries for these adjectives, nor in the representation of their meanings in these entries. What we find instead is a crucial distinction between a typical deverbal adjective *eager*, whose lexical entry is based on that of the verb *want*, and a typical scalar *easy*, whose entry is based on the scale EASE/DIFFICULTY, a PROPERTY ontological concept. Now, if it turned out that all deverbals behaved transformationally as *eager* and all scalars as *easy*, the assumption would be justified. What happens instead is that there is indeed a small group of deverbals which behave as *eager* and a small group of scalars which behave as *easy*, but the syntactic distinction does not hold for most deverbals or scalars and is irrelevant to them. The syntactic distinction is perfectly real in that it affects, of course, the way the MikroKosmos analyzer assigns the proper slot for each adjective meaning in the TMR of the text which contains them but it does not affect the contents of their meanings. Once again, the distinction will be reflected in the SYN-STRUC zone of the lexical entry but it will nor affect its SEM-STRUC zone.

On the other hand, the fact that *easy* does not modify John while *eager* does is reliably captured in the SEM-STRUC zone of their respective entries by assigning ^$var1, the meaning of the noun each adjective does modify to the appropriate ontological concept. In the case of *eager*, it is the agent of an event; in the case of *easy*, it is an event.

Interestingly related both to the existence of denominal and deverbal adjectives and to the assumption of the primacy of syntax over semantics, there is a class of nouns and verbs, whose lexical entries are essentially adjective entries adapted for nominal or verbal use, respectively, e.g., *redness* or *redden* from *red*. It is notable that the verb is semantically adjective-derived in both of its senses, reflexive and non-reflexive. In order to represent the meaning of *redden*, we use a generic event CHANGE-IN-QUALITY, so that the entry for *redden* reads something like "change in quality from less red to more red." Clearly, the syntactic behaviors of these verbs and nouns is different from those of the related adjectives but their meanings are not. And like the related adjectives, these nouns and verbs have meanings which are based on scales, which are PROPERTY ontological concepts, and not on OBJECT and PROCESS ontological concepts as most noun and verb meanings are based, respec-

[4] *John is eager to please* transforms into something like *John pleases eagerly,* while *John is easy to please* transforms instead into something like *It is easy to please John*.

tively.

The gradable/ungradable distinction of Section 1 (see especially Section 1.8 above) retains its significance. Gradable adjectives are for us a large subset of all adjectives, which cut across all the three categories of adjectives. Ungradable adjectives also consist of subsets of scalars (*male*), denominals (*wooden*), and deverbals (*ablaze*): neither *male* nor *wooden* nor *ablaze*, technically, should allow for degrees of comparison, at least not without a meaning shift. It is a fact, however, that such meaning shifts are not too hard to make, thus rendering the trait of gradability potentially nearly universal within the lexical category. The terms 'scalar' and 'gradable' are often confused in the literature because, of course, the most typically gradable adjectives are scalars. There is no confusion between these terms for us: the scalar adjectives are, of course, those whose meanings are based on scale-type PROPERTY ontological concepts, while gradable adjectives are those which can be used comparatively. There are scalars which are not gradable, and there are gradables which are not scalars. Sometimes, gradable scalars are referred to as 'true scalars,' and gradable non-scalars as 'non-true-scalars,' but we will try to avoid these terms if we can help it.

The use of continuous scales for representing scalar adjectives eliminates complications, discussed in Section 1.8, associated with the representation of comparative degrees. Whether it is a straightforward morphological comparative (41i) or superlative (41ii) degree, the use of an adjective, such as *very* (42i) or *not very* (*hardly*, *barely*) (42ii), or the use of a different adjective from the same scale (43i-ii), comparison is simply a matter of assigning one or more values on the same scale, and it is very simple to handle within the approach.

(41) (i) Don's house is bigger than my house.
(ii) Don's house is the biggest among his siblings.
(42) (i) Don's house is very big.
(ii) Don's house is not very big.
(43) (i) Don's house is gigantic.
(ii) Don's house in minuscule.

For straightforward comparatives like those in (41i), we use a quantification relation to establish that the value for one property on the same scale is 'less than' or 'greater than' the value for the other, as shown in (44). In the SYN-STRUC zone of the lexicon entry in (44), two noun variables, $var1 and $var2, are introduced for the nouns with the designated property instead of the usual one: $var1 stands, of course, for the first occurrence of *house* in *Don's house* and $var2 for the second occurrence of *house* in *my house*. The meaning specification simply states a 'greater than' relation between ^$var1 and ^$var2, that is, between *Don's house* and *my house*.

```
(44)  (bigger
          (bigger-adj1
              (CAT adj)
              (SYN-STRUC
                  ((root $var0)
                      (cat adj-comp)
                      (subj ((root $var1)
                      (conj ((root +than-conj1)
                      (obj ((root $var2)
                          (cat n)))))))
              (SEM-STRUC
                  (LEX-MAP
                      (quantifier-rel
                          (quant          >)
                          (arg1           ^$var1.size-attribute.range)
                          (arg2           ^$var2.size-attribute.range))))))
```

A similar quantitative relation can be extended to non-scalar gradables, but its arguments look somewhat different. It is important to note that the intrinsically comparative nature of positive adjectives, as noted by Sapir (1944) and Lyons (1977) (see Section 1.6 above) is underscored by their values on the appropriate scales which are indeed higher than the average value. Our approach makes it equally clear that the same can be stated about such "negative" adjectives as *bad* or *small*.

The MikroKosmos approach cannot, of course, statically disambiguate between the intersective/ nonintersective adjectival meanings in sentences like (16) in Section 1.4 above. Two distinct candidate readings will be produced and disambiguation will be attempted, based on context parameters. If Olga is beautiful (and a dancer) the representation of this intersective use will be adjectival for *beautiful*, exactly as per the second SYN-STRUC in (38) above; if, on the other hand, the intended usage is nonintersective, the sentence is represented essentially as *Olga dances beautifully*.

When a relative adjective, which is supposed to be nonpredicating (see Sections 1.4-6 above) is used predicatively, its meaning is shifted so that it becomes qualitative. Here also, the syntactic feature of nonpredicativeness is replaced by a new and more reliable semantic feature of denominalness, that is, having the lexical entry based on an OBJECT ontological concept. The susceptibility of literally any such nonpredicating adjective to a shift of meaning which makes it into a predicating adjective is accounted for, again purely and reliably semantically, by postulating an additional and totally different, non-OBJECT-based meaning for such an adjective in its predicative usage. Thus, the entry for *provincial* (8ii-a) in the sense of 'of a province' is derived from the entry for the noun *province* (see Section 3.4 below); *provincial* in the sense of 'of restricted interests or outlook,' gets a meaning based on a scale, e.g., SOPHISTICATION (see also (46-47), (49), and (65) below).

The order of adjectives modifying a noun (see Section 1.7 above) is irrelevant for the purposes of analysis but important in generation. Obviously, the rules governing the order are those of the target language, and, as we saw in Section 1.7 above, these rules are not exactly language-independent. It is, however, believed that the least "inherent," or the least "objective" adjectives take the most remote position from the noun they modify. Evaluative adjectives qualify for this distinction, and it is significant that, within the MikroKosmos approach, they are explicitly represented not as modifying any property of the noun but rather as expressing an attitude about it (45).

(45)
```
(good
    (good-Adj1
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (attitude
                    (type               evaluative)
                    (attitude-value (value (> 0.75))
                        (relaxable-to (value (> 0.6))))
                    (scope              ^$var1)
                    (attributed-to      *speaker*))))))
```

We believe that it is in this sense that the meanings of some adjectives are non-compositional rather than the range of phenomena Lahav (1989) designated by this term (see Section 1.10 above).

Marx's (1983) term 'plasticity' seems to be more appropriate to designate Lahav's 'non-compositionality,' that is, the fact that the meaning of an adjective shifts with the meaning of the noun it modifies, depending on what property of that noun the adjective pertains to. An adjective meaning is non-compositional in our sense if it deviates from the usual adjectival meaning function of highlighting a property of the noun the adjective modifies and--in a typical case--assigning a value to it. Non-compositional adjectives, besides the evaluative ones, are also temporal adjectives (see (40) above) and those of Vendler's classes A_5-A_8 of adjectives that "ascribe the adjective... to a whole sentence," and a few others.

In summary, we discovered that developing adjective semantics for an application modifies many popular views on the subject. It becomes clear, for instance, that:

- many adjectives do not modify semantically the nouns that they modify syntactically;
- adjectival (attributive) meanings may be delivered by other parts of speech, and thus the semantics of adjectives only partially reflects their possible syntactic distinctions;
- more generally, the syntactic behavior of an adjective does not determine its lexical meaning, even as it may, in some cases, modify the processing of this meaning by the analyzer;
- the major distinction among adjectives is scalar vs. denominal vs. deverbal;
- the attributive/predicative distinction, dominating the current scholarship on the adjective, has virtually no semantic significance, thus essentially crushing any hope to derive meaning from deep syntactic analysis;
- there is a significant gap in our knowledge about relations between truly relative adjectives (as well as nominal modifiers in English) and the nouns they modify;
- the typology of scales for scalars, i.e., those adjectives whose meanings cannot be reduced to the more ontologically acceptable verb and noun meanings, emerges as a major issue in adjective semantics and lexicography;
- it is efficient and more reliable to establish semantic distinctions among adjectives in terms of semantic features rather than as reflections of various syntactic distinctions, which are popular in the literature.

3. Description of Adjective Meaning in English

3.1 Classes and Subclasses of Adjectives

Our assumption is that the lexicon is the locus of the microtheory of adjectival meaning in Mikro-Kosmos. Our earlier work on verbs and nouns --see, for instance, Carlson and Nirenburg (1990), Meyer *et al*. (1990), and Nirenburg and Defrise (1991) have yielded *de facto*, implicit microtheories which allowed for the mass acquisition of entries for these lexical categories. Since little had been done on adjectives, they were a clear choice for an explicit microtheory.

The effort on building a microtheory of adjectives started with corpus analysis. The initial corpus of English adjectives was obtained by intersecting all the adjectives in the **Longman's Dictionary of Contemporary English** (LDOCE) with the full texts of *The Wall Street Journal* (WSJ) for 1987-89. The resulting list was manually divided into scalars and non-scalars. The adjectives were then cross-divided into gradables and non-gradables, with the former being qualitative adjectives with full comparison possibilities and the latter being those ambiguous relative/qualitative adjectives that were discussed in Sections 1.6 and 2.3. The non-scalars were divided into three subclasses: proper names, event-related adjectives, whose entries were to be derived from the

corresponding verb entries, and truly-relative adjectives, whose meanings were to be derived from the corresponding nominal entries.

While *big* (38) or *red* (39) are typical--and different--scalars, gradable non-scalars are relative adjectives, which can be used comparatively when used in a qualitative sense. Thus, in (46i), *administrative decision* means a decision by the (appropriate) administration. In (46ii), *administrative style* means something like the style typical of administrators. It is interesting to note, in passing, that contrary to the arguments quoted in Section 1.6 above, the adjective can be used, *albeit* marginally, in a predicative position as well without a change of meaning, e.g., (47).

(46) (i) The resettlement awaits an administrative decision.
(ii) His style is more administrative than hers.
(47) The decision the resettlement awaits is administrative.

The (intersecting) subclasses, their numerical strengths, and typical examples are summarized in (48);

(48) Classes and Subclasses Statistics and Examples:

Categories	Number in Corpus	Examples
All adjectives	6183	ablaze, administrative, aeronautical, African, big, red
Gradable adjectives	3636	big, red, administrative
Scalar gradables	3038	big, red
Non-scalar gradables	598	administrative
Non-scalar adjectives	2547	African, ablaze, aeronautical
Proper non-scalars	151	African
Event-related non-scalars	1979	ablaze
True relative non-scalars	417	aeronautical

As we mentioned earlier and will illustrate in Section 3.4, the so-called true relative adjectives (denominals) turn out to be not so “true” up close. A true relative adjective cannot be used predicatively and or comparatively, but it is hard to come up with an example which is guaranteed against that. After all, (49i-ii) are not really ill-formed, and it is hard to imagine a more truly-relative adjective than *aeronautical* ‘related to aeronautics.’

(49) (i) His approach to the problem was aeronautical.
(ii) His approach to the problem was much more aeronautical than mine.

Clearly, a productive semantic process takes place here, probably along the lines of (50), and, therefore, a dynamic rule exists which creates adjective entries for these predicating, pseudo-sca-

lar, pseudo-qualitative senses of the seemingly perfectly relative adjectives. Their one telling difference from the truly qualitative, predicating, scalar adjectives is that the relative adjectives cannot make the qualitative shift in the attributive position.

(50) Pertaining to [noun meaning] ---> Characteristic of [noun meaning]

The difficulty of finding a relative adjective which would be absolutely resistant to a predicative shift of meaning is similar to the difficulties Katz (1964: 753) had, looking for a noun which could never be used with *good*.

3.2 Elements of (Practical) Methodology

Our lexicographic effort concentrated on the most numerous class of English adjectives, gradable adjectives. This is a computational-linguistic perspective, which is the opposite of the typical theoretical-linguistic approach to any problem, which calls for the lion's share of attention to be devoted to exceptional, borderline cases (see Introduction above). Theoretical linguists tacitly assume that the general cases are self-evident and do not require any special work. A good example of that is the attention to the mixed, relative/qualitative class of adjectives (see Sections 1.4-6 above), while the general rules concerning either the true qualitative adjectives or, especially, true relative adjectives have never been formulated explicitly enough to be of much use for lexicographic description. The focus of our approach is the representation of large numbers of "ordinary" cases.

Polysemous or homonymous adjectives were handled one sense, not one word, at a time. Obviously, it is not really possible to delimit a single sense without a general view of what the other senses are, but this is part of a more general issue of how we capture lexical meaning. Let us explain our method on an example. For the notoriously difficult adjective *good* (see, for instance, Ziff 1960, Vendler 1963, Katz 1972--see also Section 4), we start with its general, unspecified, and unrestricted evaluative meaning (45). This gives us several advantages. First, by taking care of *good* (45), we facilitate the acquisition of all adjectives whose meanings relate to the same evaluative scale, such as *bad*, *excellent*, *terrible*, *mediocre*, etc. Practically, it means the creation of a template, which is copied for each new adjective. The entries for all the adjectives of this class may differ only in range values (51) and constraints on the category of nouns which these adjectives modify (52).

(51)
```
(excellent
        (excellent-Adj1
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2 ((root $var0)
                                 (cat adj)
                                 (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (attitude
                                        (type                   evaluative)
                                        (attitude-value (value (> 0.9))
                                                (relaxable-to (value (> 0.8))))
                                        (scope                  ^$var1)
                                        (attributed-to          *speaker*))))))
```

(52)
```
(comfortable
        (comfortable-Adj1
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2 ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (^$var1
                                        (instance-of (sem (OR (furniture clothing))))
                                (attitude
                                        (type                   evaluative)
                                        (attitude-value (value (> 0.75)
                                                (relaxable-to (value (> 0.6))))
                                        (scope                  ^$var1)
                                        (attributed-to          *speaker*)))))))
```

Second, this approach maximizes the use of each type of lexical entry and, by the same token, of the ontological material it is based upon (ontological concepts, facets, etc.) and thus contributes significantly to the parsimony of the ontology, an important concern. Third, it makes uses of synonymy, antonymy, and other paradigmatic relations among words to generate lists of adjectives that can be acquired using a given lexical entry template. Availability of thesauri and similar online resources facilitates this method of acquisition.

Finally and perhaps most importantly, the judicious selection of an entry template and an ontological scale facilitates the acquisition of adjective entries across languages. The single word senses acquired in this fashion are, essentially, language-independent, as our work on Spanish has confirmed.

Obviously, this one-sense-at-a-time, maximum concept utilization approach has yielded quite a few pairs, triples, etc., of senses of the same English adjective, but we assembled them into "super-entries" much later. Thus, *great-1* (53i) is an evaluative sense of *great* and *great-2* (53ii) is its importance sense (note that the latter is treated as an attitude just like evaluative adjectives such as *good* and pretty much for the same reasons--see also Sections 3.3 and 4.3.2 below).

(53) (i)
```
(great
        (great-Adj1
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
        (SEM-STRUC
                (LEX-MAP
                        (attitude
                                (type                   evaluative)
                                (attitude-value (value (> 0.9))
                                        (relaxable-to (value (> 0.8))))
                                (scope                  ^$var1)
                                (attributed-to          *speaker*))))))
```

(ii)
```
(great
        (great-Adj2
                (CAT    adj)
```

```
(SYN-STRUC
        (1 ((root $var1)
            (cat n)
            (mods ((root $var0)))))
        (2  ((root $var0)
            (cat adj)
            (subj ((root $var1)
                (cat n))))))
(SEM-STRUC
        (LEX-MAP
            (attitude
                (type               salience)
                (attitude-value (value (> 0.75)))
                (scope              ^$var1)
                (attributed-to      *speaker*)))))
```

We found it useful to identify large classes of gradable scalars and check out their homogeneity in terms of the type of lexical entries each class utilizes. In case some heterogeneity is detected in the process of representation, an adjective can be moved to another class. This rough classification is discussed in the next section.

3.3 Classes of English Adjectives and Their Representation

Besides scalars, this section deals with adjectives whose meanings derive from meanings of verbs.

3.3.1 Scalar Subclasses and Their Representation

The quick and dirty non-exhaustive first-run classification of scalars produced the following results.

(54) Rough taxonomy of true scalars

Subclass	Number in Corpus	Basis/Explanation	Examples
Attitude-based	116	Evaluation, salience	good, superb, important
Numerical scale	318	Size, weight, price, age and other measurements	big, heavy, forte, pricey, opulent, ripe, young
Literal Scale	23	Color, shape, orientation, direction, etc.	red, magenta, oval, front, backward
Member	85	Set membership	authentic, fake, similar

We will now comment on each of the four above classes. The membership class was somewhat of a surprise because it had been largely ignored in the literature (we will defer for now its rather complex version of scalarity). There had been a sporadic interest in the adjective *fake* (see Iwańska 1995--cf. Raskin 1981) because it clearly violated the simplistic subset-forming notion of adjective meaning (see, for instance, Strawson 1959: 168; Riegel 1993: 5-10; Iwańska 1995), such that red houses are a subset of all houses; intersective meaning (see Section 1.4 above) is, of course, a sub-

set-forming meaning as well. But there are many other adjectives which use exactly the same type of lexical entry, and their similarity to each other and to *fake* had not been noticed before.

Attitude-based adjectives can be illustrated by lexical entries for evaluative adjectives *good* (45), *excellent* (51), and *comfortable* (52), and salience-related adjectives important (55) and *great-2* (53ii).

(55)
```
(important
    (important-Adj2
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (attitude
                    (type                salience)
                    (attitude-value (value (> 0.75)))
                    (scope               ^$var1)
                    (attributed-to       *speaker*))))))
```

Adjectives of the **numerical scale** class are interpreted using values for ontological properties which are relevant to the of nouns these adjectives modify, such as SIZE (38, 56), PRICE (57), QUANTITY (58) or AGE (59i -ii).

(56)
```
(buxom
    (buxom-Adj2
        (CAT adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (^$var1
                    (instance-of (sem (human)))
                    (gender              female)
                    (has-as-part         refsem1
                (refsem1
                    (instance-of (sem breast)))
                 ((1 2) (size-attribute
                    (domain (value refsem1))
                    (range    (value (> 0.75)))))))))
```

(57)
```
(pricey
    (pricey-Adj2
        (CAT adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                (cat n))))))
        (SEM-STRUC
            (LEX-MAP
```

```
                                ((1 2) (cost-attribute
                                        (domain (value ^$var1)
                                                (sem commodity))
                                        (range    (sem > 0.75))))))))
(58)  (plentiful
        (plentiful-Adj2
          (CAT adj)
          (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                        (cat n))))))
          (SEM-STRUC
            (LEX-MAP
                ((1 2) (quantity-attribute
                        (domain (value ^$var1)
                                (sem commodity)))
                        (range    (sem > 0.75)))))))
```

Most numerical scalars allow for absolute and relative values, as illustrated for the scale of age using the senses of the adjective *old*.

```
(59)  (i)   (old
              (old-Adj1
                (CAT    adj)
                (SYN-STRUC
                  (1 ((root $var1)
                      (cat n)
                      (mods ((root $var0)))))
                  (2   ((root $var0)
                      (cat adj)
                      (subj ((root $var1)
                              (cat n))))))
                (SEM-STRUC
                  (LEX-MAP
                      ((1 2) (age-attribute
                              (domain (value ^$var1)
                                      (sem human))
                              (range    (value (> 0.75)))))))))
      (ii)  (old
              (old-Adj1
                (CAT    adj)
                (SYN-STRUC
                  (1 ((root $var1)
                      (cat n)
                      (mods ((root $var0)))))
                  (2   ((root $var0)
                      (cat adj)
                      (subj ((root $var1)
                              (cat n))))))
                (SEM-STRUC
                  (LEX-MAP
                      ((1 2) (age-attribute
                              (domain (value ^$var1)
                                      (sem human))
                              (range    (value (> 60)))))))          ;by convention,
                                                                     ;in years
```

Adjectives of the **literal scale** class are interpreted using sets of literal values for ontological properties which are relevant to the meanings of nouns these adjectives modify, such as COLOR or SHAPE. The COLOR scale currently has just 11 values, and each of these has an entry like (60). An alternative analysis of this class using a continuous scale (see the discussion of grain-size in Section 4), would be to define each color in terms of three ranges, one each for hue, saturation, and value, with each range determined by two numbers standing for the lower and upper bounds of the

range.

```
(60)  (magenta
          (magenta-Adj1
              (CAT    adj)
              (SYN-STRUC
                  (1 ((root $var1)
                      (cat n)
                      (mods ((root $var0)))))
                  (2  ((root $var0)
                      (cat adj)
                      (subj ((root $var1)
                          (cat n))))))
              (SEM-STRUC
                  (LEX-MAP
                      ((1 2) (color-attribute
                          (domain (value ^$var1)
                              (sem physical-object))
                          (range   (sem magenta))))))))
```

The SHAPE scale currently has only five values -- round, rectangular, oval, triangular (61) and irregular-shaped.

```
(61)  (triangular
          (triangular-Adj1
              (CAT    adj)
              (SYN-STRUC
                  (1 ((root $var1)
                      (cat n)
                      (mods ((root $var0)))))
                  (2  ((root $var0)
                      (cat adj)
                      (subj ((root $var1)
                          (cat n))))))
              (SEM-STRUC
                  (LEX-MAP
                      ((1 2) (shape-attribute
                          (domain (value ^$var1)
                              (sem physical-object))
                          (range   (sem triangular))))))))
```

The most typical adjectives in the **member** subclass are *authentic* (62), *fake* (63), and *nominal* (64). Many others are their synonyms and near-synonyms. The lexical entry type for this subclass focuses on two major elements: first, whether the modified noun is a member of a certain set, and, second, whether the properties of this noun intersect significantly with those of the set members. The first element is represented straightforwardly in the set notation: the nouns modified by *authentic* and *nominal* do belong to the set; the nouns modified by *fake* don't. The second element is represented as the value of a saliency attitude to the intersection between the properties of the modified noun and those of the set members: the saliency value is 1.0 for *authentic*, still high for *nominal*, and low for *fake*. This representation is based on the assumption that functioning as a member, which differentiates between *authentic* and *nominal*, in that the former does and the latter does not function as a member should, is the most salient feature, while something like physical similarity (a fake gun only looks like a gun) is the least salient one (see a discussion of grain-size in lexical entries in Section 4 below).

```
(62)  (authentic
          (authentic-Adj1
              (CAT    adj)
              (SYN-STRUC
                  (1 ((root $var1)
                      (cat n)
                      (mods ((root $var0)))))
```

```
                (2 ((root $var0)
                    (cat adj)
                    (subj ((root $var1)
                        (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                ((1 2) (set1
                    (member refsem1)
                    (member ^$var1))
                (set2
                    (member refsem1.*))        ;refsemX are variables which are
                (set3                          ;not used by the linking process
                    (member ^$var1.*))         ;* denotes all properties in the
                (set 4                         ;concept referred to by the variable
                    (member (AND (set2.member set3.member))))
                (attitude
                    (type              salience)
                    (attitude-value    1.0)
                    (scope             set4)
                    (attributed-to     *speaker*)))))))
```

(63)

```
(fake
    (fake-Adj1
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                ((1 2)(set1
                    (member refsem1)
                    ((member ^$var1)
                        (polarity negative)))
                (set2
                    (member refsem1.*))
                (set3
                    (member ^$var1.*))
                (set 4
                    (member (AND (set2.member set3.member))))
                (attitude
                    (type              salience)
                    (attitude-value (value (< 0.25)))
                    (scope             set4)
                    (attributed-to     *speaker*)))))))
```

(64)

```
(nominal
    (nominal-Adj1
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                 (cat n)
                (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                ((1 2)(set1
                    (member refsem1)
                    (member ^$var1))
                (set2
                    (member refsem1.*))
                (set3
                    (member ^$var1.*))
                (set 4
                    (member (AND (set2.member set3.member))))
                (attitude
```

```
                (type              salience)
                (attitude-value (value (< 0.75)))
                (scope             set4)
                (attributed-to     *speaker*)))))))
```

3.3.2 Event-Derived Adjectives (Deverbals)

A large class of adjectives whose meanings are derived from those of verbs straddle the gradable/ non-gradable divide. The event-related gradables do not really differ from scalar gradables in terms of their gradability (65); the event-related non-gradables can acquire gradability at the cost of a meaning shift or marginal acceptability (66).

(65) (i) Jake is employable
(ii) Jake is very employable
(iii) Jake is more employable than Bob
(iv) Jake is most employable of all
(v) Bob is barely employable

(66) (i) ?Jake's initiative was abortive
(ii) ?Jake's initiative was very abortive
(iii) ?Jake's initiative was more abortive than Bob's
(iv) ?Jake's initiative was most abortive of all
(v) ?Bob's initiative was barely abortive

To derive the semantic part of an adjectival entry from a verbal entry, first one must identify the case, or thematic role (such as agent, theme, beneficiary, etc.) filled by the noun modified by the adjective in question. We illustrate this process through the lexical entries for *abusive* and *abuse*. The superentry for *abuse* includes at least three senses, roughly, *abuse-V1* 'insult verbally,' *abuse-V2* 'violate a law or a privilege,' or *abuse-V3* 'assault physically,' and the adjective may correspond to any one of them. What is *abusive* is either the event (E) itself, as in *abusive speech* or *abusive behavior*, or the agent (A) of the event, as in *abusive man or abusive neighbor*. *Abusive*$_{1E}$ (68) is then the eventive sense of the adjective formed from *abuse-1* (67), and *abusive*$_{1A}$ (69) is the agentive sense of the adjective in the same sense of *abuse*.

(67)
```
(abuse
        (abuse-V1
                (CAT     V)
                (SYN-STRUC
                        ((root $var0)
                                (cat v)
                                (subj ((root $var1)
                                        (cat n))
                                (obj    ((root $var2)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (communicative-event
                                        (agent (value ^$var1)
                                                (sem human))
                                        (benef (value ^$var2)
                                                (sem human))
                                        (theme (value refsem1))
                                (attitude1
                                        (type              evaluative)
                                        (attitude-value (value (< 0.25)))
                                        (scope             refsem1)
                                        (attributed-to     (OR (^$var2 speaker))))
                                (attitude2
```

```
                                        (type                evaluative)
                                        (attitude-value (value (< 0.25)))
                                        (scope               ^$var2)
                                        (attributed-to       ^$var1))))))
```

(68)
```
(abusive
    (abusive-Adj1E
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (^$var1
                    (instance-of (sem communicative-event))
                    (agent (value refsem1)
                        (sem human))
                    (benef (value refsem2)
                        (sem human))
                    (theme (value refsem3)))
                (attitude1
                    (type                evaluative)
                    (attitude-value (value (< 0.25)))
                    (scope               refsem3)
                    (attributed-to       (OR (refsem2 speaker))))
                (attitude2
                    (type                evaluative)
                    (attitude-value (value (< 0.25)))
                    (scope               refsem2)
                    (attributed-to       refsem1))))))
```

(69)
```
(abusive
    (abusive-Adj1A
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (communicative-event
                    (agent (value ^$var1)
                        (sem human))
                    (benef (value refsem1)
                        (sem human))
                    (theme (value refsem2)))
                (attitude1
                    (type                evaluative)
                    (attitude-value (value (< 0.25)))
                    (scope               refsem3)
                    (attributed-to       (OR (refsem1 speaker))))
                (attitude2
                    (type                evaluative)
                    (attitude-value (value (< 0.25)))
                    (scope               refsem1)
                    (attributed-to       ^$var1))))))
```

A large subclass of the event-related adjectives are adjectives that end in *able*/*ible* (cf. Kjellmer 1986 and also Hall 1877, Jespersen 1942, Marchand 1960, Abraham 1970, Meus 1975, for a discussion of such adjectives in English, even though much of the discussion sheds little light on the semantic and lexicographic issues in hand). Over 85% of them mean ‘something than can be [verb]’: thus, *readable* means ‘something that can be read.’ In other words, a typical *-able* entry is

derived from the lexical entry of the appropriate verb, with the positive potential attitude added, and in either the beneficiary or theme role, depending on the animateness/inanimateness of $var1, respectively (70i-ii). There are cases of semantic "suppletivism," when the entry for an adjective is derived from a semantically immediately related but morphologically unrelated verb (71i). There are suppletive cases like that among all event-related adjectives, not just the ones ending in *-ble*; thus, for instance, *ablaze* is derived from *burn*. In fact, one difference we captured among the event-related scalars and event-related non-scalars is that the former show more suppletive relations like that.

(70) (i)
```
(replaceable
    (replaceable-Adj1B
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (replace
                    (benef (value ^$var1))
                (modality
                    (type           potential)
                    (value          1.0)
                    (scope          replace)
                    (attributed-to  *speaker*))))))
```

(ii)
```
(readable
    (readable-Adj1T
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (read
                    (theme (value ^$var1))
                (modality
                    (type           potential)
                    (value          1.0)
                    (scope          read)
                    (attributed-to  *speaker*))))))
```

(71)
```
(audible
    (audible-Adj1T
        (CAT    adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
              (mods ((root $var0)))))
            (2  ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (hear
                    (theme (value ^$var1))
                (modality
                    (type           potential)
                    (value          1.0)
```

```
                    (scope          hear)
                    (attributed-to  *speaker*))))))
```

3.4 Relative Adjective (Denominal) Representation

Relative adjectives are denominal, object-related, in their meaning. The following example illustrates the connection between nominal and adjectival meanings.

(72) (i)

```
(medicine
        (medicine-N1)
                (CAT n)
                (SYN-STRUC
                        (root $var0)
                                (cat n)))
                (SEM-STRUC
                        (LEX-MAP
                                medicine))))
```

(ii)

```
(medical
        (medical-Adj)
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                 (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (^$var1
                                        (pertain-to medicine))))))
```

A well-known problem in semantic analysis is finding the property on which a modifier is connected to the modified. In the worst case, the MikroKosmos analyzer uses the catch-all relation PERTAIN-TO. What we need to discuss here, however, is whether we have the ability to produce entries that are more specific than that. We have indeed identified several more specific relations.

The first such relation is OWNED-BY, as in *federal* (73):

(73)

```
(federal
        (federal-Adj1)
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (^$var1
                                        (owned-byfederation))))))
```

Another specific relation is HAS-AS-PART, as in *malignant-3* (74):

(74)

```
(malignant
        (malignant-Adj3
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
```

```
                    (mods ((root $var0)))))
            (2   ((root $var0)
                    (cat adj)
                    (subj ((root $var1)
                            (cat n))))))
    (SEM-STRUC
            (LEX-MAP
                    (^$var1
                            (has-as-part cancer-cell))))))
```

LOCATION is also a common relation, as in *international-1* (75i). It is interesting that another sense of *international* utilizes the OWNED-BY property noted above (75ii), and yet another combines LOCATION with event-relatedness (75iii).

(75) (i)
```
(international
        (international-Adj1
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                 (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (event
                                        (location (value set1))
                                        (theme (value ^$var1))
                                (set1
                                        (member-type     country)
                                        (cardinality     >1))))))
```

(ii)
```
(international
        (international-Adj2
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (^$var1
                                        (instance-of (sem object)
                                                (def organization))
                                        (owned-by set1))
                                (set1
                                        (member-type     country)
                                        (cardinality     >1))))))
```

(iii)
```
(international
        (international-Adj3
                (CAT    adj)
                (SYN-STRUC
                        (1 ((root $var1)
                                (cat n)
                                (mods ((root $var0)))))
                        (2   ((root $var0)
                                (cat adj)
                                (subj ((root $var1)
                                        (cat n))))))
                (SEM-STRUC
                        (LEX-MAP
                                (produce
                                        (location set1)
                                        (theme>agent>benef (value ^$var1)) ; theme, agent,
```

```
(set1                                   ; or beneficiary,
    (member-type country)               ; in this order
    (cardinality      >1))))))          ; of preference
```

The disambiguation among such multiple senses as (75i-iii) is not a simple matter, and in an unusual contraposition to the standard semantic problem of infinite polysemy (see, for instance Weinreich's (1966) critique of Katz and Fodor (1963) on this ground), a move up, rather than down, to the undifferentiated generic meaning of an adjective like *international* is recommended in cases of disambiguation problems. In other words, while we continue to discover more specific relations between the lexical entries of denominal adjectives and the nouns they are derived from, the generic PERTAIN-TO property should not be discarded. This move is, of course grain-size-related (see Section 4.2 below).

4. Acquisition of Adjectival Meaning

In this section, we tackle the central issues of computational semantics and lexicography, namely, how to capture the meaning of an adjective. This question includes at least these three aspects:

- how to determine what exactly the adjective means;
- how to determine how detailed ("fine-grained") the representation should be; and
- how best to represent the meaning given the ontological and lexical means we have.

We have basically two resources for capturing meaning, and their status is quite different: one of them, the speaker's intuition, works very well for humans but not for machines (it is difficult to represent it explicitly); the other, human-oriented published dictionaries, represents meaning explicitly but are known to be faulty and unreliable. Dictionaries also typically list too many different senses. If a computational lexicon recognizes the same number of senses, it would be very difficult to specify how each of them differs from the others, and the human-oriented dictionaries do not always provide this information. Thus, in a computational application it becomes important to reduce the number of senses to a manageable set.

4.1 Reducing Polysemy

In his critique of Katz and Fodor (1963), Weinreich (1966) accused them of having no criteria for limiting polysemy, i.e., for determining when a sense should no longer be subdivided. Thus, for example, having determined that one of the senses of *eat* is "ingest by mouth," should we subdivide this sense of *eat* into eating with a spoon and eating with a fork, which are rather different operations? Existing human-oriented dictionaries still do not have theoretically sound criteria for limiting polysemy of the sort Weinreich talked about. They definitely have their own implicit rules of thumb, but the results come out quite uneven. More importantly, the number of senses listed for each entry is usually quite high.

It is often difficult to reduce the number of senses for a word even in a computationally-informed lexical resource, as can be illustrated by an example from WordNet, a most useful and consistent online resource. In WordNet, each sense in an entry is determined by a 'synset,' a set of synonyms, rather than by a verbal definition. (76) contains the 12 synsets WordNet lists for the adjective *good*.

(76) 12 senses of *good*

Sense 1
good (vs. evil) -- (morally admirable)

=> angelic, angelical, saintly, sainted -- (resembling an angel or saint in goodness)
=> beneficent, benevolent, gracious -- (doing or producing good)
=> white -- (“white magic”)
Also See-> good, moral, right, righteous, virtuous, worthy

Sense 2
good (vs. bad) -- (having positive qualities, asp. those desirable in a thing specified: “good news”; “a good report card”; “a good joke”; “a good exterior paint”; “a good secretary”)
=> bang-up, bully, cool, corking, cracking, dandy, great, keen, neat, nifty, not bad(predicate), peachy, swell, smashing -- ((informal) very good)
=> fine -- (very good of its kind or for its purpose: “a fine gentleman”; “a fine mind”; “a fine speech”; “a fine day”)
=> redeeming(prenominal), saving(prenominal) -- (offsetting some fault or defect: “redeeming feature”; “saving grace”)
=> safe, sound -- (“a good investment”)
=> satisfactory -- (meeting requirements: “good qualifications for the job”)
=> suitable -- (serving the desired purpose: “Is this a good dress for the office?”)
=> unspoiled -- (“the meat is still good”)
=> well-behaved -- (“when she was good she was very good”)
Also See-> best, better, favorable, genuine, good, obedient, respectable, sound, well(predicate)

Sense 3
benevolent (vs. malevolent), good -- (having, showing, or arising from a desire to promote the welfare or happiness of others)
=> beneficent, charitable, generous, kind -- (“a benevolent contributor”)
=> good-hearted, kindly, openhearted -- (“a benevolent smile”; “take a kindly interest”)
Also See-> beneficent, benefic, charitable, kind

Sense 4
good, upright, virtuous -- (of moral excellence: “a genuinely good person”; “an upright and respectable man”; “the life of the nation is secure only while the nation is honest, truthful, and virtuous”- Frederick Douglass; “the...prayer of a righteous man availeth much”- James 5:16)
=> righteous (vs. unrighteous)

Sense 5
estimable, good, honorable, respectable -- (“all reputable companies give guarantees”; “ruined the family's good name”)
=> reputable (vs. disreputable)

Sense 6
good, right, seasonable, timely, well-timed -- (occurring at a fitting time: “opportune moment”; “a good time to plant tomatoes”; “the right time to act”; “seasonable summer storms”; “timely warning”; “the book's publication was well-timed”)
=> opportune (vs. inopportune)

Sense 7
good, pleasing -- (agreeable or pleasant: “we had a nice time”; “a nice day”; “nice manners”)
=> nice (vs. nasty)

Sense 8
good, intact -- (not impaired in any way: “I still have one good leg”)
=> unimpaired (vs. impaired) -- (not damaged or diminished)

Sense 9
good -- (not forged: “a good dollar bill”)
=> genuine (vs. counterfeit)

Sense 10
good -- (“good taste”)
=> discriminating (vs. undiscriminating)

Sense 11
good, Sunday, Sunday-go-to-meeting(prenominal) -- (used of clothing: “my good clothes”; “his best suit”; “her Sunday-go-to-meeting clothes”)
=> best (vs. worst) -- (superlative of “good”: “the best film of the year”)

Sense 12
full, good -- (“gives full (good) measure”; “a good mile from here”)
=> ample (vs. meager) -- (more than enough in size or scope or capacity)

The first thing one notices about the 12 senses is that noun classes which they modify vary a great

deal in size. Sense 2 dwarfs all the other senses in this respect. Senses 1 and 3-5 all pertain to humans and their acts and are very similar to each other, at least in the sense that the association of one of these senses with a noun strongly entails or presupposes the association of the others with the same noun. Thus, in (77), *good* will probably be understood in a somewhat vague combination of all these four senses, and the native speaker will not feel the need for further specification. This feeling, if captured reliably by a well-defined procedure, is the basis Weinreich sought for determining if further polysemy is required. A group of individuals, if defined as good as in (78), is indeed more likely to be understood in Sense 5, but none of the other three is excluded. In fact, other than in a context of at least several sentences, if not paragraphs, it is very hard to use *good* specifically in one of these similar senses. This observation can serve as an operational criterion for limiting polysemy: if it is hard to pinpoint a sense within a one-sentence example, the status of the meaning as a separate sense in the lexical entry should be questioned.

(77) (i) Fred is a good man.
(ii) Fred's behavior in that difficult situation was very good.

(78) Mom & Pop, Inc. is a good company

It is crucially important that if there is a shift in meaning at all from (77) to (78), it is caused by the shift from one person to a group of individuals. The determining role of the nominal meaning on the meaning of *good* is even more obvious in the other WordNet senses of the adjective. Starting with Sense 6, the noun classes to which these senses apply shrink, and with Senses 8-12 come dangerously close to phrasals consisting of *good* and the corresponding nouns, phrasals in which the meaning of *good* varies significantly.

WordNet itself recognizes some of the observations above by reducing the 12 senses of *good* in (76) to the three senses in (79) in response to a different set of parameters:

(79) 3 senses of *good*

Sense 1
good (vs. evil) -- (morally admirable)
=> good, virtue, goodness -- (the quality of being morally excellent or admirable)

Sense 2
good (vs. bad) -- (having positive qualities, esp. those desirable in a thing specified: "good news"; "a good report card"; "a good joke"; "a good exterior paint"; "a good secretary")
=> goodness -- (being of positive value)

Sense 3
benevolent (vs. malevolent), good -- (having, showing, or arising from a desire to promote the welfare or happiness of others)
=> benevolence -- (an inclination to do kind or charitable acts)

This "short list" of the main senses of *good* is still rather unbalanced with respect to the sizes of noun classes they modify, and the distinction between Senses 1 and 3 remains perhaps only slightly less problematic than the distinction among Senses 1 and 3-5 in (76). It is, however, the WordNet long list rather than the short one that is very similar to typical dictionary fare: (80) is the entry from the online Webster (1963) and (81) from the American Heritage (1995)--we list only meaning-related information in both entries.

(80) 1. good... 1a1: of a favorable character or tendency {~ news} 1a2: BOUNTIFUL, FERTILE {~ land} 1a3: COMELY, ATTRACTIVE {~ looks} 1b1: SUITABLE, FIT {~ to eat} 1b2: SOUND, WHOLE {one ~ arm} 1b3: not depreciated {bad money drives out ~} 1b4: commercially reliable {~ risk} 1b5: certain to last or live {~ for another year} 1b6: certain to pay or contribute {~ for a hundred dollars} 1b7: certain to elicit a specified result {always ~ for a laugh} 1c1: AGREEABLE, PLEASANT 1c2: SALUTARY, WHOLESOME {~ for a cold} 1d1: CONSIDERABLE, AMPLE {~ margin} 1d2: FULL {~ measure} 1e1: WELL-FOUNDED, COGENT {~ reasons} 1e2: TRUE {holds ~ for society at large} 1e3: ACTUALIZED, REAL {made ~ his promises} 1e4: RECOGNIZED, HONORED {in ~

standing} 1e5: legally valid or effectual {~ title} 1f1: ADEQUATE, SATISFACTORY {~ care} 1f2: conforming to a standard {~ English} 1f3: DISCRIMINATING, CHOICE {~ taste} 1f4: containing less fat and being less tender than higher grades - used of meat and esp. of beef 2a1: COMMENDIBLE, VIRTUOUS, JUST {~ man} 2a2: RIGHT {~ conduct} 2a3: KIND, BENEVOLENT {~ intentions} 2b: UPPER-CLASS {~ family} 2c: COMPETENT, SKILLFUL {~ doctor} 2d: LOYAL {~ party man} {~ Catholic}: in effect: VIRTUALLY {as good as dead}: VERY, ENTIRELY {was good and mad}

(81) good

1. Being positive or desirable in nature; not bad or poor: a good experience; good news from the hospital.
2.a. Having the qualities that are desirable or distinguishing in a particular thing: a good exterior paint; a good joke. b. Serving the desired purpose or end; suitable: Is this a good dress for the party?
3.a. Not spoiled or ruined: The milk is still good. b. In excellent condition; sound: a good tooth.
4.a. Superior to the average; satisfactory: a good student. b. Used formerly to refer to the U.S. Government grade of meat higher than standard and lower than choice.
5.a. Of high quality: good books. b. Discriminating: good taste.
6. Worthy of respect; honorable: ruined the family's good name.
7. Attractive; handsome: good looks.
8. Beneficial to health; salutary: a good night's rest.
9. Competent; skilled: a good machinist.
10. Complete; thorough: a good workout.
11.a. Reliable; sure: a good investment. b. Valid or true: a good reason. c. Genuine; real: a good dollar bill.
12.a. In effect; operative: a warranty good for two years; a driver's license that is still good. b. Able to continue in a specified activity: I'm good for another round of golf.
13.a. Able to pay or contribute: Is she good for the money that you lent her? b. Able to elicit a specified reaction: He is always good for a laugh.
14.a. Ample; substantial: a good income. b. Bountiful: a good table.
15. Full: It is a good mile from here.
16.a. Pleasant; enjoyable: had a good time at the party. b. Propitious; favorable: good weather; a good omen.
17.a. Of moral excellence; upright: a good person. b. Benevolent; kind: a good soul; a good heart. c. Loyal; staunch: a good Republican.
18.a. Well-behaved; obedient: a good child. b. Socially correct; proper: good manners.
19. Sports. Having landed within bounds or within a particular area of a court: The first serve was wide, but the second was good.
20. Used to form exclamatory phrases expressing surprise or dismay: Good heavens! Good grief!

The high quality of WordNet as an online resource and of its (largely unspecified) method of distinguishing senses is confirmed by the fact that the other two dictionaries do not really add any significant new senses to the WordNet long list--all they do is further specify the senses and add new phrasal and near-phrasal senses.

Our two main objections to adding a sense to an adjective entry are:

(82) (i) lack of clear distinction between the candidate sense and those already in the entry, and
(ii) small size of the set of nouns to which this sense applies.

(83) lists the rules of thumb for reducing polysemy, associated with (82).

(83) (i) Try to make the word carry the candidate sense in a one-sentence example. If you need to provide additional context for this to happen, this sense should be rejected and subsumed by one of the existing senses in the entry.
(ii) Check if the candidate sense applies only to a small number of semantically similar nouns. If it does, reject this sense; its meaning will be subsumed by one of the existing senses in the entry.

Both these rules are manifestations of a general linguistic principle of complementary distribution, widely used for establishing variance and invariance in phonology and morphology: if two different senses of the same adjective can only be realized when used with two different nouns or sets of nouns, they should be seen as variants of the same sense. In a way, some dictionaries try to cap-

ture this in their entries by grouping all senses into a small number of "main" ones which are further divided, often iteratively. Thus, Webster (80) has only two main senses and two levels of specification under them, but American Heritage (81) prefers putting 20 senses on the top level, with minimum further subdivision. Both from the point of view of theoretical linguistics (the essential complementary distribution principle) and of natural language processing, entries like (81) are the least helpful.

The objections in (82) push us in an obvious direction: we see *good* as having one sense, which takes different shades, depending on the meaning of the modified nouns. This sense of *good* is something like "assigning a high positive value range" to a selected property of the noun. Our entry for *good* (45) captures this meaning but refuses to specify the noun property, and we have a good reason for not doing that (see Section 4.2 below). *Good* is, of course, an adjective with a very broadly applicable meaning, but the same objections to excessive polysemy hold for other adjectives as well. The same principle of polysemy reduction pertains to other lexical categories: thus, in Nirenburg *et al* (1995), we reduced 52 listed senses for the Spanish verb *dejar* to a manageable set of just 7.

4.2 Grain Size

Reducing the number of senses in a polysemous lexical item affects the grain size of its semantic representation: the fewer the number the larger the grain size. We are interested in formulating principles of granularity which will allow us to keep the number of senses in an entry low.

4.2.1 Grain Size on a Principled Basis: Practical Effability

The grain size of lexical representation in an NLP system must be as follows:

(84) (i) principle-based
(ii) application-oriented

The principles which guided the acquisition of the MikroKosmos lexicon entries for adjectives are those formulated in (83) above. It is certain that more principles were used in this process. However, they still await their formulation due to the usual difficulties with explicating intuitions. In fact, we have imposed yet another principle which we expect to remove in later work. For reasons of simplicity of acquisition, we have strived to maintain the grain size of description at the same level of detailization throughout the system. In fact, however, variable-depth meaning descriptions (see Nirenburg and Raskin 1986) are necessary when one wants to balance economy of effort and ability to disambiguate.

It has been demonstrated in various schools of semantics that natural languages dissect reality differently and fill their words with different chunks of that reality (see, for instance, Hjelmslev 1959, Whorf 1956, Hayakawa 1975). It has also been experienced by translators, who know that word-for-word rendition of the text from one language to another never makes sense. This is the reason for crucial semantic difficulties in MT, necessitating the kind of meaning analysis we are engaged in here.

A well-evolved interlingua resulting from such meaning analysis creates lexicons for the source and target languages which represent enough different senses of the words and other lexical items to give serious credence, demonstrated in practice, to a hope that a meaning expressed in one language will be expressed in another language in the same grain size without much difficulty--in

most cases. There are, however, cases when it will not happen, and it is those cases which require a finer grain size than all the others, thus strongly suggesting an uneven, variable-depth grain-size approach.

One such case would be a situation when one word in a source language can be translated into a target language as either one of two words, and the decision as to which word to use requires additional information that the source text may not contain at all or in an easily extractable way. This is the situation holding between English and Spanish words in (85) and English and Russian words in (86), making the English sentences in (87i-ii) difficult to translate into Spanish and Russian, respectively.

(85) (i) Engl. *corner*
(ii) Span. *rincón* '(inside) corner, nook'
(iii) Span. *esquina* '(outside) corner, street corner'
(86) (i) Engl. *blue*
(ii) Russ. *siniy* 'dark blue, navy blue'
(iii) Russ. *goluboy* 'light blue, baby (sky) blue'
(87) (i) He could see the corner clearly.
(ii) She wore a blue dress.

Refining the grain size for *corner* and *blue* in their lexical entries--by adding to their lexicon definitions appropriate distinguishing properties in order to accommodate Spanish and Russian--is possible though often useless because the data on which lexical constraints can be checked may not be present in either the text or extralinguistic context. Such situations are difficult for human translators as well. The reason for this state of affairs can be that language always underdetermines reality (cf. Barwise and Perry 1983: 30): any sentence leaves out numerous details of the situation described in it, and in the case of (86-87), one language underdetermines it more (English) and the other (Spanish and Russian) determines it more.

In our work, we rely on a specific approximation of the principle of effability, or mutual intertranslatability of natural languages, namely that "[e]ach proposition can be expressed by some sentence in any natural language" (Katz 1978: 209; see also Katz 1972/1974: 18-24, Frege 1963: 1, Tarski 1956: 19-21, and Searle 1969: 19-21 -- a view which is opposite to that formulated by Quine 1960: 26-30).We are proceeding on a practical hypothesis (88i), which is a stronger form of this principle. While (88i) is expressed in the terms of the debate on effability, a version more attuned to the environment of computational microtheories is (88ii).

(88) (i) *Hypothesis of Practical Effability*: Each sentence can be translated into another natural language on the basis of a lexicon with equally limited polysemy.

(ii) *Hypothesis of Practical Effability for Computational Microtheories*: Any text in the source language can be translated into the target language in an acceptable way on the basis of a lexicon for the source language and a lexicon for the target language, such that their respective entries are limited in exactly the same fashion with regard to polysemy.

The equally limited polysemy we practice recommends fewer than 10, preferably fewer than 5 senses per lexical entry. The limitation does not, of course, effect the scope of the word meaning: all the possible senses of a lexical item are captured in the superentry. The small number of these

senses simply means a larger grain size. In a limited domain, however, some--or often many--senses of the same word can be ignored because they denote concepts which are not used in the domain, are not part of the sublanguage that serves the domain, and thus are unlikely to occur in the corresponding corpora (see Nirenburg and Raskin 1987b; Raskin 1971, 1987b).

4.2.2 Grain Size in Adjective Entries

The practical effability hypothesis was successfully applied to a corpus of English with 1,506 adjective senses described in Section 3.1. Let us see how exactly it is reflected in the choices forming the lexical entries. The adjective *good* is, again, a good place to start. We will show how, for this adjective, we settled on a grain size of description larger than the most detailed semantic analysis possible. We will then see how the same principle--of not specifying in detail the specific noun property modified by an adjective--applies to all the other adjectives as well. And we will briefly discuss the conceptual and computational status of those properties which are introduced by the scales we need to postulate for our adjective entries.

As indicated in (45), we interpret *good* in a sentence like (89i) as, essentially, (89ii). We realize that, in fact, *good* in (89i) may have a large variety of senses, some of which are illustrated in the possible continuations of (89i) in (90). Obviously, *good* may have additional senses when used to modify other nouns (91)--up to and probably above the maximum number of different senses of the adjective listed for it in the dictionaries (76, 80-81).

(89) (i) This is a good book.
(ii) The speakers evaluates this book highly.
(90) (i) ...because it is very informative.
(ii) ...because it is very entertaining.
(iii) ...because the style is great.
(iv) ...because it looks great on the coffee table.
(v) ...because it is made very sturdy and will last for centuries.
(91) (i) This is a good breadmaker.
(ii) He is a good teacher.
(iii) She is a good baby.
(iv) Rice is good food.

In each case, *good* selects a property of a noun and assigns it a high value on the evaluation scale associated with that property. The property changes not only from noun to noun but also within the same noun, depending on the context. This is the “plasticity” that Marx (1983) was complaining about (see Section 1.10).

The finest grain-size analysis requires that a certain property of the modified noun is contextually selected as the one on which the meaning of the noun and that of the adjective is connected. This is what many psychologists call a ‘salient’ property. In our approach, the representation solution for *good* would be to introduce an evaluation attitude, with a high value and scoped over this property.

Now, it is difficult to identify salient properties formally, as is well known, for instance, in the scholarship on metaphor, where salience is the determining factor for the similarity dimension on which metaphors (and similes) are based (see, for instance, Black 1954-55, 1979; Davidson 1978; Lakoff and Johnson 1980, Lakoff 1987; Searle 1979; on salience, specifically, see Tversky and Kahnemann 1983). It is, therefore, wise to avoid having to search for the salient property, and the

hypothesis of practical effability for KBMT (88) offers a justification for this. What this means, in plainer terms, is that if we treat the meaning of *good* unspecified with regard to the noun property it modifies, there is a solid chance that there will be an adjective with a matching generalized, unspecified meaning like that in the target language as well.

In fact, however, we go one step further with the lexical entry of *good* and other adjectives from the same scale and remove their meaning from the nouns they modify, making them contribute instead to an evaluative attitude pertaining to the whole sentence. It can be argued, of course, that since the scope of the attitude remains the modified noun, all that changes is the formalism and not the essence of the matter. We do not wish to insist, therefore, that this additional step constitutes a step towards an even larger grain size.

The other, non-attitude-based scalars operate in a standard fashion (92):

(92) Standard Treatment of Scalar Meanings:
Insert the scale name and scale value for an adjective as a property-value pair in the frame describing the meaning of the noun the adjective modifies.

With a simple noun like *house* (93), simple in the sense that its meaning--at least the one used in the example--is directly mapped into an ontological concept, the meanings of *big house* and *red house* will be represented in our TMR as shown in (94i-ii), respectively:

(93)
```
(house
    (house-N1
        (CAT    n)
        (SYN-STRUC
            (1      ((root $var0)
                     (cat n))) )
`       (SEM-STRUC
            (LEX-MAP
                (2      (private-home))
```

(94) (i)
```
(private-home
    (size-attribute (value > 0.75))
```

(ii)
```
(private-home
    (color-attribute (value red))
```

In (94i) the linking attribute is selected rather high in the hierarchy of attributes, because in the ontology SIZE-ATTRIBUTE is the parent of such properties as LENGTH-ATTRIBUTE, WIDTH-ATTRIBUTE, AREA-ATTRIBUTE, WEIGHT-ATTRIBUTE, etc. If the context does not allow the analyzer to select one of those, a coarser-grain solution is preferred. In other words, we represent the meaning of *big house* without specifying whether *big* pertains to the length, width, height or area of a house.

Some adjectives like *big* and other spatial adjectives (see Section 1.10 and references there, especially Spang-Hanssen 1990), which are applicable to different dimensions and their various combinations, allow for more "plasticity" due to this property indeterminacy, and others, such as *red*, allow for less, but different interpretations of a finer size are always available, and we deliberately choose to ignore them.

The advantage of a larger grain size is, of course, the increased feasibility and manageability of lexical description and analysis, thanks, for instance, to much more limited polysemy. But there is a price to pay for this position: if a translation depends on the availability of a finer-grain polysemy, the translation will fail. We are obviously gambling on the infrequency of such situations and on the applicability of the practical effability principle in many cases.

4.2.3 Adjectives and Other Modifiers

The MikroKosmos analyzer treats modification by merging the meanings of the modifiers into the meanings of the modified at a pre-selected coarse grain-size. For those modifiers whose meanings are (possibly, sets of) property-value pairs, the method is to insert the values they carry into the same property slot in the modified. For instance, the sense of *smooth* as in *smooth silk* will be a range on the TEXTURE scale. If TEXTURE is defined as a property of PHYSICAL-OBJECT or MATERIAL, and SILK is a descendent of either of them, then the value carried in the lexicon entry for *smooth* will be inserted by the analyzer as the TEXTURE property value for the instance of *silk* in the TMR. Problems arise when an adjective has several senses, each of which is explicated in terms of a different scale. The task of the analyzer is then to disambiguate the adjective-noun complex by determining the particular property on which the meaning of the adjective must be linked to that of the noun. If the disambiguation does not require a finer grain size, the problem remains manageable for the analyzer, at least as far as the lexicon support for its solution is concerned.

This mechanism clearly covers all property modification in language, not only adjective-noun combinations. Thus, it would be applicable to noun-noun combinations, adverb-verb combinations and other modification situations, as illustrated in (95), and the degree of allowed polysemy will determine the grain size and disambiguation possibilities in each case.

(95)

Modified	Modifiers
Verb	Adverb, Noun, Prepositional Phrase
Noun	Adjective, Prepositional Phrase
Adjective	Adverb, Prepositional Phrase
Adverb	Adverb

Guided by the desire to explain the meanings of each of the 1506 English adjectives in our corpus, for which we have acquired lexical entries, using the smallest number of properties, we have identified the following eleven scale properties.

(96) Numerical Properties/Scales:

- EVALUATION-ATTRIBUTE
- SIZE-ATTRIBUTE
- MASS-ATTRIBUTE
- GIRTH-ATTRIBUTE
- AGE-ATTRIBUTE
- COST-ATTRIBUTE
- PRICE-ATTRIBUTE
- SPEED-ATTRIBUTE
- EASE-ATTRIBUTE

Literal Properties/Scales:

- ORIENTATION-ATTRIBUTE

- SIDE-ATTRIBUTE
- SHAPE-ATTRIBUTE
- DIRECTION-ATTRIBUTE

This division imposes a coarse grain size of description which is likely to have to be made refined and substantially extended, as dictated by the needs to support disambiguation in semantic analysis.

4.3 "What Does This Adjective Mean?"

In this subsection, we discuss two related but distinct issues, namely, how a lexicon acquirer can discover what an adjective means and how to decide how to represent this meaning. Much more effort has been spent in the field on the latter question, though the former is a much more difficult issue. We intend to demonstrate that the difficulties of determining what the meaning actually is are often not appreciated by researchers.

4.3.1 Representation of Meaning

Our commitment to the ontological representation in the lexicon (see Section 2.1) helps us to determine the actual representation of a lexical entry but it does not make it a deterministic process: there are still choices to make and, accordingly, principled bases for making these choices.

One good example of such a choice and a theoretical basis for making it is our treatment of the adjective *abhorrent*. In general, this adjective is morphologically related to the verb *abhor*, and its lexical entry is derived from that of the verb. There are, however, at least two very distinct ways of representing *abhor*, one as an event and the other as an attitude. If we had an event concept LIKE, for instance, we would easily present *abhor* as an intensified negation of LIKE. Alternatively, we can represent *abhor*--and *like*--as an attitude: *like* is represented pretty much along the lines of *good* (see (45) above), and *abhor* simply replaces the "> 0.75" value of *like* on the evaluation scale with something like "< 0.1." Accordingly, either an event concept or an evaluative attitude appear in the LEX-MAP for *abhorrent*. Which should it be?

The answer is based on our independently motivated position with regard to the representation of verbs: we represent actions but not states as events. This disqualifies *abhor*--and *like*, along with many other evaluative states--from an event-based representation, and the adjective *abhorrent* gets an attitude-based treatment (97):

(97)
```
(abhorrent
    (abhorrent-Adj1
        (CAT     adj)
        (SYN-STRUC
            (1 ((root $var1)
                (cat n)
                (mods ((root $var0)))))
            (2   ((root $var0)
                (cat adj)
                (subj ((root $var1)
                    (cat n))))))
        (SEM-STRUC
            (LEX-MAP
                (attitude
                    (type                evaluative)
                    (attitude-value (value (< 0.1)))
                    (scope               ^$var1)
                    (attributed-to       *speaker*))))))
```

Even if we decide on this form of representation for *abhorrent*--and we do--there are still choices to make. The same lexical entry (97) can be derived from the entry for *abhor*, as we mentioned before, or directly as an evaluative adjective. In the former case, *abhorrent* is treated as a member of the adjective set including such words as *lovable, likable, repulsive, repellent,* etc. In the latter case, it belongs to a set of adjectives, such as *awful, terrible, dismal, abysmal,* etc. The difference between the two sets is the fact that the first one is associated with the morphologically related verbs and the second is not.

Other choices may not be related to our or any other principle of representation or notation. In fact, they are addressed in traditional lexicography, *albeit* in its typically intuitive fashion, not directly related to any linguistic semantic wisdom. Thus, the "twelve basic principles of lexicographic definition" by Benson *et al*. (1986: 203-226) favor 1) "referential definition by the same part of speech," with 2) a minimum of, if any, metalanguage, 3) "the use of synonyms," and 4) "illustrative phrases," 5) "definitions... [that] give only those relevant features that are necessary to differentiate the referent from other members of its general class" (op. cit.: 211), 6) the "inclusion of lexical patterns," 7) the use of field, temporal, regional, etc. "labelling," 8) a certain "order of defined meanings," 9) a clear and separate treatment of connotation, 10) clarity of definitions, 11) consistency of definitions, and 12) the need for objectivity.

This is pretty standard fare in traditional lexicographic literature (cf., for instance, Svensén 1990: 112-139, or Landau 1984: 120-174; see also Benson 1985, Congleton *et al*. 1979, Hartmann 1983, Ilson 1986, Kipfer 1984, McDavid and Duckert 1973, Zgusta 1971 and 1980). Those of the twelve steps above that are readily interpretable describe a desirable state of lexicographic affairs but contain very few clues as to how they can be realized. The assumption is that an expert knows that intuitively. There is no criterion of evaluation and little methodology: whatever is there is of a negative nature, such as "do not use a different part of speech in the definition," "use as little metalanguage in the definition as possible, preferably none at all," or "do not use any features other than the distinctive ones" (cf. McCawley 1986, ridiculing this very principle on the example of a standard dictionary definition of *horse*). As to the positive methods of lexicographic description, for instance, how to identify relevant features, how to achieve clarity or objectivity, this literature does not provide answers, except by pointing out at some positive examples and sometimes comparing them with the less successful ones. Lexicography is treated as an art and/or a craft (Landau 1984), and this is, indeed, a self-fulfilling prophecy: without a reliable methodology and an explicit theoretical foundation, it is guaranteed not to become a science.

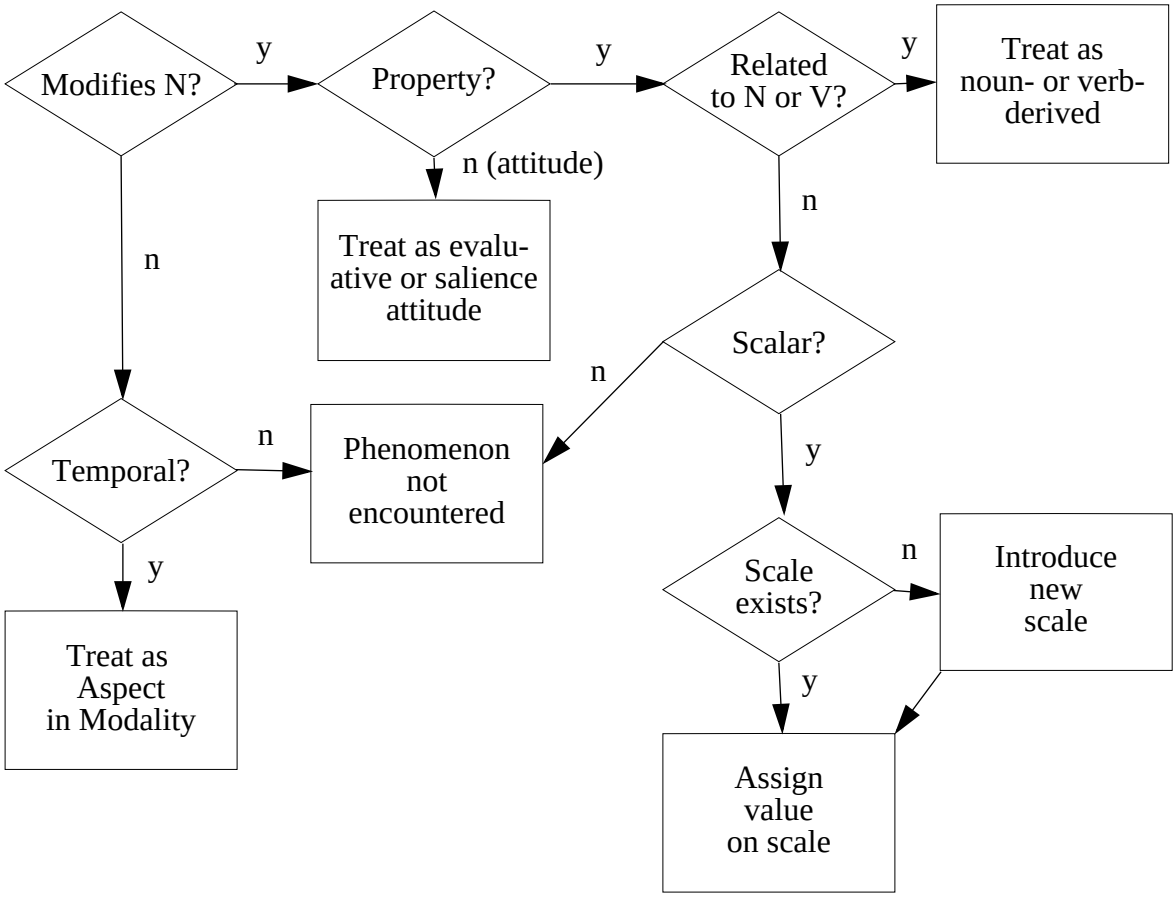
At the same time, the last decades have seen a significant change in linguistics, especially in semantics, with regard to dictionaries. As Lewandowska-Tomaszczyk and Tomaszczyk (1990: xi) and several other authors in Tomaszczyk and Lewandowska-Tomaszczyk (1990) point out, "[t]here is little doubt that linguistics is now going through a period of heightened interest in the lexicon, lexical semantics and lexicography." As we already pointed out in Section 4.1 above, the depth of polysemy (rather than the ordering of the senses arrived at in an unspecified fashion in the twelve steps above) has been a point of heated semantic debate (Bolinger 1965, Weinreich 1966). Other semanticists have attempted to introduce elements of semantic theory and principles of semantic analysis into lexicography, showing that failure to do so leads to arbitrariness, unevenness, *adhoc*ness, and even inaccuracy in lexicographic definitions (see, for instance, Householder and Saporta 1967, Weinreich 1962 and 1968, Apresyan *et al*.1969 and 1973, Read 1973, Fillmore 1978, Wierzbicka 1985, McCawley 1986; Raskin 1986). Under this pressure from linguistics, some lexicographers (e.g. Rey 1977) started including sections or even chapters on semantics in

their work but these are still kept separate from the traditional lexicographic stuff and thus fail to inform it. Similarly, the advantages that computers provide for lexicographers are typically reviewed by lexicographers with regard to their purely technical aspects rather than in connection with the making of entries (see, for instance, Landau 1984: 272-293).

Unfortunately, traditional lexicography and linguistics semantics have yet to find a way for productive synthesis. The massive interest in computational lexicology and lexicography in the 1980s hinted at the start at the possibility of such a synthesis, especially in the light of the emergence of dictionaries, created by traditional lexicography, in machine-readable form and of the early hopes of adapting these dictionaries for computer use in a relatively easy and feasible way (Amsler 1982, 1984a,b; Ahlswede *et al*. 1985; Boguraev *et al*.1987; Boguraev and Briscoe 1987; Calzolari 1984; Chodorow *et al*. 1985; Cullingford and Graves 1987; Fox *et al*. 1986; Markowitz *et al*. 1986; Slator and Wilks 1987; Slocum and Morgan 1986; Walker 1984, 1987; Walker and Amsler 1986; Wilks *et al*. 1987). But most recent work in computational lexical semantics stems clearly from the linguistic (and logical) semantic scholarship rather than from the traditional lexicographic approach (see, for instance, Boguraev and Briscoe 1989; Briscoe *et al*. 1990, 1993; Carlson and Nirenburg 1990; Copestake 1990, 1992; Meyer *et al*. 1990; Levin 1991, 1992; Pustejovsky 1991, 1993; Ageno *et al*. 1992; Nirenburg and Levin 1992; Nunberg and Zaenen 1992; Onyshkevych and Nirenburg 1992, 1994; Ostler and Atkins 1992; Pustejovsky and Bergler 1992; Sanfilippo and Poznanski 1992; Sanfilippo *et al*. 1992; Dorr 1993; Farwell *et al*. 1993; Knight 1993; Raskin *et al*. 1994a,b; Levin and Nirenburg 1994; Nirenburg *et al*. 1994; Saint-Dizier and Viegas 1995).

Our methodology for creating lexical entries for adjectives is illustrated in (98).

(98)



Obviously, we need bases for all the decisions represented by the diamonds in (98), and for that, we need to determine what an adjective means as well as to have guidance for the actual choices. A good methodology offers such guidance in the form of tests, and this is precisely what we will attempt to formulate next.

4.3.2 Determination of Meaning and Making Choices

Our lexicographic resources include a variety of online dictionaries, tools for showing the actual usages of the word in context on a wide selection of corpora, and an arsenal of acquisition tools which can display useful templates, bring up the entries of similar words, and traverse our lexicon and ontology in other ways. Nevertheless, no tool has the capability of determining the meaning of the word automatically: our acquisition of the lexicon (and of the ontology) is semi-automatic in that it requires a human participant, even though human intuition is guided and checked through these tools.

For nouns and verbs, the simplest outcome is the discovery of an ontological concept which directly corresponds to their meanings. Failing that, the next step is an attempt to discover the concept for the hyperonym of the word: a positive outcome will result in either adding a new daughter concept in the ontology into which the word would be mapped directly, or adding meaning constraints to the entry for this word in the lexicon, while linking it to the concept for its hyperonym.

With adjectives, however, we will not find the corresponding concept in the ontology unless the adjective pertains to a noun or a verb and the LEX-MAP of the adjective is to be derived from that of the corresponding noun or verb. In this case, the adjectival meaning can be determined only after the meaning of the noun or verb is specified.

Before pursuing the particular path of the determination of the adjectival meaning, let us pause to consider what resources we can use in the determination of meaning in general. The dictionary entries and/or the speaker's intuition give us the general idea. The contexts in which the word occurs allows us to remove the word, replace it with an antonym, synonym, or other cognate word and see what happens to the meaning of the sentence. Obviously, if the entry being acquired is synonymous to a previously acquired entry, the problem is solved even though there are no identical synonyms in languages, and the distinctions between two synonyms, represented by their diagnostic constructions, i.e., contexts in which one of them fits and the other does not (see, for instance, Raskin and Weiser 1987: 115), should be carefully checked out; we may, in fact, have identical synonyms in the selected grain-size: in that case the set of diagnostic constructions will be conveniently empty.

Let us focus, however, on the most difficult and interesting case, when we do not get any easy escapes. If we find no previously acquired close meaning cognates and we cannot quite figure out how to bend a dictionary entry into our framework, we should focus on the contexts in which the word occurs. Bloomfield's unfriendly advice would be to look for the features brought by the word into each situation in which it is uttered, focusing on the distinctive features (see Bloomfield 1935: 139; cf. Alston 1964: 26-28). Now, Bloomfield introduced this definition only to declare meaning unknowable. Alston is not too hopeful about this approach either.

If, while working on the word *shirt*, the very one that baffled Alston, in its garment sense, we attempt an IS-A hypothesis, such as (99), linguistics offers a standard test to confirm or falsify such a hypothesis: we do it by negating it as, for instance, in (99ii). If the resulting negative sentence makes no sense, the semantic element hypothesized about is indeed part of the meaning of the word (cf. Raskin 1986: 53-54).

(99) (i) A shirt is a garment.
(ii) *I have a shirt but I have no garment.

If, on the other hand, the negation of a hypothesis (100i) makes sense (100ii), the semantic element hypothesized about is not part of the meaning of the word:

(100) (i) Shirts have collars.
(ii) I have a shirt which has no collar.

This test, which we call "the deniability filter," weeds out presuppositions, entailments, and inferences from the meaning of the word proper. Thus, marriage may be firmly associated in the mind of the native speaker with sexual intercourse, but the deniability filter in (101ii) effectively removes sex from the meaning of marriage:

(101) (i) Sex is an obligatory aspect of a marriage.
(ii) John and Mary are husband and wife, but they have never made love to each other.

The deniability filter (102ii) confirms the hypothesis (102i) as the only semantic element in the def-

inition of marriage:

(102) (i) Marriage is legal procedure which makes two people which undergo it with each other married to each other.
(ii) *John and Mary are husband and wife but they have never undergone any legal procedure making them so.

By the same token, an adjective like *round* can be described, using the property of shape (103i--successfully) or the property of ability to roll (104i--unsuccessfully):

(103) (i) Roundness is a shape
(ii) *I saw a round object, which had no particular shape.
(104) (i) Roundness means the ability to roll.
(ii) I saw a round object, but it could not roll.

At this point, we are ready to see how the algorithm in (98) helps us in the process of acquisition. The first decision to make is whether the adjective modifies semantically the noun it modifies syntactically. The decision is made much easier for us by the finding that all those adjectives which definitely do not are of a temporal nature (see, for instance, example (40) above). Our framework assigns temporal information to events, and it properly belongs together with the aspect-related information in modality.

The next question to answer is whether the adjective is an attitude or a property. We have two attitudes, evaluative and saliency, so all the evaluation-attribute adjectives, such as *good*, *bad*, *superb*, *awful*, etc. (see example (45) above), and the saliency-attribute adjectives, such as *important*, *unimportant*, *significant*, *prominent*, etc. (see examples (53ii) and (59) above) belong here. All other adjectives are treated as properties.

We are approaching the most critical part of the procedure, but there is one "easy" question left: is the adjective a morphological derivative of a noun or a verb, such that the meaning of the adjective "follows" from the meaning of the underlying noun or verb. This is particularly easy to establish when the morphological derivation follows the standard N--->Adj or V--->Adj route, such as in (105i-ii). If a noun and a verb of the same root may both claim an adjective, we give preference to the latter (106). It is a little less trivial to relate an adjective to an underlying verb, for instance, "suppletively," which can, of course be done only semantically, as in (107--cf. (71)).

(105) (i) abusive <--- abuse
(ii) national <--- nation
(106) (i) *successful <--- success
(ii) successful <--- succeed
(iii) success <--- succeed
(107) audible <--- hear

The noun-derived adjectives are clearly demarcated from cases like (108), where the noun is obviously derived from the adjective. Such nouns are, in fact, treated as attributes semantically as well (see Section 2.3 above).

(108) red ---> redness

As we already established in Sections 3.3-4 above, the LEX-MAPs of the adjectives truly derived from verbs or nouns (deverbals and denominals, respectively) are created from the LEX-MAPs of the corresponding verbs or nouns with the help of lexical rules.

The remaining adjectives are scalars, and the task we face is to assign each of them to an appropriate scale. Obviously, with each new adjective, we must decide if it fits into an existing scale or it requires the addition of a new scale. Before answering this question, let us discuss the conditions of "membership" in a scale.

There are two types of scale, as we know, numerical ones and literal ones (see also Section 3.3). If we suspect that the adjective we are processing belongs on an existing numerical scale we must place it there with a certain numerical value, which in most cases will be greater than that of some other adjectives and less than that of still others. We can then check on the comparative constructions involving these adjectives.

Thus, if the currently-processed adjective is *minuscule* and the candidate scale is, of course, SIZE, and we tentatively place the adjective on the scale with a value greater than *microscopic* but less than *itty-bitty* (109), then the two comparative statements in (110) should obtain.

(109) microscopic < minuscule < itty-bitty
(110) (i) X is minuscule, Y is microscopic: therefore X is bigger than Y.
(ii) X is minuscule, Y is itty-bitty: therefore X is smaller than Y.

If the existing scale is literal, such as, for instance SHAPE (see (61)), the operation is a little more evolved. What is true for the different values on a literal scale is that no object can have two of them at the same time (111). (112), a generalization of (111) is not, however, a sufficient condition for Y and Z to belong on the same scale because Y and Z may be very different in meaning but incapable to modify the same type of noun; thus, for instance, if Y = round and Z = psychological, the former may define only physical-objects and the latter only mental-objects. Something like (113) will definitely work for the SHAPE scale, and some variation of its generalized formula (114) should work for other literal scales as well.

(111) X cannot be both round and square.
(112) X cannot be both Y and Z.
(113) X cannot be both round and square, and round and square are both shapes.
(114) X cannot be both Y and Z, and Y and Z are both [scale-name N or NP].

It may seem that the second propositions of (113-114) should suffice to determine the membership of an adjective on a literal scale, but if, for instance, our current adjective is *rectangular* and we have already placed *square* on the SHAPE scale, (115) will incorrectly accept the former adjective as another value on the scale but it will fail the (112/114) test in (116), prompting a more complicated resolution of such a case (e.g., replace the square value on the scale with the more general rectangular value).

(115) Rectangular and square are both shapes.
(116) *X cannot be both rectangular and square.

These considerations about literal scales guide the postulation of a new literal scale. If we are processing the adjective *front* and we don't have a scale for it, we must first come up with related ad-

jectives to which *front* stands in a relation described in (114). An antonym like *back* usually comes to mind the easiest. We may want to add the *left-side*, *right-side*, and even *top* and *bottom* value to the same scale, but we will not get away with adding *inside* and *outside* as values because front and inside, for instance, will fail the (112) test. (There are, in fact, reasons not to add *top* and *bottom* to the same scale with *front* and *back* as well, because there are objects with fronts and backs but no tops and bottoms, such as a fence.)

Similar considerations guide the postulation of new numerical values, except that the tests are, of course, based on (110). Antonyms still play an important role, evoking in a way the status accorded them in the work of Miller and his associates (see Section 1.8). If, for instance, the currently processed adjective is *humble*, *arrogant* is likely to follow, and *modest* (in one of its senses) and *proud* may be prompted by such a tool as a thesaurus or a synonym dictionary. These tools have to be used with caution because they list words in each entry quite loosely, quickly abandoning the domain of real synonyms or even closely related meanings. The greater availability of such tools for numerical values does make their acquisition easier than that of literal values. These adjectives will quickly pass the (110) test among themselves, but they will fail it with regard to other scales. This is a serious reason to open a new scale such as PRIDE-ATTRIBUTE.

The procedures described in this section go beyond mere heuristics because they are firmly anchored in the adjective microtheory within the ontological semantic approach. The choices the acquirer faces are much more rigid than the questions themselves may imply; the choices are limited by the framework; and the decision-making is rigorous and, occasionally and with luck, algorithmic.

It is customary to believe both in linguistics and in the philosophy of science, in general, that heuristics are a matter of experience, trial and error, and the resulting intuition. What we claim here is that a microtheory-based heuristics is much more--and much more useful--than just that.

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References

Åqvist, L. 1979. Predicate calculi with adjectives and nouns. Mimeo, University of Stuttgart.

Aarts, Joannes M. G. A. 1976. Adjective-Noun Combinations: A Model for Their Semantic Interpretation. Unpublished Ph.D. Thesis, University of Nijmegen.

Abraham, Werner 1970. Passiv und Verbableitung auf e. -able, dt. -bar. *Folia Linguistica* 4, pp. 38-52.

Agent, A., I. Castellon, G. Rigau, H. Rodriguez, M. F. Verdejo, M. A. Marti, and M. Taule 1992. SEISD: An environment for extraction of semantic information from online dictionaries. In: **Proceedings of the 3rd Conference on Applied Natural Language Processing--ANLP '92** . Trento, Italy, pp. 253-255.

Ahlswede, Thomas E., Martha Evans, K. Rossi, and Judith Markowitz 1985. Building a lexical database by parsing Webster's Seventh Collegiate Dictionary. In: **Advances in Lexicology. Proceedings** . Waterloo, Ontario, Canada, pp. 65-78.

Alston, William P. 1964. **Philosophy of Language** . Englewood Cliffs, N.J.: Prentice-Hall.

The American Heritage Electronic Dictionary of the English Language 1992. 3rd Edition. New York: Houghton Mifflin.

Amsler, Robert A. 1982. Computational lexicology: A Research Program. In: **AFIPS. Proceedings of the National Computer Conference** , Vol. V, pp. 657-663.

Amsler, Robert A. 1984a. Lexical knowledge bases. In: **Proceedings of COLING '84** . Stanford, CA: Stanford University, pp. 458-459.

Amsler, Robert A. 1984b. Machine-readable dictionaries. In: M. E. Williams (ed.), **Annual Review of Information Science and Technology** , Vol. 19. White Plains, N.Y.: Knowledge Industry Publications, pp. 161-209.

Apresyan Yury D., Igor' A. Mel'čuk, and Alexander K. Zholkovsky 1969. Semantics and lexicography: Towards a new type of unilingual dictionary. In: F. Kiefer (ed.), **Studies in Syntax and Semantics** . Dordrecht: Reidel, pp. 1-33.

Apresyan Yury D., Igor' A. Mel'čuk, and Alexander K. Zholkovsky 1973. Materials for an explanatory combinatory dictionary of Modern Russian. In: F. Kiefer (ed.), **Trends in Soviet Theoretical Linguistics** . Dordrecht: D. Reidel, pp. 411-438.

Arnauld et Lancelot 1660. **Grammaire générale et raisonnée** , ed. 1676. Facsimile edition Paris: Republications Paulet, 1969.

Babby, Leonard 1971. A Transformational Analysis of Russian Adjectives. Unpublished Ph.D. Thesis, Harvard University, Cambridge, MA.

Babby, Leonard 1973. The deep structure of adjectives and participles in Russian. *Language* 49: pp. 349-360.

Bache, Carl 1978. **The Order of Pre-modifying Adjectives in Present-Day English** . Odense: Odense University Press.

Baldi, P. 1987. Prefixal negation of English adjectives: Psycholinguistic dimensions of productivity. In: G. Gardona and N. H. Zide (eds.), **Festschrift for Henry Hoenigswald** . Tübingen: Günter Narr, pp. 37-44.

Bally, Charles 1909. **Traité de stylistique française** . Heidelberg: no pub.

Bally, Charles 1944. **Linquistique générale et linguistique française** , 2nd ed., Berne: Francke.

Bartning, Inge 1976. **Remarques sur la syntaxe et la sémantique des pseudo-adjectifs dénominaux en français** . Stockholm: Institut d'Etudes Romanes, University of Stockholm.

Bartning, Inge 1976/1980. **Remarques sur les pseudoadjectifs dénominaux en français** . Stockholm: Acta Universitatis Stockholmiensis 10. AWE International.

Bartning, Inge, and Michèle Noailly 1993. Du relationnel au qualificatif: Flux et reflux. *Information grammaticale*, pp. 27-32.

Bartsch, Renate 1976. **The Grammar of Adverbials** . New York: North Holland.

Bartsch, Renate, and Theo Venemann 1972. **Semantic Structures** . Frankfort: Athenaum.

Barwise, Jon, and John Perry 1983. **Situations and Attitudes** . Cambridge, MA: M.I.T. Press.

Beale, Stephen, Sergei Nirenburg, and Kavi Mahesh 1995. Semantic Analysis in the Mikrokosmos Machine Translation Project. In **Proceedings of the Second Symposium on Natural Language Processing (SNLP-95)** , Bangkok, Thailand.

Beckwith, Richard, Christiane Fellbaum, Derek Gross, and George A. Miller 1991. WordNet: A lexical database organized on psycholinguistic principles. In: Uri Zernik (ed.), **Lexical Acquisition: Exploiting On-line Resources to Build a Lexicon** . Hillsdale, N.J.: Erlbaum, pp. 211-232.

Benson, Morton 1985. Lexical combinability. *Papers in Linguistics* 18. Special Issue: William J. Frawley and R. Steiner (eds.), **Advances in Lexicography** , pp. 3-15.

Benson, Morton, Evelyn Benson, and Robert Ilson 1986. **Lexicographic Description of English** . Amsterdam: John Benjamins.

Berman, Arlene 1973. Adjectives and Adjective Complement Constructions in English. Unpublished Ph.D. Thesis, Harvard University.

Berman, Arlene 1974. Adjectives and Adjective Complement Constructions in English. Technical report No. NSF-29. Department of Linguistics, Harvard University, Cambridge, MA.

Bernstein, Judy B. 1995. Adjectives and their complements. Paper presented at the 1995 LSA Annual Meeting.

Bierwisch, Manfred 1967. Some semantic universals of German adjectivals. *Foundations of Language* 5:1, pp. 1-36.

Bierwisch, Manfred 1989. Focussing on dimensional adjectives: Introductory remarks. In: Manfred Bierwisch and Ewald Lang (eds.), **Dimensional Adjectives and Conceptual Interpretation** . Berlin-Heidelberg: Springer-Verlag, pp. 1-11.

Black, Max 1954-55. Metaphor. *Proceedings of the Aristotelian Society* 55, pp. 273-294. Reprinted in: Max Black, **Models and Metaphors** . Ithaca, N.Y.: Cornell University Press, 1962.

Black, Max 1979. More about metaphor. In: Andrew Ortony (ed.), **Metaphor and Thought** . Cambridge: Cambridge University Press.

Bloomfield, Leonard 1935. **Language** . London: George Allen and Unwin.

Boguraev, Bran, and Ted Briscoe 1987. Large lexicons for natural language processing: Exploring the grammar coding system for LDOCE. *Computational Linguistics* 13, pp. 203-218.

Boguraev, Bran, and Edward J. Briscoe 1989. **Computational Lexicography for Natural Language Processing** . London: Longman.

Boguraev, Bran, Ted Briscoe, J. Carroll, D. Carter, and C. Grover 1987. The derivation of a grammatically indexed lexicon from the Longman Dictionary of Contemporary English. In: **Proceedings of ACL '87** . Stanford, CA: Stanford University, pp. 193-200.

Boguslawski, Andrzej 1975. Measures are measures: in defense of the diversity of comparatives and positives. *Linguistische Berichte* 36:75, pp. 1-9.

Bolinger, Dwight 1965. Atomization of meaning. *Language* 41:4, pp. 555-573.

Bolinger, Dwight 1967a. Adjectives in English: Attribution and predication. *Lingua* 18, pp. 1-34.

Bolinger, Dwight 1967b. Adjective comparison: a semantic scale. *Journal of English Linguistics* 1, pp. 2-10.

Bolinger, Dwight 1972. **Degree words** . The Hague: Mouton.

Bonnard, H. 1960. L'attribut se rapport-t-il au nom? *Le français moderne* 23, pp. 241-248.

Borodina, M. A. 1963. L'adjectif et les rapports entre sémantique et grammaire en français moderne. *Le Français moderne* 31, pp. 193-98.

Bosredon, A. 1988. Un adjectif de trop, l'adjectif de relation. *Information grammaticale* 37, pp. 3-7.

Bouillon, Pierrette, and Viegas, Evelyne 1994. A semi-polymorphic approach to the interpretation of adjectival constructions: A cross-linguistic perspective. In: **Proceedings of the Sixth EURALEX International Congress** , Amsterdam: Free University of Amsterdam, pp. 36-44.

Bourdieu, Pierre 1977. **Outline of a Theory of Practice** . Cambridge: Cambridge University Press.

Bresnan, Joan 1973. Syntax of the comparative construction in English. *Linguistic Inquiry* 4, pp. 275-345.

Briscoe, Edward J., Ann Copestake, and Bran Boguraev 1990. Enjoy the paper: Lexical semantics via lexicology. In: **Proceedings of COLING '90** . Helsinki, Finland, pp. 42-47.

Briscoe, Ted, Valeria de Paiva, and Ann Copestake (eds.) 1993. **Inheritance, Defaults, and the Lexicon** . Cambridge: Cambridge University Press.

Calzolari, Nicoletta 1984. Machine-readable dictionaries, lexical database and the lexical system. In: **Proceedings of COLING '84** . Stanford, CA: Stanford University, p. 460.

Cann, Ronnie 1991. **Formal Semantics: An Introduction** . Cambridge: Cambridge University Press.

Carlson, Lynn, and Sergei Nirenburg 1990. World modeling for NLP. Technical Report CMU-CMT-90-121, Center for Machine Translation, Carnegie Mellon University, Pittsburgh, PA.

Charles, W. G., and G. A. Miller 1989. Contexts of antonymous adjectives. *Applied Psycholinguistics* 10, pp. 357-375.

Chevalier, J.-C., C. Blanche-Benveniste, M. Arrivé, and J. Peytard 1964. **Grammaire Larousse du français contemporain** . Paris: Larousse.

Chierchia, Gennaro, and Sally McConnell-Ginet 1990. **Meaning and Grammar: An Introduction to Semantics** . Cambridge, MA-London: M.I.T. Press.

Chodorow, Martin S., Roy J. Byrd, and George E. Heidorn 1985. Extracting semantic hierarchies from a large on-line dictionary. In: **Proceedings of ACL '85** . Chicago: University of Chicago, pp. 299-304.

Chomsky, Noam 1957. **Syntactic Structures** . The Hague: Mouton.

Chomsky, Noam 1965. **Aspects of the Theory of Syntax** . Cambridge, MA: M.I.T. Press.

Claude, P. 1981. La relation adjectif-nom en français et en anglais. *Information grammaticale* 11, pp. 11-18.

Clements, J. Clancy 1988. The semantics and pragmatics of the Spanish <COPULA + ADJECTIVE> construction. *Linguistics* 26, pp. 770-822.

Congleton, J. E., J. Edward Gates, and Donald Holar (eds.) 1979. **Papers in Lexicography in Honor of War-**

ren N. Cordell . Terre Haute, IN: The Dictionary Society of America-Indiana State University.

Conte, Maria-Elisabeth 1973. L'aggettivo in Italiano--Problemi sintattici. *Storia Linguistica Dell' Italia nel Novecento*.

Copestake, Ann 1990. An approach to building the hierarchical element of a lexical knowledge base from a machine readable dictionary. In: **Proceedings of the First International Workshop on Inheritance in Natural Language Processing** . Toulouse, France, pp. 19-29.

Copestake, Ann 1992. The ACQUILEX LKB: Representation issues in semi-automatic acquisition of large lexicons. In: Proceedings of the 3rd Conference on Applied Natural Language Processing--ANLP '92. Trento, Italy, pp. 88-96.

Cresswell, Max 1985. **Adverbial Modification** . Dordrecht: Reidel.

Cullingford, Richard E. and Mark A. Graves 1987. Knowledge acquisition for NLP: Two prospects. In: Sergei Nirenburg (ed.), **Proceedings of Natural Language Planning Workshop** . RADC: Blue Mountain Lake, N.Y., pp. 47-55.

Cutler A. 1972. A note on a reference by J. D. McCawley to adjectives denoting temperature. *Linguistics* 87, pp. 47-49.

Cygan, Jan 1975. Synthetical comparatives in English. *Bulletin de la Societé Polonaise de Linguistique* XXXIII, pp. 53-57.

Damerau, Fred J. 1975. On "fuzzy" adjectives. IBM Research Report RC 5340. Thomas J. Watson Research Center. Yorktown Heights, N.Y.

Danks, J. H., and S. Glucksberg 1971. Psychological scaling of adjective order. *Journal of Verbal Learning and Verbal Behavior* 10, pp. 63-67

Danks, J. H. and M. A. Schwenk 1972. Prenominal adjective order and communication context. *Journal of verbal learning and verbal behavior* 11, pp. 183-187.

Davidson, Donald 1978. What metaphors mean. *Critical Inquiry* 5:1. Reprinted in: Sheldon Saks (ed.), **On Metaphor** . Chicago: University of Chicago Press, 1979, pp. 29-45.

Dell, F. 1970. Les règles phonologiques tardives et la morphologie dérivationnelle du français. Unpublished Ph.D. Thesis, Massachusetts Institute of Technology.

Deese, J. 1964. The associative structure of some English adjectives. *Journal of Verbal Learning and Verbal Behavior* 3, pp. 347-357.

Deese, J. 1965. **The Structure of Associations in Language and Thought** . Baltimore: Johns Hopkins Press.

Dirven, Rene (ed.) 1989. **User's Grammar of English: Word, Sentence, Text, Interaction** . Berlin: Peter Lang.

Dixon, Robert M. W. 1982. Where Have All the Adjectives Gone? In: Robert M. W. Dixon, **Where Have All the Adjectives Gone? and Other Essays in Semantics and Syntax** . Berlin-Amsterdam-New York: Mouton, pp. 1-62.

Dowty, David 1972. Temporally descriptive adjectives. In: John Kimball (ed.), **Syntax and Semantics** , Vol. I. New York: Seminar Press.

Dorr, Bonnie 1993. **Machine Translation: A View from the Lexicon** . Cambridge, MA: M.I.T. Press.

Entich, Veronika 1975. Pragmatische Restriktionen der Bedeutung von Graduierbaren Adjektiven und Vergleichsätzen. In: Veronika Entich and Peter Finke (eds.), **Beiträge zur Grammatik und Pragmatik** . Kronberg, Ts: Skriptor.

Farwell, David, Louise Guthrie, and Yorick A. Wilks 1993. Automatically creating lexical entries for ULTRA, a multilingual MT system. *Machine Translation* 8:3, pp.127-146.

Ferris, D. Connor 1993. **The Meaning of Syntax: a Study in the Adjectives of English** . London-New York: Longman.

Fillmore, Charles J. 1978. On the organization of semantic information in the lexicon. In: Donna Farkas *et al*. (eds.), **Papers from the Parasession on the Lexicon** . Chicago: Chicago Linguistic Society, pp.148-173.

Forsgren, Mats 1993. L'adjectif et la fonction d'apposition: observations syntaxiques, sémantiques et pragmatiques. *Information grammaticale* 58, pp. 15-22.

Fox, E. A., R. C. Wohlwend, P. R. Sheldon, Q. F. Chen, and R. K. France 1986. Building the CODER lexicon: The Collins English Dictionary and its adverb definitions. Technical Report 86-23, Department of Computer Science, Virginia Polytechnical Institute and State University, Blacksburg, VA.

Frawley, William 1992. **Linguistic Semantics** . Hillsdale, N.J.: Erlbaum.

Frege, Gottlob 1963. Compound thoughts. *Mind* 72, pp. 1-17.

Giatigny, M. 1966. L'adjectif en apposition se rapporte-t-il au nom? *Le Français moderne*, pp. 264-279.

Givón, Talmy 1970. Notes on the semantic structure of English adjectives. *Language* 46:4.

Givón, Talmy 1984. **Syntax: A Functional-Typological Introduction** , Vol. I. Amsterdam: John Benjamins.

Gnutzman, Claus 1974. Zur Graduierbarkeit von Adjektiven in Englischen. *Linguistische Berichte* 31:74, pp. 1-12.

Goes, Jan 1993. À la recherche d'une définition de l'adjectif. *Information grammaticale* 58, pp. 11-14.

Goyvaerts, D. L. 1968. An introductory study on the ordering of a string of adjectives in present-day English. *Philologica Pragensia* 11, pp. 12-28.

Grechko, B. A. 1962. Parallel'nye imena prilagatel'nye na *-icheskiy* i *-ichnyy* v sovremennom russkom literaturnom yazyke /The parallel adjectives ending in *-icheskiy* and *-ichnyy* in contemporary literary Russian/. In: **Leksikograficheskiy sbornik** No. 5. Moscow: Nauka, pp. 156-166.

Greimas, A. J. 1966. **Sémantique structurelle** . Paris: Larousse.

Grevisse, M. 1969. **Le bon usage** . Paris: Hatier, Gembloux.

Gross, Derek, Ute Fischer, and George A. Miller 1989. The organization of adjectival meanings. *Journal of memory and language* 28:1, pp. 92-106.

Grundt, L. O. 1970. **Etudes sur l'adjectif invarié en français** . Bergen-Oslo: Universitestsforlaget.

Hall, Fitzedward 1877. **On English Adjectives in -ABLE with Special Reference to RELIABLE** . London: Trübner.

Halliday, M. A. K. 1985. **An Introduction to Functional Grammar** . London-Baltimore: E. Arnold.

Hankamer, J. 1973. Why there are two than's in English. In: C. Corum. T. C. Smith-Stark, and A. Weiser (eds.), **Papers from the Ninth Regional Meeting of the Chicago Linguistic Society** . Chicago, IL: Chicago Linguistic Society.

Hartmann, R. R. K. (ed.) 1983. **Lexicography: Principles and Practice** . London: Academic Press.

Hayakawa, S. I. 1975**. Language in Thought and Action** , 3rd ed. New York: Harcourt Brace Jovanovich.

Hetzron, Robert 1978. On the relative order of adjectives. In: Hansjakob Seiler (ed.), **Language Universals** . Tübingen: Günter Narr, pp. 165-184.

Hietbrinck, M. 1985. A propos du statut exceptionnel des adjectifs dénominaux. *Langue Française* 66, pp. 41-53.

Higginbotham, J. 1989. Elucidations of meaning. *Linguistics and Philosophy* 12, pp. 465-517.

Hjelmslev, Louis 1928. **Principes de grammaire générale** . Copenhague: no pub.

Hjelmslev, Louis 1959. Pour une sémantique structurale. In: Louis Hjelmslev, **Essais Linguistiques** . Copenhague: Cercle Linguistique de Copenhague.

Hoepelman, Jaap 1983. Adjectives and nouns: A new calculus. In: Rainer Bäuerle, Christoph Schwarze, and Arnim von Stechow (eds.), **Meaning, Use, and Interpretation of Language** . Berlin-New York: Walter de Gruyter, pp. 190-220.

Householder, Fred, and Sol Saporta (eds.) 1967. **Problems in Lexicography** . Bloomington, IN: Indiana University Press, 2nd ed.

Howden, Marcia S. 1979. Structure in the lexicon: The French adjectives Neuf and Nouveau. In: Linda R. Waugh and Frans Van Coetsem (eds.), **Contribution to Grammatical Studies** . Leiden: Brill, pp. 70-92.

Ilson, Robert (ed.) 1986. **Lexicography: An Emerging International Profession. The Fulbright Colloquium on Lexicography** . Manchester: Manchester University Press/The Fulbright Commission (London).

Iwańska, Lucja 1995. Semantics, pragmatics, and context of intensional negative adjectives: Not a toy problem. Paper presented at the IJCAI '95 SIGLEX Workshop on "Context in Natural Language Processing," Montreal, August.

Jackendoff, Ray 1983. Semantics and Cognition. Cambridge, MA-London: M.I.T. Press.

Jamrozik, Elzbieta 1989. Description et appréciation dans les adjectifs qualificatifs. **Acta Universitatis Wratislaviensis No. 1064. Romanica Wratislaviensia** . Wroclaw: University of Wroclaw, pp. 129-134.

Jespersen, Otto 1929. **The Philosophy of Grammar** . London: Allen & Unwin. Reprinted New York: Norton, 1965.

Jespersen, Otto 1942**. A Modern English Grammar on Historical Principles. Part 6: Morphology** . Copenhagen: Munksgaard.

Justeson, John S., and Slava M. Katz 1991. Co-occurrences of antonymous adjectives and their contexts. *Computational Linguistics* 17:1, pp. 1-19.

Justeson, John S., and Slava M. Katz 1995. Principled disambiguation: Discriminating adjective senses with modified nouns. *Computational Linguistics* 21:1, pp. 1-27.

Kalik, A. 1967. L'expression des rapports de déterminé à déterminant/adjectifs de relation. *Le Français moderne* 35, pp. 270-285.

Kamp, H. 1975. Two theories of adjectives. In: Edward L. Keenan (ed.), **Formal Semantics of Natural Languages** . Cambridge: Cambridge University Press, pp. 123-155.

Katlinskaya, L. P. 1977. Ob odnoy kategorii slov v razryade otnositel'nykh prilagatel'nykh sovremennogo russkogo yazyka /On a group of words in the class of relational adjectives in contemporary Russian/. In: **Grammatika i norma** . Moscow: Nauka, pp. 92-106.

Katz, Jerrold 1972. Semantic theory and the meaning of good. *Journal of Philosophy* 61, pp. 736-760.

Katz, Jerrold J. 1972/1974. **Semantic Theory** . New York: Harper and Row.

Katz, Jerrold J. 1978. Effability and translation. In: F. Guenthner and M. Guenthner-Reutter (eds.), **Meaning and**

Translation: Philosophical and Linguistic Approaches . London: Duckworth, pp. 191-234.

Katz, Jerrold J., and Jerry A. Fodor 1963. The structure of a semantic theory. *Language* 39:1, pp. 170-210.

Kayne, Richard S. 1994. **The Antisymmetry of Syntax** . Cambridge, MA: M.I.T. Press.

Keenan, Edward L., and L. M. Faltz 1985. **Boolean Semantics for Natural Language** . Dordrecht-Boston: D. Reidel.

Kiefer, Ferenc 1978. Adjectives and presuppositions. *Theoretical linguistics* 5:2-3, pp. 135-173.

Kim, Stanislav L. 1986**. Semantika otnositel'nykh prilagatel'nykh russkogo i uzbekskogo yazykov** /The semantics of relational adjectives in Russian and Uzbek/. Tashkent: Fan.

Kipfer, Barbara Ann 1984. **Workbook on Lexicography** . Exeter: University of Exeter.

Kjellmer, Göran 1986. Legible but not readable: On the semantics of English adjectives in *-ble*. *Studia Neophilologica* 58:1, pp. 11-38.

Klein, E. 1980. A semantics for positive and comparative adjectives. *Linguistics and Philosophy* 4:1, pp. 1-45.

Klein E. 1981. The interpretation of adjectival, nominal, and adverbial comparatives. In: Stokhof, Groenendijk, and Janssen (eds.), **Formal Methods in the Study of Language** , Mathematical Centre Tracts, Amsterdam.

Knight, Kevin 1993. Building a large ontology for machine translation. In: **Proceedings of the ARPA Human Language Technology Workshop** . Princeton, N.J.

König, E. 1971. **Adjectival Constructions in English and German. A Comparative Analysis** . Heidelberg: Julius Groos.

Kratochvíl, P. 1968. **The Chinese Language Today** . London: Hutchinson.

Lahav, Ran 1989. Against compositionality: The case of adjectives. *Philosophical Studies* 57, pp. 261-279.

Lakoff, George 1966. Stative adjectives and verbs in English. Report No. NSF-17. Harvard Computational Laboratory, Cambridge, MA.

Lakoff, George 1987. **Women, Fire, and Dangerous Things** . Chicago: Chicago University Press.

Lakoff, George, and Mark Johnson 1980. **Metaphors We Live by** . Chicago: Chicago University Press.

Landau, Sidney I. 1984. **Dictionaries: The Art and Craft of Lexicography** . New York: Charles Scribner's Sons.

Landheer, Ronald, and Julia C. Szirmai 1988. Les effets sémantiques de la recatégorisation de l'adjectif. In: Ronald Landheer (ed.), **Aspect de linguistique française. Hommage à Q. I. M. Mok** . Amsterdam: Rodopi, pp. 119-140.

Langacker, Ronald W. 1987. **Foundations of Cognitive Grammar** , Vol. 1. Stanford: Stanford University Press.

Larson, Richard 1983. Restrictive modification: Relative Clauses and Adverbs. Unpublished Ph.D. Thesis, University of Wisconsin, Madison, WI.

Larson, Richard 1995. Olga is a beautiful dancer. Paper presented at the 1995 LSA Annual Meeting.

Larson Richard, and G. Segal 1995. **Knowledge of Meaning** . Cambridge, MA: Bradford Books/MIT Press.

Lees, Robert B. 1960. **The Grammar of English Nominalizations** . *International Journal of American Linguistics* 26 Supplement, Publication 12.

Lees, Robert B. 1961. Grammatical analysis for the English comparative construction. *Word* 17, pp. 171-85.

Leitzke, E. 1989. **(de)nominale Adjektive im heutigen Englisch** . Tübingen: Niemeyer.

Levi, Judith N. 1973. Where do all these other adjectives come from? In: C. Corum. T. C. Smith-Stark, and A. Weiser (eds**.), Papers from the Ninth Regional Meeting of the Chicago Linguistic Society** . Chicago: Chicago Linguistic Society, pp. 332-345.

Levi, Judith N. 1975. The Syntax and Semantics of Nonpredicating Adjectives in English. Unpublished Ph.D. Thesis, University of Chicago. Distributed by the Indiana University Linguistics Club.

Levi, Judith N. 1978. **The Syntax and Semantics of Complex Nominals** . New York: Academic Press.

Levin, Beth 1991. Building a lexicon: The contribution of linguistics. *International Journal of Lexicography* 4:3, pp. 205-226.

Levin, Beth 1992. **Towards a Lexical Organization of English Verbs** . Chicago: University of Chicago Press.

Levin, Lori and Sergei Nirenburg 1994. Construction-based MT lexicons. In: Antonio Zampolli, Nicoletta Calzolari, and Martha Palmer (eds.), **Current Issues in Computational Linguistics: In Honour of Don Walker** . Dordrecht-Piza: Kluwer-Giardini, pp. 321-338.

Lewandowska-Tomaszczyk, Barbara, and Jerzy Tomaszczyk 1990. Introduction. In: Jerzy Tomaszczyk and Barbara Lewandowska-Tomaszczyk, pp. xi-xxvii.

Lewis, David 1972. General semantics. In: Donald Davidson and Gilbert Harman (eds.), **Semantics of Natural Language** . Dordrecht: D. Reidel, pp. 169-218. Reprinted in: Barbara H. Partee (ed.), **Montague Grammar** . New York: Academic Press, 1976, pp. 1-50.

Ljung, M. 1970. **English Denominal Adjectives** . Göteborg: Acta Universitatis Gothoburgensis.

Lord, John B. 1970. Sequence clusters of pre-nominal adjectives. *Journal of English Language* 4, pp. 57-69.

Loux, M. J. 1978. **Substance and Attribute: A study in Ontology** . Dordrecht: D. Reidel.

Lujan, M. 1980. **Sintaxis y semantica del adjetivo** . Madrid: Cátedra.

Lyons, John 1977. **Semantics** . Cambridge: Cambridge University Press.

Mahesh, Kavi, and Sergei Nirenburg 1995. A situated ontology for practical NLP. A paper presented at the IJCAI '95 Workshop on Basic Ontological Issues in Knowledge Sharing. Montreal, August 19-21.

Marchand, Hans 1960. **The Categories and Types of Present-Day English Word-Formation** . Wiesbaden.

Marchand, Hans 1966. On attributive and predicative derived adjectives and some problems related to their distinction. *Anglia* 84, pp. 131-149.

Marchand, Hans 1969. **The Categories and Types of Present-Day English Word-Formation,** 2nd ed. München: Beck.

Markowitz, Judith, Thomas Ahlswede, and Martha Evans 1986. Semantically significant patterns in dictionary definitions. In: **Proceedings of ACL '86** . New York, pp. 112-119.

Martin, J. E. 1969a. Semantic determinants of preferred adjective order. *Journal of Verbal Learning and Verbal Behavior* 8, pp. 697-704.

Martin, J. E. 1969b. Some competence-process relationships in noun phrases with prenominal and postnominal adjectives. *Journal of Verbal Learning and Verbal Behavior* 8, pp. 471-480.

Martin, J. E. 1970. Adjective Order and Juncture. *Journal of Verbal Learning and Verbal Behavior* 9, pp. 379-384.

Martin R. 1986. Le vague et la sémantique de l'adjectif. Réflexions sur l'adjectif antéposé en français. *Quaderni di Semantica* VII:2, pp. 246-63.

Marx, Wolfgang 1977. Die Kontextabhängigkeit der Assoziativen Bedeutung. *Zeitschrift für experimentelle und angewandte Psychologie* 24, pp. 455-462.

Marx, Wolfgang 1983. The meaning-confining function of the adjective. In: by Gert Rickheit and Michael Bock (eds.), **Psycholinguistic studies in language processing** . Berlin: Walter de Gruyter, pp. 70-81.

Maurel, J. P. 1993. Des adjectifs de relation en Latin. *Information grammatical*e 58, pp. 23-26.

McCawley, James D. 1968. The role of semantics in a grammar. In: Emmon Bach and Robert T. Harms (eds.), **Universals in Linguistic Theory** . New York: Holt, Rinehart, and Winston, pp. 124-169.

McCawley, James D. 1986. What linguists might contribute to dictionary making if they could get their act together. In: Peter C. Bjarkman and Victor Raskin (eds.), **The Real-World Linguist: Linguistic Applications in the 1980s** . Norwood, N.J.: Ablex, pp. 1-18.

McCawley, James D. 1988. **The Syntactic Phenomena of English** , Vol. II. Chicago: Chicago University Press.

McConnell-Ginet, Sally 1982. Adverbs and logical form. *Language* 58, pp. 144-184.

McDavid, Raven I., and Audrey R. Duckert (eds.) 1973. **Lexicography in English** . Annals of the New York Academy of Sciences.

Mélis-Puchulu, Agnès 1991. Les adjectifs denominaux: Des adjectifs de "relation." *Lexique* 10, pp. 33-60.

Mélis-Puchulu, Agnès 1993. Les adjectifs en -esque: D'abord des adjectifs construits. *Information grammaticale* 58, pp. 33-39.

Meus, V. 1975. English adjectives in -able. *Studia Germanica Gandensia* 16, pp. 35-59.

Meyer, Ingrid, Boyan Onyshkevych, and Lynn Carlson 1990. Lexicographic principles and design for knowledge-based machine translation. Technical Report CMU-CMT-90-118, Center for Machine Translation, Carnegie Melon University, Pittsburgh, PA.

Miller, George A., and Christiane Fellbaum 1991. Semantic networks of English. *Cognition* 41, pp. 197-229.

Miller, George A., Christiane Fellbaum, J. Kegl, and K. Miller 1988. Wordnet: An electronic lexical reference system based on theories of lexical memory. *Révue Québecoise de Linguistique* 17, pp. 181-211.

Montague, Richard 1974. **Formal Philosophy. Selected Papers of Richard Montague** . Ed. by Richmond Thomason. New Haven, CT: Yale University Press.

Nemchenko, V. N. 1974. Semanticheskaya struktura imen prilagatel'nykh s suffiksom -an- (-yan-, -yann-) v sovremennom russkom yazyke /The semantic structure of adjectives with the suffix -an- (-yan-, -yann-) in contemporary Russian. In: **Voprosy semantiki** , No. 1. Leningrad: Leningrad University Press, pp. 75-88.

Ney, J. W. 1981. Optionality and choice in the selection of order of adjectives in English. *General Linguistics* 23:2, pp. 94-128.

Nirenburg, Sergei 1980. Application of Semantic Methods in Description of Russian Morphology. Unpublished Ph.D. Thesis, The Hebrew University of Jerusalem.

Nirenburg, Sergei, Jaime Carbonell, Masaru Tomita, and Kenneth Goodman 1992. **Machine Translation: A Knowledge-Based Approach** . San Mateo, CA: Morgan Kaufmann.

Nirenburg, Sergei, and Christine Defrise 1991. Practical computational linguistics. In: Rod Johnson and Michael Rosner (eds.), **Computational Linguistics and Formal Semantics** . Cambridge: Cambridge University Press.

Nirenburg, Sergei, and Lori Levin 1992. Syntax-driven and ontology-driven lexical semantics. In: Pustejovsky and Bergler, pp. 5-20.

Nirenburg, Sergei, and Victor Raskin 1986. A metric for computational analysis of meaning: Toward an applied theory of linguistic semantics. **Proceedings of COLING '86** . Bonn, F.R.G.: University of Bonn, pp. 338-340. See the full version in: Nirenburg *et al*. 1985.

Nirenburg, Sergei, and Victor Raskin 1987a. The analysis lexicon and the lexicon management system. *Computers nd Translation* 2, pp. 177-88.

Nirenburg, Sergei, and Victor Raskin 1987b. The subworld concept lexicon and the lexicon management system. *Computational Linguistics* 13:3-4, pp. 276-289.

Nirenburg, Sergei, Victor Raskin, and Boyan Onyshkevych 1995. *Apologiae ontologiae*. Memoranda in Computer and Cognitive Science MCCS-95-281. New Mexico State University: Computing Research Laboratory. Reprinted in: Judith Klavans, Bran Boguraev, Lori Levin, and James Pustejovsky (eds.), **Symposium: Representation and Acquisition of Lexical Knowledge: Polysemy, Ambiguity, and Generativity. Working Notes** . AAAI Spring Symposium Series. Stanford, CA: Stanford University, 1995, pp. 95-107. Reprinted in a shortened version in: **TMI 95: Proceedings of the Sixth International Conference on Theoretical and Methodological Issues in Machine Translation** . Centre for Computational Linguistics, Catholic Universities Leuven Belgium, 1995, pp. 106-114.

Nirenburg, Sergei, Victor Raskin, and Allen B. Tucker (eds.) 1985. **The TRANSLATOR Project** . Hamilton, N.Y.: Colgate University.

Noailly, Michèle 1993. Sur un étrange privilège des adjectifs au comparative. *Information grammaticale* 58, pp. 47-51.

Nunberg, Geoffrey, and Annie Zaenen 1992. Systematic polysemy in lexicology and lexicography. In: **Proceedings of the EURALEX** . Tampere, Finland.

Okayed, Nauka 1990. Semantic analysis of basic adjectives by concept formation process. In: Werner Banner, Tacoma Scheldt, and Dieter Overeager (eds.), **Proceedings of the Fourteenth International Congress of Linguists** , Vol. II. Berlin: Academia-Verlag, pp. 1225-1227.

Onyshkevych, Boyan, and Sergei Nirenburg 1992. Lexicon, ontology, and text meaning. In: Pustejovsky and Bergler, pp. 289-303.

Onyshkevych, Boyan, and Sergei Nirenburg 1994. The lexicon in the scheme of KBMT things. Memoranda in Computer and Cognitive Science MCCS-94-277. Las Cruces, N.M.: New Mexico State University.

Ostler, Nicholas, and B. T. S. Atkins 1992. Predictable meaning shift: Some linguistic properties of lexical implication rules. In: Pustejovsky and Bergler, pp. 87-100.

Parsons, Terence 1972. Some problems concerning the logic of grammatical modifiers. *Synthèse* 21:3-4, pp. 320-334. Reprinted in: Donald Davidson and Gilbert Harman (eds.), **Semantics of Natural Language** . Dordrecht: Reidel, pp. 127-141.

Parsons, Terence 1980. Modifiers and quantifiers in natural language. *Canadian Journal of Philosophy* 6, Supplement, pp. 29-60.

Parsons, Terence 1985. Underlying events in the logical analysis of English. In: Ernest LePore and Brian P. McLaughlin (eds.), **Actions and Events: Perspectives on the Philosophy of Donald Davidson** , Oxford: Blackwell, pp. 235-267.

Parsons, Terence 1990. **Events in the Semantics of English: A Study of Subatomic Semantics** . Cambridge, MA: MIT Press.

Pavlov, V. M. 1960. O razryadakh imen prilagatel'nykh /On classes of adjectives/. *Voprosy yazykoznaniya*, No. 2, pp. 65-70.

Picabia, L. 1976. Sur trois classes d'adjectifs. In: J.-C. Chevalier and M. Gross (eds.), **Méthodes en grammaire français** . Paris: Klincksieck.

Picabia, L. 1978. **Les constructions adjectivales en français: systématique transformationnelle** . Génève: Droz.

Post, Michael 1981. **Comparatives of Identity in English: A Semantic Study** . Anglica Wratislaviensia IX. Wroclaw: Wydawnictwo Uniwersytetu Wroclawskiego.

Postal, Paul M. 1972. The derivation of English pseudo-adjectives. Unpublished manuscript, Thomas J. Watson Research Center, IBM, Yorktown Heights, N.Y.

Pinkham, Jessie E. 1982. The Formation of Comparative Clauses in French and English. Bloomington, IN: Indiana University Linguistics Club.

Pustejovsky, James 1991. The generative lexicon. *Computational Linguistics* 17:4, pp. 409-441.

Pustejovsky, James 1995. **The Generative Lexicon** . Cambridge, MA: M.I.T. Press.

Pustejovsky, James (ed.) 1993. **Semantics and the Lexicon** . Dordrecht-Boston-London: Kluwer.

Pustejovsky, James, and Sabine Bergler (eds.) 1992. **Lexical Semantics and Knowledge Representation** . Berlin: Springer-Verlag.

Quine, Willard Van Orman 1960. **Word & Object** . Cambridge, MA: M.I.T. Press.

Quirk, Randolph, and Sidney Greenbaum 1973. **A University Grammar of English** . London: Longman.

Quirk, Randolph, Sidney Greenbaum, Geoffrey Leach, and Jan Svartvik 1985. **A Comprehensive Grammar of the English Language** . London: Longman.

Raskin, Victor 1971. **K teorii yazukovykh podsistem** /Towards a Theory of Linguistic Subsystems/. Moscow: Moscow State University Press.

Raskin, Victor 1981. How to handle fake guns. **Meeting Handbook, Annual Meeting of the Linguistics Society of America** , New York.

Raskin, Victor 1986. Script-based semantic theory. In: Donald G. Ellis and William A. Donohue (eds.), **Contemporary Issues in Language and Discourse Processes** . Hillsdale, N.J.: Erlbaum, pp. 23-61.

Raskin, Victor 1987a. Linguistics and natural language processing. In: Sergei Nirenburg (ed.), **Machine Translation: Theoretical and Methodological Issues** . Cambridge: Cambridge University Press, pp. 42-58.

Raskin, V. 1987b. What is there in linguistic semantics for natural language processing? In: Sergei Nirenburg (ed.), **Proceedings of Natural Language Planning Workshop** . RADC: Blue Mountain Lake, N.Y., pp. 78-96.

Raskin, Victor 1990. Ontology, sublanguage, and semantic networks in natural language processing. In: Martin C. Golumbic (ed.), **Advances in Artificial Intelligence: Natural Language and Knowledge-Based Systems** . New York-Berlin: Springer-Verlag, pp. 114-128.

Raskin, Victor 1994. Frawley: Linguistic Semantics. A review article. *Language* 70: 3, pp. 552-556.

Raskin, Victor, Donalee H. Attardo, and Salvatore Attardo 1994a. The SMEARR semantic database: An intelligent and versatile resource for the humanities. In: Don Ross and Dan Brink (eds.), **Research in Humanities Computing 3** . Series ed. by Susan Hockey and Nancy Ide. Oxford: Clarendon Press, pp. 109-124.

Raskin, Victor, Salvatore Attardo, and Donalee H. Attardo 1994b. Augmenting formal semantic representation for NLP: The story of SMEARR. *Machine Translation* 9:1, pp. 81-98.

Raskin, Victor, and Irwin Weiser 1987. **Language and Writing: Applications of Linguistics to Rhetoric and Composition** . Norwood, N.J.: Ablex.

Rey, Alain 1977. **Le lexique: Images et modèles du dictionnaire à la lexicologie** . Paris: Armand Colin.

Read, Allen Walker 1973. Approaches to lexicography and semantics. In: Thomas E. Sebeok (ed.), **Current Trends in Linguistics** , Vol. X. The Hague: Mouton, pp. 145-205.

Riegel, Martin 1985. **L'adjectif attribut** . Paris: Presses Universitaires de France.

Riegel, Martin 1993. Grammaire et référence: à propos du statut sémantique de l'adjectif qualificatif. *Information grammaticale* 58, pp. 5-10.

Rivara, René 1975. How many comparatives are there? *Linguistics* 163, pp. 35-51.

Rivara, René 1993. Adjectifs et structure sémantiques scalaires. *Information grammaticale* 58, pp. 40-46.

Ross, John R. 1969. Adjectives as noun phrases. In: David A. Reibel and Sanford A. Schane (eds.), **Modern Studies in English. Readings in Transformational Grammar** . Englewood Cliffs, N.J.: Prentice-Hall, pp. 352-360.

Rusiecki, Jan 1985. **Adjectives and Comparison in English: A Semantic Study** . Harlow, Essex-New York: Longman.

Saint-Dizier, Patrick, and Evelyne Viegas 1995. **Computational Lexical Semantics** . Cambridge: Cambridge University Press.

Sanfilippo, A., and V. Poznanski 1992. The acquisition of lexical knowledge from combined machine-readable sources. In: **Proceedings of the 3rd Conference on Applied Natural Language Processing--ANLP '92** . Trento, Italy, pp. 80-88.

Sanfilippo, A., E. J. Briscoe, A. Copestake, M. A. Marti, and A. Alonge 1992. Translation equivalence and lexicalization in the ACQUILEX LKB. In: **Proceedings of the 4th International Conference on Theoretical and Methodological Issues in Machine Translation--TMI '92** . Montreal, Canada.

Sapir, Edward 1944. On grading: a study in semantics. *Philosophy of Science* 2, pp. 93-116. Reprinted in Edward Sapir**, Selected Writings in Language, Culture, and Personality** . Ed. by D. G. Mandelbaum. Berkeley, CA: University of California Press, 1949.

Sarma, C. R. S. 1991. A critique of Dixon's 'universal semantic types' hypothesis. *International journal of Dravidian Linguistics* 20:1, pp. 94-103.

Schooneveld, C. H. van 1969. On the word order in modern Russian. *International Journal of Slavic Linguistics and Poetics* 3, pp. 4--44.

Searle, John R. 1969. **Speech Acts** . Cambridge: Cambridge University Press.

Searle, John R. 1979. Metaphor. In: John R. Searle, **Expression and Meaning** . Cambridge: Cambridge University Press, pp. 76-116. Also printed in: Andrew Ortony (ed.), **Metaphor and Thought** . Cambridge: Cambridge University Press, 1979.

Seiler, Hansjakob 1978. Determination: A Functional dimension for interlanguage comparison. In: Hansjakob Seiler (ed.), **Language Universals** . Tübingen: Günter Narr, pp. 301-328.

Seymour, Deborah Mandelbaum 1995. New women's suitcases: The possessive-adjective switch. Paper presented at the LSA Annual Meeting.

Shramm, Aleksandr N. 1979. **Ocherki po semantike kachestvennykh prilagatel'nykh (na materiale sovremennogo russkogo yazyka)** /Essays in the semantics of qualitative adjectives (on the material of the Russian language/. Leningrad: Leningrad University Press.

Siegel, Muffy E. A. 1976a. Capturing the Adjective, Unpublished Ph.D. Thesis, University of Massachusetts, Amherst, MA.

Siegel, Muffy E. A. 1976b. Capturing the Russian adjective. In: Barbara H. Partee (ed.), **Montague Grammar** . New York: Academic Press, pp. 293-309.

Siegel, Muffy E. A. 1979. Measure adjectives in Montague grammars. In: Steven Davis and Marianne Mithun (eds.), **Linguistics, Philosophy, and Montague Grammar** . Austin, TX: University of Texas Press, pp. 223-261.

Slator, Brian M., and Yorick A. Wilks 1987. Towards semantic structures from dictionary entries. In: **Proceedings of the Second Annual Rocky Mountain Conference on Artificial Intelligence** . Boulder, CO, pp. 85-96.

Slocum, Jonathan, and Martha G. Morgan 1986. The role of dictionaries and machine-readable lexicons in translation. Unpublished Ms.

Smadja, Frank 1991. Macrocoding the lexicon with co-occurrence knowledge. In: Uri Zernik (ed.), **Lexical Acquisition: Exploiting On-line Resources to Build a Lexicon** . Hillsdale, N.J.: Erlbaum, pp. 165-189.

Spang-Hanssen, Ebbe 1990. La sémantique des adjectifs spatieux. *Revue Romane* 25:2, pp. 292-309.

Sproat, R. and C. Shih 1988. Prenominal adjectival ordering in English and Mandarin. In: **Proceedings of the North Eastern Linguistic Society (NELS)** 18, pp. 465-488.

Spejewski, Beverly 1995. Two classes of frequency adverbs. Paper presented at the LSA Annual Meeting.

Stalnaker, Robert, and Richard Thomason 1973. A semantic theory of adverbs. *Linguistic Inquiry* 4, pp. 195-220.

Stati, S., 1979. **La sémantique des adjectifs: Essai d'analyse componentielle appliquée aux langues romanes** . Saint-Sulpice-de-Faviers: J. Fayard.

Stephany, U. 1969. **Adjektivische Attributionkonstruktionen des Französischen** . Munich: W. Fink.

Strawson, Peter F. 1959. **Individuals: An Essay in Descriptive Metaphysics** . Thetford, Norfolk: Lowe & Brydone.

Sussex, Ronald 1974. The deep structure of adjectives in noun phrases. *Journal of Linguistics* 10, pp. 111-131.

Svensén, Bo 1993. **Practical Lexicography: Principles and Methods of Dictionary-Making** . Oxford: Oxford University Press.

Swart, Henriëtte de 1991. Adverbs of Quantification: A Generalized Quantifier Approach. Unpublished Ph.D. Thesis, Groningen University.

Szalay, L. B., and J. Deese 1978. **Subjective Meaning and Culture: An Assessment Through Word Association** . Hillsdale, N.J.: Erlbaum.

Tamba-Mecz, I. 1980. Sur quelques propriétés de l'adjectif de relation. *Travaux de linguistique et de litérature* XVII:1, pp. 119-132.

Tarski, Alfred 1956. The semantical conception of truth. In: Leonard Linsky (ed.), **Semantics and the Philosophy of Language** . Urbana, IL: University of Illinois Press. Reprinted in the 2nd paperback edition, 1972, pp. 13-47.

Taylor, J. R. 1992. Old problems: Adjectives in cognitive grammar. *Cognitive Linguistics* 3:1, pp. 1-37.

Teller, Paul 1969. Some discussion and extension of M. Bierwisch's work on German adjectivals. *Foundations of Language* 5, pp. 185-217.

Thompson, Sandra A. 1988. A discourse approach to the cross-linguistic category 'adjective.' In: John A. Hawkins (ed.), **Explaining Language Universals** . Oxford-New York: Basil Blackwell, pp. 167-185.

Tomaszczyk, Jerzy, and Barbara Lewandowska-Tomaszczyk 1990. **Meaning and Lexicography** . Series "Linguistic and Literary Studies in Eastern Europe (LLSEE)," ed. by Philip A. Luelsdorf. Amsterdam: John Benjamins.

Topolinska, Zuzanna 1975. An attempt toward a syntactic description and semantic interpretation of the so-called grammatical category of degree. *Linguistica Silesiana* I, pp. 55-62.

Trofimov, M. I. 1972. O formal'no-semanticheskoy klassifikatsii prilagatel'nykh v russkom yazyke (k postanovke voprosa) /On a formal-logical classification of adjectives in Russian (setting the issue)/. In: **Problemy strukturnoy lingvistiki-1971** . Moscow: Academy of Sciences.

Tversky, Amos, and Daniel Kahnemann 1983. Probability, representativeness, and the conjunction fallacy. *Psychological Review* 90:4, pp. 293-315.

Ultan, R. 1972. Some features of basic comparative constructions. *Stanford Working Papers on Language Universals* 9, pp. 117-162.

Urdang, L. 1968. **The Random House Dictionary of the English Language** . New York: Random House.

Vendler, Zeno 1963. The grammar of goodness. *The Philosophical Review* 72:4, pp. 446-465.

Vendler, Zeno 1968. **Adjectives and Nominalization** . The Hague: Mouton.

Vinogradov, Viktor V. 1947. **Russkiy yazyk. Grammaticheskoe uchenie o slove** /The Russian Language. The Grammatical Study of the Word/. Moscow-Leningrad: Uchpedgiz.

Vol'f, Elena M. 1978. **Grammatika i semantika prilagatel'nykh** /The grammar and semantics of the adjectives/. Moscow: Nauka.

Walker, Donald E. 1984. Panel session: Machine-readable dictionaries. In: **Proceedings of COLING '84** . Stanford, CA: Stanford University, p. 457.

Walker, Donald E. 1987. Knowledge resource tools for accessing large text files. In: Sergei Nirenburg (ed.), **Machine Translation: Theoretical and Methodological Issues.** Cambridge: Cambridge University Press, pp. 247-261.

Walker, Donald E. and Robert A. Amsler 1986. The use of machine-readable dictionaries in sublanguage analysis. In: Ralph Grishman and Richard Kittredge (eds.), **Analyzing Language in Restricted Domains** . Hillsdale, N.J.: Erlbaum, pp. 69-83.

Warren, Beatrice 1984. **Classifying Adjectives** . Gothenburg Studies in English 56. Göteborg, Sweden: Acta Universitatis Gothoburgensis.

Waugh, Linda R. 1976. The semantics and paradigmatics of word order. *Language* 52, pp. 82-107.

Waugh, Linda R. 1977. **A semantic analysis of word order: Position of the adjective in French** . Leiden: Brill.

Webster's 7th Collegiate Dictionary 1963. Merriam-Webster.

Weinreich, Uriel 1962. Lexicographic definition in descriptive semantics. In: Householder and Saporta, pp. 25-43. Reprinted in: Weinreich 1980, pp. 295-314.

Weinreich, Uriel 1966. Explorations in semantic theory. In: T. A. Sebeok (ed.), **Current Trends in Linguistics** , Vol. III. The Hague: Mouton, pp. 395-477.

Weinreich, Uriel 1968. Lexicography. In: Thomas E. Sebeok (ed.), **Current Trends in Linguistics** , Vol. I. The Hague: Mouton, pp. 60-93. Reprinted in: Weinreich 1980, pp. 315-357.

Weinreich, Uriel 1980. **On Semantics** . Ed. by William Labov and Beatrice S. Weinreich. Philadelphia: University of Pennsylvania Press.

Wey F. 1848. **Nouveau, nouvelle, avant ou après le substantif. Remarques sur la langue française, I** . Paris: Didot.

Whaley, Lindsay J. 1995. The discourse function of Hellenistic Greek adjectives. Paper presented at the 1995 LSA Annual Meeting.

Wheeler, Samuel 1972. Attributes and their modifiers, *Noûs* IV:4, pp. 310-334.

Whorf, Benjamin Lee 1956**. Language, Thought, and Reality: Selected Writings of Benjamin Lee Whorf** . Ed. By J. B. Carroll. New York: Wiley.

Wierzbicka, Anna 1985. **Lexicography and conceptual analysis** . Ann Arbor, MI: Karoma.

Wierzbicka, Anna 1988. What's a noun? (or: How do nouns differ from adjectives?). In: Anna Wierzbicka, **The Semantics of Grammar** . Amsterdam: John Benjamins, pp. 463-497

Wilks, Yorick A., Dan Fass, Cheng-Ming Guo, James E. M. McDonald, Tony Plate and Brian M. Slator 1987. A tractable machine dictionary as a resource for computational semantics. In: Sergei Nirenburg (ed.), **Proceedings of Natural Language Planning Workshop** . RADC: Blue Mountain Lake, N.Y., pp.95-123.

Wright, G. H. von 1959. On the Logic of Negation. *Societas Scientiarum Fennica: Commentationes Physico-Mathematicae* XXII: 4. Helsinki.

Zgusta, Ladislav 1971. **Manual of Lexicography** . Prague-The Hague-Paris: Academia-Mouton.

Zgusta, Ladislav (ed.) 1980. **Theory and Method in Lexicography: Western and Non-Western Perspectives** . Columbia, S.C.: Hornbeam Press.

Zhurinskiy, Alfred N. 1971. O semanticheskoy strukture prostranstvennykh prilagatel'nykh /On the semantic structure of spatial adjectives/. In: **Semanticheskaya struktura slova** . Moscow: Nauka, pp. 196-24.

Ziff, Paul 1960. **Semantic Analysis** . Ithaca, N.Y.: Cornell University Press.

Zimmer, Karl E. 1964. Affixal Negation in English and Other Languages: An Investigation of Restricted Productivity. Supplement to *Word* 20:2, Monograph No. 5.