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KNOWLEDGE SEMANTICS

a knowledge-based semantic theory

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ABSTRACT

The main goal of this book is to determine whether it is possible to develop a theory which satisfies the requirements normally placed on a linguistic semantic theory but which does not involve a level on which meaning is defined. The theory developed here with the above goal in mind is called the knowledge-based theory or knowledge semantics. It is based on the premise that the meaning of a sentence depends on the context in which it is uttered, which may be represented by the knowledge of the interpreter, and that it includes logical and factual entailments and presuppositions. According to the theory, it is impossible to define meaning, since any definitional representation must be expressed in some vocabulary, the meaning of which still has to be defined. Such a representation constitutes nothing more than an unexplained paraphrase of the original. Consequently, the theory describes only the processes operating during semantic interpretation in terms of an arbitrary knowledge base, representing the context of the utterance, or the knowledge of the interpreter. It is developed within the revised extended standard theory (REST). Its embodiment is the knowledge component, part of the semantic component. The input to the knowledge component is the indexed surface structure enriched by traces produced by the rules of construal and conditions on binding defined under REST. The indexed surface structure is translated into the input semantic marker, represented in higher-order predicate logic notation, and then mapped onto the knowledge base, represented in
the same notation. Within each proposition in the knowledge base there are associated propositions implied by it. The output of the knowledge component, which constitutes the interpretation of the sentence, is the knowledge base with the input semantic marker mapped onto it, and the sum of all implications resulting from the mapping. The theory also defines the processes of meaning acquisition and extension. There are no indications that these should not be part of a linguistic semantic theory. It is concluded that it is possible to develop a viable semantic theory not requiring a level on which meaning is defined. Such a theory is not only capable of satisfying the requirements normally placed on a linguistic semantic theory but also raises many interesting empirical issues which do not arise under any of the established theories.
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PREFACE

Linguistics emerged as a science in the mid 1950’s when Noam Chomsky, a young professor in the MIT Research Laboratory of Electronics, gave a series of lectures which culminated in his book: Syntactic Structures (1957). In the then broad field of linguistics, which mainly studied bible translations, language variation, the Indo-European and other language families, historical linguistics, animal communication, bee languages, and sundry other topics, his book, actually a small soft-cover monograph of about 100 pages, fell almost stillborn from the press. A brave publisher, Mouton, printed several hundred copies, and Chomsky’s contract required him to buy all the unsold copies after a year or two.

In the MIT Research Lab of Electronics, his book caused reverberations, which, to get ahead of our story, resulted in Syntactic Structures selling tens of thousands of copies and being translated into dozens of languages. How and why did his book electrify the nascent fields of what became computational linguistics, cognitive psychology, signal processing theory, and computer science? George Miller, a close friend and colleague of Chomsky, presents a readable version of the early history and impact on psychology and education (“The Cognitive Revolution,” TRENDS in Cognitive Sciences Vol.7 No.3 March 2003). When I first read Syntactic Structures (1963) I was working on a PhD in electrical engineering to develop a ‘computational typewriter’ such that one would speak into it and it would type your text. After reading the book, I told my advisor that the device could never be built using the incorrect (finite state grammar) model we were using. I simultaneously applied to the MIT Linguistics
Department to work with Chomsky. I joined the MIT Linguistics Department, graduating in 1968 with a PhD advised by Chomsky.

In 1964 I earned a Master of Science degree at Dartmouth College Thayer School of Engineering where we used the GE 235 computer, probably one of the biggest in the world at that time, to solve problems in vibrating systems, and in particular, how to dampen vibrations in battleships when the big guns went off, the shaking in airplanes during turbulence, the steering of submarines and torpedoes, and so on. General Electric, Dartmouth, and MIT (as well as others) teamed up to develop the first ‘time-sharing computer’. It had 60 or so remote terminals linked to it by coaxial cables, and a person a mile or so away could do all computations remotely and have the results transmitted back to their local printer. Prof. John Kemeny headed the project. The early history of the 235 time-sharing project led to interdisciplinary work between almost all departments of all the universities involved. Circuit design and power supplies dominated my engineering work, and early on they had me doing the ‘interfacing’ of keyboards, printers, and plug-boards. The operating system of the GE 235 was called multics, or MULTIX. After the project was killed, two young men took the basic idea to Bell Labs and called their project UNIX.

Early computers did have ‘languages’, but much of the ‘programming’ constituted itself as ‘running wires from here to there’, or plugging cables into holes. Look up the German Enigma Code machine and you can see what type of ‘cutting edge’ devices we thought about. Some early thinkers, Alan Turing, John von Neumann, Claude Shannon, and Norbert Wiener, all of whom had an enormous influence on me and the groups I worked with, thought very little (very, very little) about ‘hardware’ such as ‘wires’, ‘switches’, and ‘plug-boards’. They talked about ‘computer languages’, which at the time seemed an arcane concept. Alan Turing, often called the ‘father of modern computing’, developed a
computer (often called ‘computational engine’) during WWII that cracked the German Enigma Code machine that secretly directed the operations of the Luftwaffe and the German submarine fleet.

In September 1940, England, fearing a German invasion, decided to send to the USA all of its military secrets, secret weapon plans, and researchers. The readable article, Groupthink (Jonah Lehrer, The New Yorker, January 30, 2012), lays this out in some detail, and indicates that many, even most, of the English scientists and engineers took up residence at MIT and did their research in MIT Building 20. Groupthink shows how this group defined the Research Laboratory of Electronics, and details how Chomsky’s Linguistic Studies grew out of the rarified, heady air of the forms of computation and symbolisms that gave rise to radar, sonar, artificial intelligence, and expert systems. In short, Chomsky offered a theory, called Generative Grammar, which provided a conceptual framework, detailed notation, and methodology to take all of the formal systems thinking and image processing ideas from radar and sonar and express them in a way that offered a clear exposition for some aspects of human language thinking and language use.

In this era (1950-1960, 61…) no clear concept existed of ‘computer language’ or how to program a computer to do anything. The ideas of Alan Turing (illustrated well in the movie, The Imitation Game, starring Benedict Cumberbatch and Keira Knightley) came to dominate all thinking over the past decades. Turing wrote little, and what he wrote, aims to educate experts. No sugar coating exists anywhere. John von Neumann, one of the world’s most brilliant mathematicians, offers a view of Turing’s work that relates directly to the ideas of Chomsky, and probably the work of just about everyone else that mentions Turing and computers. People may argue, but the current ideas of ‘computer’ and ‘computer language’ derive almost totally from John von Neumann’s writing, which range from the popular (The Human Brain) to the
outlandishly complex (*Theory of Self-Replicating Machines*). The best introduction to John von Neumann exists in his voluminous publications and the writings of his ubiquitous students. The best introduction to Turing for beginners exists in von Neumann’s writing about what he thought Turing accomplished.

One could say that Chomsky’s views of generative grammar and *Syntactic Structures* reflect John von Neumann’s views of Turing’s research. Let us just take one idea discussed at length by von Neumann: Any computer of any interest always has two different languages, and, the main function of the computer is to translate sentences from one language into the other. (I believe this is the best way of thinking about Turing.) The two languages may use the same symbols \{a, b, c..., space, period, question...\}, but each language defines a different set of sentences. A machine that translates from English to German, or vice versa, fits this system. The German *Enigma* encoding/encryption machine input a ‘normal’ German sentence, scrambled the letters, and produced an encoded sentence of apparently random letters. When Turing entered the encrypted sentence into his Turing machine, the output constituted the original unencrypted sentence.

In Turing’s system, the only thing a computer does is convert one string of symbols written in alphabet X into another set of symbols written in alphabet Y, where X and Y may or may not be the same alphabet. Here is an ‘in-joke’ among Turing aficionados: The German *Enigma* machine converted a ‘plain-text’ German sentence into a random string of letters from the German alphabet; *but*, and this is a giant ‘but’, in the encoded text, no letter could be encoded at the original letter in the plain-text. So, if the input contained the letter ‘a’, the random output encryption could not have an ‘a’ to represent the encrypted ‘a’. This was an Achilles Heel enabling Turing to ‘break into the Enigma’ system. Turing said: *A is not A* to the *Enigma*. This is a contradiction. From a contradiction we can derive any conclusion. This was Turing’s way
of saying that the Enigma had a flaw, a keyhole, an Achilles heel. I thought it was funny when I heard it. Turing made great use of this fact, but his argumentation tends towards the difficult.

What came to be called cognitive studies took over this perspective and assumed the Turing/von Neumann computer could model some aspects of the human mental capacities. In many, perhaps most, studies, the Chomsky interpretation of the Turing/von Neumann computer view dominated. Chomsky argued that the grammar of a human language defined the speaker’s knowledge of the language. The grammar, being realized as neurons and assorted brain input-output mechanisms (ears, hands, mouth, tongue…) defined a computer. Hence, following our discussion, the human brain/computer might in fact have two different formal computer languages defining its operation.

In this discussion, the term language (a technical term with a specific definition: ‘a sequence of elements’) includes all what are called Natural Languages (such as English, French…), and often these are called Languages, with a capital ‘L’. But language also includes the language of telephone numbers (there are valid phone numbers and invalid ones). It includes all chemical formulae, all computer languages, and so forth.

The term Language (English, Chinese…) actually decomposes into many different languages (lower case ‘l’), and these ‘languages’ represent specific capacities of a normal speaker of a language. Since Syntactic Structures first appeared, the use of terminology has become under control, and instead of talking about ‘many languages’, most people say ‘components of the mind’: a sound component, a syntactic component, a meaning component, and so on. Internal to each component is some formal system of representation, and this formal system of representation is a ‘language’. Look in the beginning of a large dictionary and there will be a ‘pronunciation guide’ using about 150 symbols, each
defining a specific sound. Then each word in the dictionary has these symbols in a string to show you how to pronounce with word you look up. The pronunciation guide defines a language similar to that in the phonetic component of a Chomsky grammar.

A school for actors, translators, or opera singers may teach only spoken Italian, German, Russian, and so on for people that do not care about meanings or even making simple sentences. They simply want to sing the opera with perfect pronunciation. Phonetics studies the ‘language’ of basic sounds and how they go together. Phonetics defines the study of the sounds of a human language, completely independent of any meanings or interpretations. Speech therapists, opera trainers, and others study and teach phonetics. The Professor in ‘My Fair Lady’ was a phonetician.

Descartes and Pascal back in 1660 argued about whether or not one should move the lips and make sounds while praying. Not a big deal to most people today, but in 1639, when the Catholic Church declared the works of St. Augustine, the founder of the Catholic Church, to be heresy, the wrong answer could get you killed. Descartes said, no lip sync, the ideas going through your head led to salvation and blessedness, not the sounds you make. Pascal in his Pensées denounced Descartes as a heathen for his concepts of silent prayer. Their mentor, St. Augustine, gave: sermons indicating that one might start a prayer in one language, switch to another, and then end it in a third. The flow and sequence of ideas coursing through the mind led to salvation, not the particular sounds or mouth movements. Semantics has traditionally been the study of the meanings expressed by languages, and in a particular language, independent of the sounds or sound sequences in the language. So, in English, Sue wondered whether or not to go and Sue wondered whether to go or not have the same meaning (are synonymous), but differ in the sequence of sounds. Going back centuries (Descartes) and millennia (St. Augustine) Chomsky’s ideas would agree with those that said the ‘sounds’ of the
prayers were divorced from the ‘meaning’, or ‘healing power’, or ‘salvation power’ of the prayer. Many religions are not like this: You must exactly pronounce the prayers as they did hundreds of years ago.

According to Chomsky, each human Language has a Grammar, but this can be factored into parts. For a Language with its Grammar, there exists a theory of phonetics (a sub-grammar of phonetics) and a theory of semantics (a sub-grammar of semantics). So, following von Neumann, a human Language has a mental representation in a brain as a Grammar, but the Grammar consists of two sub grammars (often called components). The phonetics component defines the sounds of the Language; and this relates to the (sensor-motor) parts of the brain that control the ears, mouth, and hands (sign language). The semantics component defines the conceptual correlations, or semantic representations, of the Language. How the semantic information of Language exists in the brain has always been a mystery that has spanned disciplines. However, almost all agree that the words and sentences of a Language point to things, actions, and events in the world in some ways.

How does the phonetics component relate to the semantic component? That is, how does a Grammar link specific sound sequences (like The dog bit Sue) to specific meanings that we can judge to be true or false about events in the world?

Dr. Tarnawsky focuses on this problem: How do the sequences of sounds (or written letters and words) relate to meanings, and these meanings relate to observable objects and events in the world?

When he wrote his dissertation, almost everyone in the world thought that each sentence of a Language had a phonetic representation (like the pronunciation given in a dictionary using
special symbols) and also a semantic representation, which would be some graphic representation that related directly to some explicitly definable conceptual scheme. Unfortunately, as Dr. Tarnawsky points out, no one ever offered any type of plausible scheme for representing meanings in any language for any wide range of concepts. Some progress had been made for representing some aspects of meaning using formal logic and various theories of quantification using numbers. These offered insights, but the representations did not seem to be 'representations of meaning' in any broad sense. They were simply a shorthand representation in no specific formalism of any generality.

In 1982, usually examples presented in the literature pointed up problems with 'meaning' inconsistencies in a human language, and then tried to show that some specific notational convention for semantic representations could show or clarify the anomaly. Most examples did not show any 'meaning' in the abstract, but offered ways to understand why some sentences were strange or did not have the meanings they should have. Consider an example.

Suppose there is one telephone, but two people involved: Tess and Tracy. One can say: Either Tess or Tracy does not have a telephone. But one cannot say: *Either of them does not have a telephone. One can say: Tess does not have a telephone, but Tracy does. Or, Either of them can use the telephone. Why is the one sentence odd? It is perfectly good English and has a phonetic representation. But semantically, somehow, the logic does not work out. This is a failure in the semantic component.

Suppose there is a room containing a lot of people and I look in. I might say: Some of the people are taller than others. Or, Some of the people are shorter than others. But it is odd to say: *Most of the people are taller than others, or *Most of the people are shorter than others. Both of them are true. If there are 20
people of different heights, then 15 are either taller or shorter than the other 5.

Much work in ‘formal semantic studies examines such constructions (which occur with similar problems in all languages). Usually the researcher offers some method/procedure to convert the sentence into some formal logical notations and try to show the formal notations lead to contradictions. Dr. Tarnawsky argues that while some such studies may produce insights in some narrow areas of language (those using logical words like each, all, some, most, not…), the work offers no general concept of semantics to apply to nouns, verbs, and general vocabulary.

A lot of research focused on types of ambiguities. For instance, the string of words: John decided on the boat contains an ambiguity: Either John decided to choose the boat or John, on the boat, made his decision. Chomsky’s theory offers two syntactic structures for the one sentence: John (decided on) the boat, with the complex verb decide on as a unit; and also, John decided (on the boat), with on the boat a description of location. The semantic difference arises from the different syntactic structures the grammar assigns to a single string.

So far, almost everyone working up till 1957, when Chomsky published his work, would pretty much agree with the above general outline. Chomsky argued that in addition to a phonetic representation (the sound) and a semantic representation (the meaning), each sentence had a syntactic structure, which indicated how the phonetic representation was broken into individual sounds/letters, how they were syntactically grouped into words, how the words grouped into phrases, and these phrases into sentences. To make a long story short, Chomsky showed rather conclusively that precisely the computational mechanisms and notations used by Alan Turing, John von Neumann, and Claude
Shannon were ideally suited to define the syntactic structures of any human language.

Chomsky persuasively argued that each sentence of every human language could best be thought of as having a graphic representation (formally, a branching network structure in computer theory) and if we knew this ‘abstract’ structure, we could read off of it the phonetics (sound) and semantics (meaning) of a sentence. Traditional linguists and semanticists criticized him mercilessly. The most interesting and witty critique came from an English literature professor with the title *Syntactic Strictures*, mocking Chomsky’s book title *Syntactic Structures*. Chomsky won the day, and today a human language is considered to be a set of syntactic structures, each of which corresponds to a sentence, and it gives all properties of the sentence relating to sound, pronunciation, meaning, and pragmatic usage.

Dr. Tarnawsky’s work offered crucial evidence to support the overall view that syntactic structures, these actually rather abstract mathematical and computation objects, were ‘real’ and not simply a convenient fiction. How did he do this? By showing that the level of semantic representation could be done away with.

While most (perhaps all, including me) people believed that each sentence was divided into three different components (*phonetic representation, semantic representation, and syntactic structure*), Dr. Tarnawsky advanced the view that we could abandon the level of semantic representation and answer any and all questions (that existed at the time) being asked, using only the syntactic structure and the phonetic representation. This not merely offered a ‘simplification’ of the theory, but gave a profound insight into the organization of human language. While meanings play a crucial role in human language design, they are not to be considered as a part of the human Grammar. They arise when the human brain/mind pragmatically applies the sentences.
(syntactic structures) to observations looking for appropriateness and usefulness of the sentence in specific situations and contexts.

Dr. Tarnawsky offered conclusive arguments in his dissertation, but they tend to be subtle and involved. They do not hinge on properties of his notations, or those that existed in the 1980s, and are as valid today as then.

Dr. Tarnawsky’s work possessed implications beyond the narrow range of examples presented in the literature of the time. His dissertation helped cause a shift in the balance of power among research departments. Basically Noam Chomsky attempted to make the ‘underlying formalisms’ of linguistic theory derive from the computational theories of Turing, von Neumann, and Shannon, all workers in the MIT Research Laboratory of Electronics, and all workers on war projects such as radar, sonar, submarine detection, and code cracking. The bulk of the researchers Dr. Tarnawsky argued against derived their ‘underlying formalisms’ from 19th century philosophers and logicians. Those that advanced ‘semantic theories’ in opposition to Dr. Tarnawsky’s tended not to come from ‘centers of computation’ but from philosophy departments, Literature departments, and clinical psychology research centers. Most of the opposition was from ‘traditional psychology’ and classical philosophical views. Dr. Tarnawsky’s formalisms were firmly in the computational views of symbolic algebras of the Research Laboratory of Electronics.

Knowledge Semantics offers a clear view of Dr. Tarnawsky’s basic thesis, and his examples, drawn from several languages, illustrate his ideas perfectly. Let us examine some of the problems clarified by the dissertation.

Pronoun co-reference (anaphora) defined main problem in extracting meanings from the syntactic structures. Very often, two
almost identical sentences not only had different meanings, but the references of the pronouns became convoluted. Consider these sentences:

(1) John appeared to Mary to perjure himself.
(2) John appealed to Mary to perjure herself.
(3) *John appeared to Mary to perjure herself.
(4) *John appealed to Mary to perjure himself.

In these next sentences, which are equivalents of the above, with Bill and himself replacing, respectively, Mary and herself, italics mean that the words refer to the same person; they are co-referential:

(5) John appeared to Bill to perjure himself.
(6) John appealed to Bill to perjure himself.
(7) John appeared to Bill to perjure himself.
(8) John appealed to Bill to perjure himself.

Dr. Tarnawsky did not only offer a new way of thinking about such problems, and a new type of notation for expressing them, but he offered novel argument structures and types of arguments for justifying any analysis that attempted to ‘unify’ a view of syntax and semantics.

For instance, when he wrote, almost all linguists would contend that sentences 1-4 posed problems in noun-antecedent agreement of masculine/feminine pronouns, and that the problem was one of syntax, not semantics. But for Dr. Tarnawsky, the problems posed by 5-8 are identical to those posed by 1-4, and also have a syntactic solution. The distribution of data is described by syntactic mechanisms of agreement with no concern for meanings.

Those with a level of semantic representation argued that while 1-4 were syntactic agreement, 5-8 were pronoun referent problems
and the antecedent of a pronoun was determined in the semantic component. But clearly, the syntactic mechanisms can treat 1-8, and other sentences like, *We appeared to you to perjure ourselves, We appealed to you to perjure ourselves, and so on as simple syntactic agreement problems.

No motivation exists to set up a whole new level of semantic representation just to handle cases where the pronouns happen to be of the same person, number, and gender, such that we can label this a problem of 'co-reference'. Syntax defines 'antecedent' and 'referent' and this does everything in all cases. In English syntactic and semantic gender tend to be the same. But in some language, like German, one has das Mädchen (the girl) which licenses the pronoun es (it) not sie (her). Sentences involving such words must be handled by syntactic agreement since the semantics is irrelevant.

The view of the syntax-semantic interface offered by Knowledge Semantics goes beyond the insights obtained by studying simple paradigms of words and sentences. Dr. Tarnawsky has always exhibited keen interest in problems of translation and the 'expressive limits' imposed on us by our languages and vocabularies. Chomsky argued that the main thrust of 'Linguistic Research' was to explain the concept of 'linguistic intuition' both as it shows up in sentence structures, but more profoundly, how it shows up in the nature of the overall structure of the Grammar that defines and constrains the Language. Consider some ways the constraints on vocabulary discussed in Knowledge Semantics helps us understand difficulties in translations.

Mark Twain, during part of the 1890’s was the music critic of the New York Herald Tribune. New York opera buffs were solidly pro-Italian, and Wagner had been given short shrift in the tabloids. Twain, asked to review Wagner’s Ring, opened his essay, Wagner’s music is not as bad as it sounds. This sentence has two syntactic
structures, and two meanings: *it is not happy on the ears*, and, *not as bad as people say*. Twain’s sentence translates directly into German and preserves the ambiguity: *Wagners Musik ist nicht so schlimm wie es klingt*. But it does not translate into French as a single sentence with the same ambiguity. What does this mean? How does this relate to intuitive grasp of a Language and Grammar?

How can one know it does not translate into French as a single sentence? A non-native speaker might have to search for a word in the dictionary and eventually give up. A fluently bilingual French-English speaker knows immediately, via intuition, that it cannot have a single sentence translation. But a fluently bilingual French-English linguist familiar with syntax and semantics can assert that not only is there no existing translation, but there can never be given the syntactic structures of French. There cannot be any new French word ‘invented’ that can support the syntactic structures simultaneously needed to preserve the ambiguity in translation.

As *Knowledge Semantics* makes abundantly clear there is a fundamental underlying architecture of the syntactic structures and another equally fundamental architecture underlying the semantic patterning that exists in any language, and in some cases, like those elaborated in the book, they correlate. But in general, the correlations require only a level of syntactic structure to be defined, not any level of semantic representations.

To step back and look broadly at *Knowledge Semantics*, it elaborates on what is probably the main theme of Chomsky’s revolutionary *Syntactic Structures*: the concept of a level. What we have called ‘components’ and ‘languages at those components’ were called ‘levels’ in the opening lines of *Syntactic Structures*. It is not that one is ‘higher’ or ‘lower’ in any sense, it is
rather that they are abstract ways of thinking about the same thing: Grammar and the Language it defines.

Consider maps describing the surface of the earth. There are at least three. At the most basic level, we have the map of the giant plates of hardened lava that float on the molten center core of the earth, the plate tectonic map. We also have a geographic topological map showing mountains, valleys, rivers, and so on. The third represents the political map, showing cities, states, nations, and lines like meridians and equators imposed by human vanity on a system basically indifferent to human values.

These three maps define abstract views of the very same object. Similarly, the syntactic structure, the semantic/pragmatic views, and the phonetic view are advanced as three views of a single object: a sentence.

It appears that the three different abstract maps of the earth are here to stay. Each view treats a qualitatively different problem. Plate tectonics describes earthquakes and volcanoes. The topological map described landslides and flooding in tidal marshes as well as glaciers and ice at the poles. The political map accounts for the locations of wars and human migrations.

But the three views of a sentence, which have dominated linguistics for centuries, are not as certain. As Dr. Tarnawsky points out, no reason exists to have a semantic level, since any task that was to be solved by the semantic representations can be solved by the syntactic level using mechanisms independently motivated, such as ‘agreement’. The semantic level is an anachronism left over from earlier, pre-Turing computational, times.

Knowledge Semantics shows rather elegantly using persuasive arguments and data from different languages that we lose nothing
by abandoning the level of semantic representations. Rather, we gain a more coherent view of the overall structure and architecture of human language. And, if Chomsky’s mantra, ‘Language is the Mirror of the Mind’, is correct, then we gain a greater understanding of the operation of the human brain.

Dr Tarnawsky’s thesis took very strong stands on many controversial issues, hotly debated in the fields of linguistics, cognitive psychology, philosophy, computational data base studies, and any discipline concerned with offering a logical or mathematical model of human knowledge and language understanding. He laid out the issues clearly, in the necessary detail, and treated all opposing theories fairly and explicitly. The overall theoretical perspective would require reading the whole dissertation. Here we touch on the types of issues raised, and indicate the contribution of the thesis.

A basic focus of all Chomsky’s generative grammar was displacement, the fact that in the semantic interpretation of a sentence, sometimes a word or phrase is understood to be the subject or object of a verb quite far from it in the sentence. In these sentences, John is the subject of please for eager, but the object of please for easy. Sentence (10) means, it is easy to please John, not that John pleases. This is an example of displacement, or often called ‘movement’ in 1982.

(9) John is eager to please.
(10) John is easy to please.

Some verbs, like ride, can take a direct object (a horse) or a prepositional phrase object (on a horse):

(11) It is easy to ride a horse.
(12) It is easy to ride on a horse.
Sentences (12) and (13) illustrate another type of displacement. Notice that they are synonymous, but a horse can be displaced from the on prepositional phrase to the beginning of the sentence, and in fact, to the subject position, where a horse replaces the pronoun it.

(13) A horse is easy to ride on.

Very strict rules—which everyone agrees are pure Chomsky-type syntax—govern where displacement phenomena can occur. So, for instance, while what, which is a noun phrase can ‘move’ to the front and replace the it, under no circumstances can the prepositional phrase on what move and take the place of the pronoun it.

(14) What is easy to ride on?
(15) What is it easy to ride on?
(16) On what is it easy to ride?
(17) *On what is easy to ride?

One of Dr. Tarnawsky’s fundamental contributions to linguistics as a science arose from two insights. (1) If we abandon the concept of a separate level of semantic representation and instead utilize the formal computationally defined entity he calls a knowledge base, which today might be called a data base of syntactic linguistic knowledge, then, we (2) can extend the concept of displacement phenomena—well defined in syntax—to account for what had traditionally been called ‘scope of quantifiers’ in semantic theory. The arguments are developed systematically throughout the thesis, but especially in chapters 5 and 6 where he discusses the works of others.

Dr. Tarnawsky’s grammar which considers ‘scope of quantifier interpretation’ to be defined by the same syntactic mechanisms called ‘displacement’, predicts that there is no sharp break
between syntactic examples and semantic examples. One can see this from examples like the following involving the lexical item whether or not. The whether can be separated from the or not by long stretches of words and phrases, usually by syntactic movement rules. The same syntactic mechanisms that determine movement in examples like the above, define the correct interpretation of these sentences with no need for any level of semantic description.

(18) Mary cannot decide whether or not to go.
(19) Mary cannot decide whether to go or not.
(20) Mary cannot decide whether to go with the boy or not.
(21) Mary cannot decide whether to go to NY with the boy or not.
(22) Mary cannot decide whether … or not.
Where … can be long.

Examples like these involve quantifiers, since whether and or not are quantifiers. It follows from Dr. Tarnawsky’s thesis and reasoning that there should be a ‘continuum’ of problems of quantifier interpretation and scope, and they all can be treated by the same syntactic, not semantic, mechanisms that define the properties of displacement.

Sometimes the displacement is not overt, that is, no words seem to move or be in the ‘wrong place’, but the interpretation shifts somehow from one part of the sentence to another (the scope of quantifier problem). Consider these examples:

(23) How did you know to wash the car?
(24) How did you want to wash the car?

The answer to the first question could be Mary told me, but not with a sponge. The answer to the second question could be with a sponge, but not, Mary told me.
In the first sentence, the *how* (a quantifier) is understood to link with the verb *know*, not the verb *wash*. In the second, *how* links with *wash* in the lower clause and not the *want* in the first clause.

The syntactic mechanisms of *Knowledge Semantics* treat cases like these where there is no overt movement or overt displacement by the same rules that define the semantics of all cases discussed above.

Dr. Tarnawsky’s fundamental underlying thesis, which gives the title *Knowledge Semantics* to his work, stems from his insight that the goal of sentence interpretation is not to obtain some ‘level’ of formal notations called a semantic reading, but instead to show that the mechanisms that actually relate a sentence to the human’s knowledge base are independently defined syntactic operations. The insight is that the meaning, or lack of meaning in some cases, derives from what knowledge the speaker brings to the interpretation process. The focus is on the ‘processes’ of interpretation, not on some final ‘data structure’ that we might call ‘the interpretation’.

There are cases in which a sentence, which one might suspect should have a ‘meaning’, in fact does not seem to have the expected or in fact any meaning. Those against Dr. Tarnawsky’s views would argue that such cases have an anomalous semantic structure. Dr. Tarnawsky argues the rules that try to match the sentence to the speaker’s knowledge base ‘jam up’ and fail to function. Examples of such phenomena abound. Dr. Tarnawsky provides a perspective and tools to deal with them.

The basic ideas of *Knowledge Semantics* defined a fruitful area for further research into murky areas. So I will pose to you a question. Think for instance, of what reasons can be given for the ill-formedness of *I don’t know why to go*, given that many other
quantifiers form interpretable sentences. Having read and understood Dr. Tarnawsky’s proposals, I suspect it has to do with trying to fit the question into my knowledge base and not some quirk in some abstract logical semantic structure.

(25) I don’t know how to go.
(26) I don’t know when to go.
(27) I don’t know whether or not to go.
(28) *I don’t know why to go.
(29) I don’t know why I should go.

PhD dissertations usually focus on one or two narrow issues that people in the discipline believe can resolve a problem and put research into a channel that will produce more insightful theories in the future. So far, we have focused on the trees, specific mechanisms and data structures of ‘Linguistics’, but now let’s focus on the forest: How does ‘Linguistics’ as a science relate to other sciences and broader concerns in the philosophy of language? In doing so, we can see how Dr. Tarnawsky’s ideas about scientific research, the goals of research, the methods of research, and the ‘utility’ of research increase insight into the formal processes of human language, which Chomsky linguists generally believe are ‘syntactic processes’ which link sounds with meanings.

Suppose we ask a chemist, ‘What is sulfur?’ or ‘What is iron?’ She might put a lump of yellow powder in front of you and call it ‘sulfur’, and place a cube of metal on the table and label it ‘iron’. One might say these physical objects are the ‘representations’ or the ‘meanings’ of ‘sulfur’ and ‘iron’. Perhaps after this you could decide if something is, or might be, ‘sulfur’ or ‘iron’. In general, this style of thinking has been called ‘ostensive definition’. But this only scratches the surface. Sulfur bears the properties yellow (eye), soft (touch), and smelly (nose) while iron tends to be shiny, hard, and odorless. Certainly these properties of how ‘objects’ and ‘words’
relate to our senses must be part of the sounds and meanings here. Also, people often build things out of iron, but few things out of sulfur. So part of the sounds and meanings must have to do with ‘use’ and ‘function’. The meanings of things and words do not seem absolute in some ways: Can one be a vegetarian and eat fish, shrimp, and oysters? Is a crawfish ‘meat’ or ‘vegetable’? Probably somewhere in between for some vegetarians. For those that eat anything on the menu, the question makes no sense, and, insofar as it does, the answer has no pragmatic significance since it will not affect behavior.

In the 1980’s, there existed two main viewpoints, usually hot button issues in philosophy departments, and simply issues in other departments. In linguistics departments following the ideas of Noam Chomsky, most linguistic research assumed the ‘semantic representation’ viewpoint, then espoused by Katz, Postal, Fodor, and Jackendoff, among most others. It was the prevalent view of MIT style linguistics. The main alternative view in the 1980’s followed the ideas of Hilary Putnam, a Harvard philosopher, who argued that semantic representations may or may not, and probably did not, exist and were quite irrelevant to studying language as a sound-meaning correlation. Everyone agreed that meanings exist, but one group (Katz, et. al.) argued they have formal representations in some logical type notation, the other group (Putnam) said they do not.

To use an analogy, Katz et al., somewhat like the chemist who placed two objects on a table, argued that the formal objects they represented in their notations were ‘real’ and constituted the ‘meaning’ of a sentence; Putnam is like the chemist who would argue that the objects only tell a part of the tale. The objects indeed are a representation, but only a part of the whole representation. We must also consider how the objects appear to the senses, how they function in human context, as well as where they come from, and many other things. For Putnam, there exists no
single thing (physical or as a formal abstraction) that we can point to and call it the ‘meaning’ of a sentence.

Putnam, an excellent writer, said that he did not know the difference between an elm and a beech tree, but he could use the words ‘meaningfully’ to differentiate two ill-defined concepts. His theory had a distinct ‘social’ aspect: Putnam said he could use the terms confidently because there were ‘experts’ in the English-speaking world that did know the difference. It made a difference in their usage of the words, but not in his usage.

Dr. Tarnawsky’s dissertation, with its strong emphasis on the ‘social and contextual usage’ of sentences falls squarely into the camp of Putnam, who was rarely discussed by Chomsky MIT linguists. Dr. Tarnawsky’s dissertation ran counter to 99 percent of semantic research in the Chomsky MIT school of linguistics. It was revolutionary in offering a novel perspective and a detailed computational theory that merged Chomsky’s and Putnam’s views.

To use an analogy, one of Dr. Tarnawsky’s criticisms of the ‘semantic representation’ group argued that all they did was ‘translate’ from one notation into another, but gave no insights into what a ‘meaning’ could be. Consider numbers and how they might be represented in various notations. Alan Turing would count using symbols like these: {□, △, □□, □□□, □□□□, } Romans used these: {I, II, III, IV, V, VI, }. Fibonacci introduced the Arabic numerals which we use today: {1, 2, 3, 4, 5, 6, }. With the advent of computers, binary numbers achieved popularity: {1, 10, 11, 100, 101, 110, 111, }. Which notation is ‘true’ or ‘correct’? The question makes no sense since they all stand for the same things—numbers.

A single young lady named Jane Bloom marries John Doe and instantly becomes Jane Doe for legal and economic purposes, such as taxes, health insurance, and the right to stay in their rent
controlled apartment if John Doe, the leaseholder dies. These label changes simply follow from the translation laws of the marriage legal code. We have not learned anything about the lady represented and probably, except that she may now have a ring on her finger, she remains otherwise unchanged. We know that Señora Jane Doe qualifies for a green card and USA citizenship, but Señorita Jane Bloom does not.

Reflecting on the understanding of the concept ‘number’ in the different representational notations above, we know ‘numbers’ no better than before, but we now have different ways to write down numbers. Each ‘representation’ has its advantages for specific reasons, and pragmatically one may surpass the others. But these representations are simply ‘notational variants’ of each other. If the Chinese and Japanese abandon their graphic scripts and use the Cyrillic or Roman alphabets to represent words in their languages, some simplicity may or may not be achieved (easier to learn to read and write), or some functional simplicity (can use the standard ASCII symbol system on the internet), but there exists no concept of ‘truth’. We would not achieve any deeper ‘insight’ into the syntax and morphology of the languages.

To summarize Dr. Tarnawsky’s criticisms in one sentence: Basically, all proposed semantic representations (as presented by Katz, et. al.) are simply systems that translate from one syntactic notation into another.

More complex mathematical examples give more complex analogies, like those discussed by Putnam and his followers. Following Rene Descartes, $x^2 + y^2 =1$, an algebraic expression in the domain of numbers, defines a circle in Cartesian coordinates in the geometric domain of Euclid. Descartes showed that many standard geometric shapes have a representation as polynomials. But this is simply ‘translation’ from one notation into another. These ‘translations’ simply relate synonymous expressions and give no
insight into what the reality underlying the various notations might be. To understand the broader implications of these issues examine the Church-Turing Hypothesis.

Dr. Tarnawsky, with his strong computational and electrical engineering background, understood all the examples discussed by the Putnam group of philosophers and mathematicians. Considering his background of NYU graduate school coursework, research at IBM, and our many one on one personal discussion, it became obvious to us both that he could write a dissertation discussing the various views of the sound-meaning correspondences, do it at the full level of mathematical/logical depth required, and further, offer a significant formal representation of a Putnam-type semantics linked to a Chomsky generative grammar syntax. He did a great job.

Following Putnam’s views Dr. Tarnawsky develops a systematic and coherent perspective in which to present ‘meaning’ as a process that defines ‘correlations’ of sentences with complex systems that may not be ‘symbolic systems’ like human language. For Dr. Tarnawsky semantic interpretation involves more than pencil and paper ‘translations’ into other notations. Consider two widely discussed ‘correlations’: one involving ‘action’, the other ‘social integration of meanings’. Neither of these was discussed in Chomsky linguistic circles. Dr. Tarnawsky’s work defined a ‘bridge’ to integrate them into the Chomsky syntactic grammar perspective.

‘The blocks world is one of the most famous planning domains in artificial intelligence. Imagine a set of cubes (blocks) sitting on a table. The goal is to build one of more vertical stacks of blocks. The catch is that only one block may be moved at a time: it may either be placed on the table or placed atop another block. Because of this, any blocks that are at a given time under another block, cannot be moved.
'The simplicity of this toy world lends itself readily to symbolic or classical AI approaches, in which the world is modeled as a set of abstract symbols which may be reasoned about.' (Wikipedia, Blocks world)

The researchers that developed the natural language interface to the blocks world and the structure of the blocks world and movement therein were Winograd and Winston. Their initial studies appeared around 1970 and developed in several places for the next ten+ years. If one typed in: ‘Put the red block on top of the blue block’, the system would perform the simple movement, or, if the blue block had something already on it, the program would remove the object and then place the red block on top. If initially the red block laid under the blue block various movements would occur. This type of semantic-pragmatic process aligns well with the ideas of Putnam and Dr. Tarnawsky’s systematic analysis. A sentence correlates with certain movements in the blocks world with well-defined start and end states.

To consider one analysis that became quite popular: Suppose you are wearing pants with pennies in the back right pocket and nickels in the front right pocket. You must switch their positions. You will need two hands. Empty the right rear pocket with the right hand and put the pennies into the left hand. Move the nickels to the back pocket using the right hand. Then move the pennies from the left hand to the right hand and into the front pocket. Of course, you could start with the front pocket, so pragmatically at the level of robotic actions, the command to ‘switch the contents of the pockets’ has a functional ambiguity given the context.

Suppose the pennies are in the left front pocket and the nickels in the right front pocket: You must switch them. This is difficult (impossible) unless there exists a ‘storage location’ for one hand to place its contents so the hands can switch coins
from one to the other. The command: ‘Switch the pennies and nickels from one pocket to the other’ differs radically in ‘computational complexity’ given the physical situation. In the 1990’s some economists picked up on ‘blocks world’ thinking to analyze how to switch ‘wealth’ in dollars into various European and Asian currencies, vice versa, and perhaps using gold as an intermediate storage mechanism. A physical paper hundred dollar bill has no more intrinsic value than a paper one dollar bill, and functions only as a symbol of wealth. Not so with gold, which in its physical form, constituted wealth. The issues are somewhat like converting from potential to kinetic energy. Putnam’s research reached into many fields. Many of the ‘modern’ issues concerning ‘electronic money’, such as bitcoins, were hashed out by Putnam’s students and colleagues decades ago.

Dr. Tarnawsky’s ‘social meaning’ approach lines up completely with Putnam’s views on how meanings seem to be held by ‘groups of people’. Vast amounts of articles, lectures, and books discuss this in many domains of inquiry. Suppose one goes to the doctor with some painful ailment. The patient describes the problem using simple English: ‘I suffer sharp pains in the big toe after eating triple crème cheeses and washing them down with Merlot’. The doctor correlates several thoughts into a diagnosis, cure, and prognosis. Probably gout inflammations. (Indicative) Stop feasting on cheese and wine and start eating salads and drink water! (Imperative) Are you on Medicare?; if so, you must take these pills. (Ostensive: handing over of pills) Do you have a solid gold health insurance?; if so, go to a spa in France. (Speculative future action). Another doctor or nutritionist might give totally different responses. A religiously inclined advisor (Pascal) might say ‘Welcome the pain. Suffering brings us closer to God.’ Notice the patient’s simple indicative sentence has ‘meanings’ that are questions, imperatives, ostensive definitions… and many more types of verbalizations and actions.
Many people after visiting a doctor visit a pharmacist who gives them pills with unpronounceable names and instructions on how many to eat, when, and with or without food. Some go to X-ray facilities or other places with complex machines they might have to climb into. All of the above concepts add up to give the meaning of the patient’s claim about ‘sharp pains….’ Here we think of Putnam’s discussion of elm versus beech trees. We have no clear ideas in our heads about the objective reality of chemicals and machines that relate to our pains. We only have the subjective knowledge of the pains, and of these, we can rank them for intensity, type (sharp, dull...), and along other dimensions. To reflect on more complex systems: What does it mean to yell ‘Fire!!!’? Why did Chief Justice Oliver Wendell Holmes argue that ‘freedom of speech’ does not include the right to yell ‘fire’ in a crowded room if there is no ‘physical fire’ present? Smoldering cigars and pipes, while burning substances, did not qualify as ‘fire’ for this utterance, and could not legitimate the exclamation.

Dr. Tarnawsky’s work appeared as ‘rebellious’ within the Chomsky linguistics researchers at MIT, who all favored ‘interpretive semantics’ and ‘representations’, all of which involved translations between symbol systems. Since Dr. Tarnawsky’s dissertation, much computational linguistic work has followed in paths laid down by Putnam. Dr. Tarnawsky’s dissertation might well have been the first work to integrate Putnam’s and Chomsky’s approaches into one formulation. Work has continued in this direction. Let us look at one recent development.

Nisan and Schocken’s The Elements of Computing Systems: Building a Modern Computer From First Principles (2005) provides a modern example, albeit somewhat conceptually difficult. In this brilliant book, they describe how one can—within the system they describe—take an English sentence and convert it to a logical notation.
They then correlate this notation with transistor and electronic circuitry to form very basic logical/electrical functional computational systems. Then they analyze these somewhat complex functional units into the lowest level of computational units, NAND gates. Then, from the most elemental NAND gate, they show how to construct a complete modern computer (a Turing machine) that has an input and an output and can solve problems of all sorts. Nisan and Schocken’s book represents one of the finest conceptual schemes to arise from the types of thinking in Putnam’s philosophy and in the semantic action and social systems discussed by Dr. Tarnawsky.

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AUTHOR’S FOREWORD

I am not sure if it was my technical background, or the general tendency to think and act my own way regardless of the consequences, which has manifested itself so clearly in my literary writing, that made me select this particular topic for my dissertation and the approach to it, but it was likely both.

Upon graduating with a BS in Electrical Engineering from Newark College of Engineering (now New Jersey Institute of Technology) in May of 1956, I joined IBM at the Thomas J Watson Research Center in Poughkeepsie, NY, where I worked on transistor circuit design and computer power supplies. In 1959, the laboratory was moved to a temporary location in Yorktown Heights, NY, and a year or so later to its permanent home in the imposing modernist Eero Saarinen building a few miles further south. Prior to the move to Yorktown Heights, a search was conducted throughout the company for people interested in working on the Russian-to-English Machine Translation project under the direction of the lab’s new director Gilbert W King who was eager to find use for his pet device, the photoscopic disc, with its, for those times, huge storage capacity. I had learned Russian on my own by reading Gogol and Dostoyevsky in the original, and immediately applied to join the project. (I had joined IBM because of my interest in information processing rather than electronics.) I was accepted and was given the task of developing the test dictionary, and ultimately headed the applied linguistics group at IBM and provided technical direction to groups of lexicographers at the Library of Congress in Washington, DC, and at the US Air Force Russian Language School in Syracuse, NY. (The work was conducted under a US government contract.)

The program has often been described as producing a word-for-word translation, but in fact it possessed significant analytic capabilities. Its complex morphological scheme was capable of
handling some 450,000 different Russian words, and it was able to carry over contextual information across multiple words, which permitting it to perform rudimentary parsing. We labeled it a “Limited-Environment-Analysis Russian-English Automatic Translation System.” It was the first Automatic Language Translation System in the world with practical application, and was used for many years by the US Air Force. It was also demonstrated at the 1964 World’s Fair in New York, where it impressed the public in its modest way.

In May of 1964 I took a leave of absence from IBM and went to Spain to work on a novel, and when I came back in the fall of 1965, the project had been terminated. King had left IBM in late 1962 for ITEC, taking many people along with him (I was asked to join his group but declined the offer), and the advances in computer memory technology were making the photoscopic disc obsolete. Upon coming back, I worked for a while at the center on computer-assisted language teaching (French), and then moved to another division and worked on assemblers and compilers as well as computer language design.

Working on the Machine Translation Project, I developed keen interest in linguistics. It was partly due to being exposed to the issues of language processing, which I found fascinating, and partly to the interaction with linguists who in one way or another were connected with the project. (The theoretical linguistics group was headed by Reid Michelson who joined IBM from the Machine Translation project at University of Washington in Seattle.) Among the better known were Bob Lees, one of the early generative linguists and a colleague of Chomsky, who spent some time working for IBM and whom I got to know quite well, and the Israeli philosopher concerned with language issues Yehoshua Bar-Hillel, who for a brief time worked at the center. I also got to meet in person a number of well-known linguists who came to visit the
center, including Noam Chomsky, whose fame, even in those days, was already considerable and was rising rapidly.

Missing this environment, I decided to pursue graduate work in linguistics and in the fall semester of 1975 was admitted to New York University under IBM’s graduate work study program. I worked full time during the day, and attended full load of classes at night, obtaining an MA degree in 1977 and a PhD degree in February of 1982.

The subject that attracted me to linguistics the most was the nature of metaphor, which played an important role in my literary work, but, for patriotic reasons, my first choice of dissertation topic was Ukrainian syntax, in particular its tendency toward free word order, most likely occasioned by its highly developed morphology, and such features as its ability to front multiple wh-type words, something not permissible in English. (In Ukrainian you can say Хто кого коли де чому поцілував?—Who whom when where why kissed?—meaning Who kissed whom when, where, and why?) This turned out to be unfeasible, however, because there wasn’t anyone in the linguistics department who knew any Slavic language let alone Ukrainian and who could steer me along.

As I recall, I actually breathed a sigh of relief when this happened and immediately set out to work on my new proposal, whose main thrust was that meaning of a sentence is dependent on what the hearer knows and that metaphorical use of language is not an anomaly but an inherent part of everyday language use. In it were merged two strains in my background—computational linguistics in the first, and literary in the second. I was lucky to find a professor who was willing to support my work—Ray C. Dougherty, a student of Chomsky, who taught most of the syntax courses in the department and who, like me, had studied engineering and whose views on semantics were close to mine.
After getting my degree, I didn’t go into linguistics, but stayed with IBM, where I worked on Artificial Intelligence, including Natural Language Processing, in particular heading a project whose aim was to develop a natural language front end to the programming language PROLOG, as well as on Expert Systems, and did little to promote what I had done in school. The approach I developed in my dissertation was contrary to anything being pursued in transformational-generative grammar semantics in those days, and I didn’t feel like spending any time sparring with windmills.

Fortunately, times have changed. Great strides have been made in natural language processing, enabling people to communicate in their language with computers, and the demarcation line between theoretical and computational linguistics has become blurred. The former lately has even been teaming up with neuroscience in its effort to explore the language faculty of the human mind. What I had proposed in 1982 seemed no longer so outlandish. So, when in 2014 Prof. Orysia Demska of National University of the Kyiv-Mohyla Academy, who came across my dissertation almost by accident, proposed we work together on translating it into Ukrainian with the aim of getting it published, I readily accepted the offer. It would take a lot of effort to oversee the translation and develop the transformative-generative grammar terminology, but it was worth it if I were to see my work in print. It was this effort that has led to the revised version of my original work, which is presented in this book.

I hadn’t looked at my dissertation for a while with publication in mind and wasn’t sure what I would find as we set out to work. I was pleasantly surprised, though, that, except for some easily correctible errors of oversight and misjudgment which I encountered, its main tenet didn’t require reshaping and seemed as sound as it did when I was originally putting my words down on
paper—it is naive to think you can state what a sentence means without referring to a repository of knowledge it will be pitted against; and since knowledge can vary not only between different people but also for the same person at different instants in time, the best you can do in this respect is state what the meaning is in terms of a particular repository of knowledge. A sentence in English from an article on string theory means one thing to a string theory physicist, and something quite different—mysterious, or perhaps gobbledygook—to a butcher, even though both are fluent speakers of the language. (It would mean something still more mysterious or nonsensical to a four-year old child even if the sentence fell within the child’s grammar.) And, since an undefinable repository of knowledge could not be part of a linguistic theory of meaning, if we want to formulate such a theory, its scope must be limited to describing the mechanisms operating on sentences in the process of interpretation, but not the meanings they generate. The mechanisms could be described in terms of an arbitrarily determined repository of knowledge, and the meaning they generate viewed as mere illustrations of the mechanisms’ potential. (They could have practical value only in cases when the knowledge repository was created for a specific purpose.)

In the dissertation, I call this repository a knowledge base, which gives the name to the theory—the knowledge-based theory or knowledge semantics. Since meaning is generally assumed to include both entailments and presuppositions, the knowledge base contains both, and since the latter doesn’t form part of the theory, it may contain both linguistic and factual (world) knowledge, thus enabling the mechanisms to generate the full range of the sentence’s meanings.

Time perspective has played a role in my reaction to the rereading, however. What struck me upon viewing the theory from some distance in time is the simplicity of its mechanisms which I
didn’t see as clearly before. Parsed and grammatically labeled sentences can be reliably translated into a language in which the knowledge in the base can be also encoded, so that the former may be easily mapped onto the latter. The mechanisms that generate the meaning are:

1. Comparing the translated sentence against the knowledge base entries and establishing identity or lack thereof.
2. Pointing from a knowledge base entry to one or more entries in the base which are implied by it.
3. Copying these pointers for all the pointed out entries and unifying them into a single list which, together with the trace of the comparison, constitutes the meaning of the sentence.
4. Adding new entries to the knowledge base and inserting and deleting matter in existing ones, in the cases of unidentifiable or anomalous elements in the sentence, which constitutes, respectively, acquisition and extension of meaning.

Simplicity suggests naturalness, and in connection with this I would like to mention one discovery I have made since completing the dissertation, which seems to give support to my proposal. During the day I often listen to the news programs on National Public Radio. These are organized into hour-long segments which are frequently repeated for the benefit of the listeners who have missed the earlier ones. I observed that, as I was hearing passages I had heard an hour earlier, I had a clear recollection—almost as if watching a movie on a screen—of what I was doing when I heard them the first time. If I was driving down the road the second time, for instance, I recalled vividly what room I was in at home and what it was I was doing—down to the exact motions of the exercises I might have been going through at the instant; and conversely that, if I had heard the passage first while diving in
my car, I would remember later the trees and buildings I was
driving by, the traffic lights I was going under, and perhaps even
some of the cars I was encountering on my way.

These are what are generally called associations, and I am
sure I am in no way unique in having had experiences of this kind.
I suspect that many people, if not most or even all, have gone
through something similar in their past and/or will do so in the
future. But, to my mind, they are strikingly similar to meaning-
pointers from one cluster of information to another, much as is
the case with the entries in the knowledge base I am proposing. To
what degree this is true, I am not sure (that is, I am not sure if
associations may be called meaning and the other way around), but
it is gratifying to see that a mechanism I am positing does play a
role in the operation of the human mind in a different situation
and that, therefore, I am not asking for anything outlandish.
Similar pointing, moreover, appears to be at play in other aspects
of the operation of the human mind, for instance in the case of
the processing of proper names. The latter are generally
considered not to have a meaning but to be mere pointers to
entities in the physical world. But, if the man John I know has
big elephant ears and a long elephant nose, when I think of John,
this is how I remember him, and when asked what John looks like, I
will say, John has big elephant ears and a long elephant nose. The
situation here is somewhat different than in dealing with
language, since it is unlikely there are entries in my knowledge
base that directly support this, which seems to indicate there
exist different levels of knowledge in the human mind and that
some kind of translation takes place between what we would call
linguistic knowledge, or meaning, and knowledge of another type,
such as visual. (See Hilary Putnam’s famous article “The Meaning
of Meaning” (Putnam (1975)) for an interesting discussion of
related topics from a viewpoint on semantics similar to mine.) But
the phenomenon does involve pointing and I don’t think the
difference invalidates anything that I have been saying. (This
subject should be a fruitful area for research, which among other things might shed some light on the validity of the Sapir-Whorf hypothesis.

I have a feeling it wouldn’t be too hard to find examples of the need for the three remaining mechanisms posited by the knowledge-based theory in other situations of the operations of the human mind, pointing out even more strongly the naturalness of the theory’s requirements. Comparison, for instance, I suspect, must be at play in recognizing anything new—seen, heard, and so forth. The same should be true of copying and forming lists of received information and combining pieces of it into one with the aim of remembering it. And inserting and deleting information ought to be employed in the course of remembering received information and modifying existing one as a result of one received. But this is too broad a theme to be discussed in detail here and I will leave it untouched.

Concluding, I would like to express my thanks to those who have made this book possible, in particular, IBM Corporation, under whose graduate work study program the courses leading to the dissertation and the research underlying it were funded; to Prof. Dougherty, who supported my original work in spite of its unpopular thrust and who has agreed to preface this book to elucidate some of the more important issues in it for the benefit of the reader; and finally to Prof. Demska for coming up with the idea of having my work translated into Ukrainian which, as I said, has led to the emergence of this book. My thanks also go to my wife Karina for tolerating my long virtual absences occasioned by this undertaking.

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April 17, 2016
KNOWLEDGE SEMANTICS
CHAPTER ONE:

INTRODUCTION

Consider the sentence (1-1a).

(1-1) a. John is a bachelor.
   b. 1. John is a human being.
       2. John is an adult.
       3. John is male.
       4. John is not married.
       5. John exists.
       6. John needs food.
       7. John needs drink.
       8. John breathes.
       9. John probably sleeps at night.
      10 John probably lives alone.
      11 John probably has no children.
      12 John could marry a woman.
      13 John wouldn't commit a crime by marrying.

If someone were to ask what does the sentence mean, some of the answers one would give might be as shown in (1-1b), assuming that one knows that bachelor does not refer to a young knight, an academic degree, or a seal. The list, obviously, could be extended (perhaps indefinitely) but it gives a reasonable indication of what the sentence means. If someone were claiming to have developed a theory whose purpose is to indicate what sentences mean, it should be legitimate to expect the theory to come up with the list of sentences in (1-1b) and to show how they have been arrived at.

Consider now the sentence (1-2a).
(1-2) a. John ate a bowl of kutya.
   b. 1. Kutya is a substance.
       2. Kutya may fit in a bowl.
       3. Kutya is edible.
       4. Kutya is probably food.

If someone were to ask what the word kutya means, even if one did not know the meaning of the word kutya. hearing the sentence, one could still say a few things about what the word means — perhaps as shown in (1-2b). Here, again, it would be legitimate to expect such an answer and it should be legitimate to expect a theory dealing with meaning to generate the sentences in (1-2b) and to show how they had been arrived at.

   Next consider the sentences (1-3a) — (1-5a).

(1-3) a. John is a bull.
(1-4) a. John is neon.
(1-5) a. John is a metaphor.

Assuming that John refers to a human being, the sentences do not mean literally what they say because a human being cannot be an animal, gas, or a language phenomenon. But, still, few speakers of English would be baffled by the sentence (1-3a) and probably every normal adult speaker would give the meaning of the sentence as something similar to (1-3b).
(1-3) b. 1. John is strong.
   2. John is probably aggressive.
   3. John is probably dangerous sometimes.

In the case of (1-4a), it is probably less likely that it would be interpreted as readily (and, especially, as uniformly) as (1-3a). But, nonetheless, it is possible that the sentence would be given the interpretation in (1-4b).

(1-4) b. John is vague.

When it comes to (1-5a), the interpretation of the sentence is probably, for most people, still more difficult, although it is conceivable that one could be found. Let us assume, however, that it receives none, as in (1-5b).

(1-5) b. ?

Now, again, it is legitimate to ask a question why the three above sentences are interpreted as shown and legitimate to expect any theory claiming to deal with meaning to explain what happens when the three sentences undergo interpretation.

Finally, consider the sentences (1-6a) and (1-7a) and their meanings given in the b versions.

(1-6) a. The diamond sparkled.
   b. The diamond reflected light.
(1-7) a. Last night John sparkled at the party.
    b. Last night John was witty at the party.

The same word *sparkle* occurs in the two sentences but its meaning is different — reflected light in (1-6a) and was witty in (1-7a). Apparently, the word originally had only one meaning. It is again legitimate to ask how it received the second meaning and legitimate to ask a theory dealing with meaning to show how the addition (that is, extension) of meaning came about.

There are a number of established linguistic semantic theories. The best known are those of Katz and Fodor (1963), Katz (1972), Bierwisch (1969, 1970), Weinreich (1966), and Jackendoff (1972, 1976). In addition, a number of solutions to the problems of semantic interpretation, and views on semantics, appear in Chomsky's works, for instance in Chomsky (1963, 1970, 1975a, 1977b, 1979, 1980b). J. D. Fodor (1977) and Kempson (1977), in the course of discussing the various established semantic theories, also reach some conclusions as to the scope and nature of a linguistic semantic theory.

None of the established theories deal with all of the problems discussed above, however. — All of the theories deal only with logical entailments (see 5.1.1 for a definition of this and the following terms), that is, sentences 1 through 4 in (1-1b), but not the remaining ones.
The latter are considered to constitute presupposition and factual entailments. No theory addresses itself to the problem of meaning acquisition (example (1-2)). Semantic anomaly (examples (1-3) – (1-5)) is considered only by Weinreich and to some degree by Chomsky (1965). And no theory deals with meaning extension (examples (1-6) and (1-7)). The reasons for this are not because there is a clear proof that the phenomena do not fall within the scope of a linguistic semantic theory but, apparently, because they are assumed not to do this. – Presupposition is assumed to be part of a theory of performance (for instance by Kempson). Factual entailment is assumed to be part of cognitive processes lying outside of grammar (virtually by everybody). Anomaly and meaning extension are also assumed to be interpreted by mechanisms lying outside grammar (by all except Weinreich). And meaning acquisition simply is not mentioned by anyone. Now, it may be true that the phenomena that are not handled by the established theories should not be part of a theory of linguistic competence. But such a conclusion can be reached only when the nature of the processes underlying the phenomena is known and when these processes are proven to clash in some defined way with the obviously linguistic ones. This, however, can be done only if the processes in question have been studied. It is reasonable, therefore, for a linguistic semantic theory to address itself to all of the questions and types of information discussed above so as to at least reach a
conclusion if the processes should be included in the theory or not.

There is another problem with the established linguistic semantic theories. - All of them are based on the mechanism of lexical decomposition, or componential analysis, at the basis of which lies the notion that, for a word to be interpreted, it must ultimately be decomposed into semantic primitives which have to be universals and, thus, presumably, be biologically determined. So for instance, the word bachelor is claimed (Katz and Fodor (1963), Fig.4) to be decomposable into the primitives human and male and a descriptor, called ‘distinguisher’, who has never married. (The first two are claimed to be universals; the status of the third is unclear.) This technique underlies all of the established theories, even those which were developed as fiercely argued counterproposals to the Katz-and-Fodor theory (for instance, Weinreich's and Jackendoff’s). The principle of decomposition underlies also non-lexical representation in some of the theories. In Jackendoff's theory, for instance, the grammatical functions of the words in a sentence are translated into so-called ‘thematic relations’ which again must be assumed to be semantic universals. And in Chomsky's theory, the interpretation rules forming part of the semantic component replace such words as quantifiers in surface structure by logical-form vocabulary, which, likewise, must be considered primitives.
But, the decompositional approach is subject to a number of serious criticisms, the most important one being that, in none of the theories, have the meanings of the primitives been defined, so that the theories are unfalsifiable (J. D. Fodor (1977) and Kempson (1977)). One might argue that this problem would be solved if the primitives were to be found to have a biological basis. (That in itself is highly unlikely for words having a referent in the physical world, since this would suggest that the world could not be different from what has been encoded in the human mind.) It is clear, however, that even if one could establish a biological basis for a primitive, its meaning could still not be defined because any purported definitional representation of it would remain nothing more than an unexplained paraphrase of the original.

This book constitutes an attempt to develop a theory which is capable of dealing with the issues discussed above and which is not based on the mechanism of decomposition. That is, the aim of this book is to develop a semantic theory which satisfies all legitimate requirements one may place on a linguistic semantic theory but which does not require a level of definitional semantic representation. Thus, the theory developed in this book is a radical departure from all established linguistic semantic theories because it claims that it is possible to construct the semantic component of generative grammar without requiring a level of semantic representation on which the meanings of sentences are defined. (Compare the arguments against a
level of taxonomic phonemic representation in Chomsky (1964). Referring to taxonomic phonemics, Chomsky says: ‘This theory makes no claim to truth: no evidence conflicts with it, just as none can be offered in its support.’ (p. 98) Similar objections may be raised against theories requiring a level of definitional semantic representation.)

In constructing a semantic theory, the first thing that comes to mind is that the meaning of a sentence depends on the hearer. For instance, if, for a person who is interpreting the sentence (1-1a), the word bachelor means that the man has never married, then (1-1b4) could be *John has never married* instead of *John is not married*. For a person who does not know the meaning of the word neon in (1-4a), the interpretation of the sentence is not an instance of handling of anomaly but of meaning acquisition; and so forth. One of the elements of a semantic theory, therefore, must be something which would account for this fact, and it could be called a knowledge base. All sentences, then, must be interpreted in terms of a knowledge base. Another important observation is that, as was said in connection with the decompositional theories, meaning definition is not possible since it will always amount to a paraphrase of the original. A semantic theory, thus, must not attempt to define, or explicate, meaning of sentences. But what, then, could it do? – It could show the processes underlying the interpretation of sentences without attempting to define their meaning. That is, a
semantic theory could show the processes which a sentence being interpreted undergoes, representing the meaning in terms of some assumed knowledge base. It is this approach that is followed in this book. It is called the knowledge-based theory or knowledge semantics.

Chapter two of this book describes the revised extended standard theory within which the knowledge-based theory is developed.

Chapter three discusses the established decompositional theories and the most important criticisms directed at them.

Chapter four constitutes a brief discussion of the questions of the goals and scope of a linguistic semantic theory. The goals are assumed to be defining its own scope and specifying the mechanisms and rules underlying semantic interpretation without attempting to define meaning. The scope is advanced to consist of specifying the role of syntactic structure in semantic interpretation; specifying the role of the components of a sentence in producing the meaning of the sentence; and specifying the mechanisms at play during the processes of meaning acquisition and extension through the means of language.

Chapter five sketches out the subcomponents of the part of the semantic component which constitutes the embodiment of the theory.

Chapter six is a lengthy analysis of the most important issues raised in connection with defining the subcomponents in chapter five. The issues pertain to the representation
of the semantic structure of the input sentence; the mechanisms producing the implications of the input sentence, such as in (1-1b) for (1-1a); the rules which generate the semantic structure of the input sentence; and the processes underlying meaning acquisition and extension.

Chapter seven summarizes the essential features of the knowledge-based theory, states the conclusions that may be reached, and discusses some of the most interesting issues raised in the course of developing the theory. It is concluded that a semantic theory that does not require a level of definitional semantic representation is indeed possible. That is, it is concluded that a semantic theory which attempts to specify the mechanisms and rules underlying semantic interpretation without a level on which meaning is defined is capable of satisfying the requirements posed by the definition of the scope of a linguistic semantic theory, and that, further, by not postulating a level of definitional semantic representation, such a theory raises many empirical issues which do not come up under any of the established theories. It is not possible to state firmly that the processes of meaning acquisition and extension belong in a linguistic semantic theory, but there are no indications that they should not. One of the interesting features of the knowledge-based theory is that it shows how purely linguistic processes, such as representing the semantic structure of the input sentence, interact with broader cognitive processes, such as those used in generating the implications of the input sentence.
2.1 REVISED EXTENDED STANDARD THEORY

Chomsky first addressed himself to the problems of semantics in *Aspects of the Theory of Syntax* (Chomsky (1965)). The approach he proposed, which was essentially the same as that proposed in *An Integrated Theory of Linguistic Descriptions* (Katz and Postal (1964)), became known as the standard theory. Under the standard theory, grammar is organized as shown in Fig. 1.

\[
\begin{array}{c}
B \\
\rightarrow \text{Deep Structures} \\
\rightarrow \text{Surface Structures} \\
\rightarrow \text{Phonetic Representations}
\end{array}
\]

Where

- B is the base component, consisting of phrase structure rules.
- T is the transformational component, consisting of transformational rules. B and T constitute the syntactic component.
- S is the semantic component, consisting of semantic rules.
- P is the phonetic component, consisting of phonetic rules.
In other words, under the standard theory, semantic representations (or semantic interpretations) are derived from deep structures.

In Chomsky (1970), a new theory was proposed, which became known as the extended standard theory. Under it, the organization of grammar is as shown in Fig. 2.

![Diagram](image)

Fig. 2

Where S1 and S2 constitute the semantic component and all other symbols are the same as in Fig. 1.

Under the extended standard theory, then, semantic representations are derived from both deep structures and surface structures. Deep structures determine the
'grammatical' (Chomsky (1970), p. 147) or 'thematic' (Chomsky (1976), p. 167) relations such as Theme, Goal, Source, and so forth. Surface structures determine all other aspects of semantic representations, for instance, 'anaphora, the scope of logical operators, the subject-predicate relationship and semantic presupposition, and so on.' (Chomsky 1976, p. 167)

In Chomsky (1973), p. 131, the notion of trace was introduced, which led to the so-called trace theory of movement rules. Under it, 'when a transformation moves a phrase P from position X to position Y it leaves in position X a trace bound by P.' (Chomsky (1975b), p. 95) What the trace theory of movement rules in effect does is to permit a reconstruction of deep structures from surface structures. Since this is so, there is no longer any need for the semantic component to act both on deep structures and surface structures; it can produce semantic representations by acting on surface structures alone. So, Chomsky says,

'it seems reasonable to postulate that only surface structures undergo semantic interpretation though our "surface structures" are no longer those of the standard theory by virtue of the trace theory of movement rules.' (Chomsky (1975b), p. 96)

---

1These notions are due to Gruber (1965) and Jackendoff (1972).
Here, the surface structures are more abstract than in the standard theory or the original version of the extended standard theory in that they are enriched by traces. Chomsky calls this new version of the extended standard theory the revised extended standard theory in Chomsky (1976), p. 195, although it is frequently still referred to as the extended standard theory, even by Chomsky (for instance in Chomsky (1977a), p. 1, Chomsky (1980a), p. 2). I will refer to this theory as the revised extended standard theory throughout this paper, however.

Under the revised extended standard theory, then, grammar is organized as shown in Fig. 3.

```
P --> Phonetic Representations
    |  
    T  
    -- Deep Structures --> Surface Structures |  
    |  (Enriched by Traces)  
    |                     |  
    |  S --> Semantic Representations  
```

Fig. 3

Since its inception, the generative grammar theory has been undergoing constant revisions. The latest version of the revised extended standard theory is that specified in (2-1) (Chomsky (1980a), p. 3).
(2-1) Syntactic Component
   1. Base Rules
   2. Transformational Rules

Phonological Component
   3a. Deletion Rules
   4a. Filters
   5a. Phonology and Stylistic Rules

Semantic Component
   3b. Construal Rules
   4b. Interpretive Rules
   5b. Conditions on Binding

Here, the basic organization is the same as in Fig. 3, that is, both the phonological and semantic components act upon the output of 2, which are the new surface structures.

(2-1), then, specifies the organization of grammar. Grammar is defined as a theory of linguistic competence which strongly generates a set of structural descriptions and weakly generates a language. The class of possible human languages is assumed to be specified by a genetically determined property which is apparently species-specific. So, grammar is an attempt to capture this property and, therefore, is a theory of universal grammar (UG). The goal of universal grammar is to specify those properties of human language which are biologically necessary. ‘Any particular grammar conforms to the principles of UG, but is further articulated; it presents as well accidental facts that distinguish the particular language in question.’ (Chomsky (1977a), p.2)

Universal grammar

‘provides a highly restricted system of "core grammar," which represents in effect the "unmarked
case." Fixing the parameters of core grammar and adding more marked constructions that make use of richer descriptive sources, the language learner develops a full grammar representing grammatical competence.' (Chomsky (1980a), p. 3)

(2-1) specifies the structure of core grammar.

The rules of the syntactic component are optional and unmarked, except that 1 precedes 2. Base rules are phrase-structure rules falling ‘under some version of X-bar theory’ (Chomsky (1980a), p. 3; for instance, see Jackendoff (1977)). Transformational rules consist of local rules and a movement rule ‘move alpha’ where alpha is a category. Local rules permute ‘a single non-phrase constituent node C and an adjacent constituent C’ that is specified without a variable, such that the operation is not subject to any condition exterior to C and C’’ (Emonds (1976), p. 4). The lexicon is considered part of the base.

The rules of the phonological component associate phonetic representations to surface structures.

The rules of the semantic component associate semantic representations to surface structures. The representations are in logical form (LF). Logical form is a repository of all sentence-grammar properties of surface structure which are required for semantic interpretation. It has the form of ‘some variant of predicate calculus.’ (Chomsky (1980a), p. 4)
Rules of construal (Chomsky sometimes calls them interpretive rules, for instance in Chomsky (1977b), pp. 6, 72) relate anaphors to antecedents within the same sentence, through the mechanism of coindexing (Chomsky (1980a), p. 6). Interpretive rules are rewrite rules which insert logical-form vocabulary in place of surface-structure symbols (Chomsky (1977b), p. 84).

Conditions on binding govern the rules of construal.

In 2.2, I will discuss in some detail these four elements of the semantic component. I will not say anything more about the syntactic and phonological components.

2.2 SEMANTIC COMPONENT

In this section, I will discuss logical form, conditions on binding, rules of construal, and interpretive rules, in the enumerated order.

2.2.1 LOGICAL FORM

Logical form is produced from surface structures enriched by traces by the rules of construal which obey the conditions on binding and by the interpretive rules. To date, there does not exist a formal definition of logical form, nor has an exhaustive and final specification of the
two types of rules been given. But, a number of statements about the nature of logical form does appear scattered across Chomsky's recent work, as well as many examples of expressions in logical form.

In Chomsky (1976), logical form is said to ‘incorporate whatever features of sentence structure (1) enter directly into semantic interpretation of sentences and (2) are strictly determined by properties of (sentence-) grammar.’ (pp. 165-6)

Rules of construal and interpretive rules are ‘rules concerned with the syntax of LF, that is, rules that give the representations that are directly interpreted through the theories of meaning, reference, and language use, in interaction with other cognitive structures beyond the grammar that specifies grammatical competence.’ (Chomsky (1977a), p. 10)

In Chomsky (1980a), logical form is said to have ‘basic properties of some variant of predicate calculus in familiar notation,’ in which ‘NPs must occur in "argument position".' (p. 4) Further on, Chomsky says ‘LF should have the form of a syntactic phrase marker, a position often advocated but certainly not logically necessary. There is other evidence that the syntax of LF involves quantifiers and variables in familiar
notation — again, there is no logical necessity for this [...] The investigation of empirical conditions on the syntax of LF may prove an important part of the study of grammar.’ (p. 17)

Finally, Chomsky says that ‘the representations in LF are "propositional" because that is the character of the syntax of LF.’ (p. 18)

Chomsky (1980a) states that ‘the determination of the elements of LF is an empirical matter not to be settled by a priori reasoning.’ (p. 143)

Following are some examples of expressions in logical form. In each of the examples, the b form constitutes the surface structure of a, while c is the logical-form expression. In b, the superscripts indicate coreference and t is the trace.

(2-2) a. Who said Mary kissed him?
   b. who^i [t^i said Mary kissed him]
   c. for which person x, x said Mary kissed him

(2-3) a. Who did he say Mary kissed?
   b. who^i [he said Mary kissed t^i]
   c. for which person x, he said Mary kissed x

(2-4) a. Who said he kissed Mary?
   b. who^i [t^i said he kissed Mary]
   c. for which person x, x said he kissed Mary
   (Chomsky (1976), pp. 194-5)

(2-5) a. Every soldier has his orders.
   b. every soldier has his orders
   c. for all x, x a soldier, x has his orders
(2-6) a. Every soldier is armed, but will he shoot?  
    b. \([s [\text{every soldier is armed}] \text{ but } [s \text{ will he t shoot}]\]  
    c. for all \(x\), \(x\) a soldier, \(x\) is armed, but will he shoot  
     (Chomsky (1976), pp. 196-7; surface structures supplied by me.)

In these examples, \(x\) is a variable and the expressions for which person \(x\) and for all \(x\) quantifiers controlling or binding the variables. Who is replaced by for which \(x\), every by for all \(x\), traces by \(x\). ‘The bound variable \(x\) functions roughly as a name.’ (Chomsky (1975b), p. 99) Logical form cannot contain ‘free variables.’ (Chomsky (1980a), p. 6) If a free variable occurs in logical form, logical form is not a sentence but an open sentence, for instance, as when a PRO in an embedded clause is not coindexed with a noun phrase in the matrix clause (p. 8).

2.2.2 CONDITIONS ON BINDING

Historically speaking, conditions on binding derive from conditions on transformations proposed in Chomsky (1973). These were the Subjacency Condition, blocking such sentences as *Who does John believe the claim that Mary loves, the Tensed Sentence Condition, blocking such sentences as *The dog is believed is hungry, and the Specified Subject Condition, blocking such sentences as
They expected the soldier to shoot each other. Subjacency applies to movement rules only but the other two to both movement rules and rules of construal.

In Chomsky (1977b), Subjacency Condition was made part of the Strict Cycle Condition on movement rules. The Tensed Sentence Condition was renamed the Propositional Island Condition.

In Chomsky (1980a), the expressed topic of which is conditions on binding, the Specified Subject Condition is replaced by the Opacity Condition (OC) and the Propositional Island Condition by the Nominative Island Condition (NIC). These are (2-8) (=27) and (2-9) (=103). They apply to the structure of the form (2-7) (=18).

(2-7) ... [b ... a ...] ...

(2-8) Opacity Condition
If a is in the domain of the subject of b, b minimal, then a cannot be free in b.

Where a is considered in the domain of b if b does not contain a (and therefore b does not equal a) and a is dominated by the first branching category dominating b, and ‘to be free’ is to be ‘unbound’ in the sense of 2.2.1.

(2-9) Nominative Island Condition
A nominative anaphor cannot be free in S'.
Where $S'$ is defined by the formula $S' \rightarrow \text{COMP } S$ and COMP is a complementizer.

As can be seen from their definitions, OC and NIC do not apply to movement rules but to rules of construal only. (2-10) $= (22b)$ is blocked by OC because PRO is in the domain of the subject, which is the trace of who, and is a PRO free in $S'$.

(2-10) * It is unclear [$s' \text{ who } [s \text{ to visit PRO}]]$

(2-11) $= (105)$ is blocked by NIC because $\text{who}^i$, the antecedent of $t^i$, is in COMP and its trace is not properly governed (by the tense of the matrix clause); as a consequence, $\text{who}^j$ does not have Case.

(2-11) * [$s' \text{ [COMP who}^i][ \text{ did you wonder } [s' \text{ [COMP what}^2][ t^1 \text{ saw } t^2])]$]

2.2.3 RULES OF CONSTRUAL

As was said earlier, both rules of construal and interpretive rules, although generally considered semantic rules, are, in Chomsky's words, actually 'concerned with the syntax of LF.' (Chomsky (1977a), p. 10, (1977b), p. 72)
The term ‘rules of construal’ is due to Kenneth Hale (Chomsky (1977b), p. 72). The purpose of these rules is to relate anaphors to antecedents. In Chomsky (1977b), the rules of construal given are those in (2-12) (=2)).

\[(2-12) \quad \text{a. Reciprocal Rule} \quad \text{Assign to each other the feature [+anaphoric to } i\text{] in a structure containing } NP_i.\]

\[\text{b. Bound Anaphora} \quad \text{Assign to a pronoun the feature [+anaphoric to } i\text{] in a structure containing } NP_i \text{ in the context } [NP\_\text{Possessive } N_{x}].\]

\[\text{c. Disjoint Reference} \quad \text{Assign to a pronoun the feature [-anaphoric to } i\text{] in the structure } NP_i.\]

Chomsky (1980a), p. 9, states that the function of the rules of construal is to perform coindexing, according to the condition (2-13) (a=(16), b=(95)).

\[(2-13) \quad \text{a. Reciprocal Rule} \quad \text{Each other is a reciprocal phrase.} \]

\[\text{b. Control rule} \quad 1. \text{If } COMP \text{ is not null and } V \text{ has no controller then} [NP \_ e] \text{ is assigned } arb.\]

\[2. \text{[NP } e\text{]} \text{ is assigned the index of the nearest controller.}\]

Where e is the identity element, and [NP \_ e] is a phonetically null element, either PRO or a trace. Arb is arbitrary reference. Nearness is defined according to the ‘Minimal Distance Principle’ of Rosenbaum (1967).
As can be seen, (2-12) is the same as (2-13), except for the wording of the rule. (2-12b) and (2-12c) are combined into one rule, (2-13b). The notion ‘reciprocal’ is assumed to fall ‘in its natural place within universal grammar’ (p. 9) and each other must have a plural antecedent (see Dougherty (1974)).

2.2.4 INTERPRETIVE ROLES

These rules give the final shape to logical form by creating new nodes and inserting terminal elements. They apply after the rules of construal. Chomsky (1980a), p. 38, states that there are two types of interpretive rules—lexically-determined structure-building rules that produce such forms as (2-14b) (=39a)) from (2-14a) (=38a)) and rules interpreting quantifiers, such as the There-Interpretation rule and the Wh-Interpretation rule.

(2-14) a. They regard me as very much like each other (them),
    b. they regard me as \[S', \text{PRO be very much like each other (them)}\]

The There-Interpretation rule is given in Chomsky (1980a) as (2-15) (=5), (6)).

(2-15) There-Interpretation Rule
    Rewrite \[S_{NP_i \text{there} \text{is NP}_i...}\]
    as \[\text{there is NP}_i x \quad S_{NP_i x...}\].
This rule produces \([\text{there is a book}_x]\) \([s \ x \ on \ the \ table]\)
from \(\text{There is a book on the table.}\)

The Wh-Interpretation rule is given in Chomsky (1977b) as (2-16) \((=)\)(38)).

(2-16) Wh-Interpretation Rule
  Given an \(S'\) of the form:
  \([-[\text{wh-}N']-[+\text{WH }]][s...t...]\) COMP
  where \(t\) is the trace of \([\text{wh-}N']\), rewrite it as:
  \([\text{COMP for which } x, \ x \ an \ N'][s...[-x-]...]\).

This rule produces the examples (2-2) – C2-4).

In Chomsky (1976), pp. 203-4, another rule of interpretation, that of FOCUS, is given, though not explicitly. It may be deduced to have the form (2-17).

(2-17) FOCUS Rule
  Given an \(S\) of the form:
  \(\text{NP}^i \ \text{VP} \ \text{NP}^j\) and \(\text{NP}^i \ \text{VP} \ \text{NP}^j\)
  where \(-\) denotes FOCUS, rewrite them as:
  the \(x\) such that \(\text{NP}^i \ \text{VP} \ x \ -\) is \(\text{NP}^j\) and
  the \(x\) such that \(x \ \text{VP} \ \text{NP}^j\) - is \(\text{NP}^i\), respectively.
Under (2-17), Bill likes JOHN is rewritten as the x such that Bill likes x — is John and BILL likes John as the x such that x likes John — is Bill.

Chomsky (1980b), pp. 125, 161-5, again informally, mentions the Quantifier rule, which, for (2-18) — (2-21), produces the b forms (= (11), (12), (15), (16), ch. 4) from the a forms (= (9), (10), (13), (14), ch. 4).

(2-18) a. Everyone betrayed the woman he loved.
    b. for every person x, x betrayed the woman he loved

(2-19) a. The woman he loved betrayed everyone.
    b. for every person x, the woman he loved betrayed x

(2-20) a. Who betrayed the woman he loved?
    b. for which person x, x betrayed the woman he loved

(2-21) a. Who did the woman he love betray?
    b. for which person x, the woman he loved betrayed x

I will not try describing this rule formally, since its ramifications are unclear, but it appears to include the Wh-Interpretation rule and to be at play in producing the examples (2-5) and (2-6). The rule, thus, suggests that wh-questions behave like quantified expressions, as Chomsky himself observes (p. 162). He finds this to be evidence
for the existence of ‘a phonetically empty trace’ (p. 162). While discussing this rule, Chomsky comes to the conclusion that the ‘quantifier-variable notation,’ such as is used in classical formal logic, is to be preferred to a ‘variable-free notation,’ such as was proposed by R. Montague (see Partee (1975a) for a discussion).²

2.3 CHOMSKY’S VIEW OF SEMANTICS

In the area of semantics, Chomsky has concentrated primarily on the elaboration of the semantic component, as described above. In addition to this, however, he has made a number of statements regarding semantics which are worth mentioning, since they constitute the foundation on which the semantic component is built. I will summarize these views in this section, going in chronological order through Chomsky’s publications.

In Syntactic Structures (Chomsky (1957)), Chomsky states that ‘grammar is autonomous and independent of meaning.’ (p. 17). This is the so-called ‘autonomy of syntax’ thesis which is one of the cardinal assumptions of

²The treatment of quantifiers and negation under the revised extended standard theory is based on that of Jackendoff (1972). Rather than discussing it here, however, I will do it in chapter three, while summarizing the work of Jackendoff.
the generative-transformational theory of grammar. It means that the syntactic component of grammar can, and should, be described independently of the semantic; or, in other words, that the rules which produce the syntactic structures of language are self-contained in that their applications do not make reference to semantic notions.

Aspects of the Theory of Syntax (Chomsky (1965)), ch. 4, devotes a number of pages to the question of semantics. In them, Chomsky investigates what the relation between syntax and semantics should be. He observes that there exists a very important distinction in language between such deviant sentences as John found sad, violating subcategorization restrictions, and Colorless green ideas sleep furiously, which violate selectional restrictions (pp. 148-9). The latter, he observes, ‘can be interpreted metaphorically.’ (p. 149) He suggests that a grammar should reflect the deviance of such strings by developing the notion of ‘degree of grammaticalness.’ (p. 150) Under this approach, the deviance of a sentence can be measured by the number and type of violations of subcategorization and selectional rules. In the case of violation of selectional rules, the higher the level of the lexical feature involved in the rule, the higher the violation. So, violations of rules involving [COUNT] are more severe than those involving [HUMAN]. We can thus calculate ‘degree of deviance.’ (p. 155) As can be seen, this suggestion presupposes the
decompositional approach to semantics, which Chomsky tacitly accepts, following Katz and Fodor (1963) and Katz and Postal (1964). Chomsky goes on to debate whether selectional rules are to be made part of the syntactic or semantic component. He concludes that the issue is not a clear-cut one and that it deserves further study.

In *Language and Mind* (Chomsky (1972)), Chomsky discusses the possibility of establishing a system of universal semantic features, by analogy with phonetic features. He says:

‘As in the case of universal phonetics, we might hope to establish general principles regarding the possible systems of concepts that can be represented in a human language and the intrinsic connections that may exist among them. With the discovery of such principles, universal semantics would become a substantive discipline.’ (p. 124)

The tenor of the passage implies that Chomsky feels that universal semantics is a distinct possibility.

‘Questions of Form and Interpretation’ (Chomsky (1975a)) is the only one of Chomsky's works in which much space is dedicated to the theoretical questions of semantics. Chomsky expounds his theory while discussing some of the notions brought forth by Jespersen in his 1924
work *The Philosophy of Grammar*. Chomsky says 'it seems plain that the syntactic structures are not a projection of the semantic, and [that] the relation between "the world of ideas" and the syntactic system is fairly intricate.' (p. 31) He does believe that a level of semantic representation can be constructed within linguistic theory. He feels that it is legitimate to consider grammar as an independent cognitive structure, interacting with other systems of knowledge and belief. But, at the same time, he feels that 'the actual system of grammar for a particular language cannot be determined in strict isolation from questions of fact and belief.' (p. 36) He goes on:

‘a rich theory of semantics with far-reaching explanatory principles might constitute a significant part of an independent theory of grammar, even though the grammar that "comes into existence in the mind of the speaker" will be intimately interwoven, at specific points, with other cognitive structures. The idealization to "grammar" will thus be entirely legitimate, but the theory of grammar will in part be "open." It will be an abstraction, leaving unspecified certain elements that are fixed in a broader theory.’ (p. 37)

So, interpretation of sentences is not independent of aspects of fact and belief, even if we view grammar as an independent structure. But the features of sentence interpretation hinging on aspects of fact and belief are
‘easily separable from those that determine literal, intrinsic meaning of the sentence, and it is surely proper to conclude that quite independent systems are interacting to provide the interpretation.’ (p. 40)

Further on, Chomsky looks at two possibilities of ‘autonomy of formal grammar’ -

‘an absolute thesis, which holds that the theory of linguistic form, including the concept “formal grammar,” and all levels apart from semantic representation, can be fully defined in terms of formal primitives, and a weaker version, which holds that this is true only conditionally, with certain parameters, perhaps localized in the dictionary.’ (pp. 42-3)

Chomsky analyzes the implication of the two hypotheses and in the end says:

‘[It seems to me fair to conclude that although there are, no doubt, systematic form-meaning connections, nevertheless, the theory of formal grammar has an internal integrity and has its distinct structures and properties as Jespersen suggested. It seems to me reasonable to adopt the working hypothesis that the structures of formal grammar are generated independently, and that these structures are associated with semantic interpretations by principles and rules of a broader semiotic theory.’ (pp. 56-7)
But, 'in evaluating a formal grammar it seems reasonable to consider the complexity of the characterization of sets of selected words in terms of semantic primitives. Similar considerations may apply elsewhere in grammar as well [...] we might hope that the syntactically arbitrary feature can be given some semantic characterization and that the complexity of the characterization in terms of core notions of semantics (say Katzian semantic markers) might be a factor in choice of grammar. If this proves to be the case in general, we can take the arbitrary syntactic feature to be, in effect, parameters to be determined elsewhere, thus rejecting the absolute autonomy thesis in favor of a parametrized theory of the sort discussed earlier. As noted before, it seems quite possible that the "openness" of the theory of formal grammar might be localized in the dictionary.' (pp. 57-8)

*Language and Responsibility* (Chomsky (1979)) devotes a whole chapter (number 6) to the question of semantics. Here, most of the above positions are restated. In discussing the Katz-and-Fodor (1963) proposal, Chomsky says that his notion of semantics, as envisioned at the time of *Syntactic Structures*, differs from that of Katz and Fodor. *Syntactic Structures* did not envision a level of semantic representation, whereas Katz’s and Fodor's hypothesis did.
Chomsky points out that in the Katz-and-Fodor approach semantic representations were to be based on universal semantic categories or semantic ‘distinctive features’ analogous to the distinctive features in phonology. He concludes that ‘It is not at all clear that there exists such a universal semantic system.’ (p. 141) He agrees that the semantic relation between words like persuade, intend, believe, and so forth, can be expressed in purely linguistic terms. The same is true of quantifiers and anaphors. So, these aspects of semantics can form part of the theory of generative grammar. But this is probably not true of such words as chair, table, and so forth, which have a reference in the world. The representation of these, Chomsky feels, cannot be separated from beliefs and knowledge about the world.

‘In studying semantics we must keep the role of nonlinguistic systems of belief: we have our expectations about three-dimensional space, about texture and sensations, about human behavior, inanimate objects, and so on. [...] My own speculation is that only a bare fragment of semantic properties, altogether insufficient for characterizing what is ordinarily called "the meaning of linguistic expressions," can be associated correctly with the idealization "language".’ (p. 143) Further along, Chomsky speaks out against the
truth-conditional semantic theory, which maintains that the meaning of a sentence is defined by the conditions in the real world under which it is true. He feels that, 'Even for the simplest sentence, it is impossible to set truth conditions outside the context of language.' (p. 144)

In Rules and Representations (Chomsky (1980b)), the position stated in Language and Responsibility is defended. Chomsky says:

'Do the "semantic rules" of natural language that are called to give meaning of words belong to the language faculty, strictly speaking, or should they be regarded perhaps as centrally-embedded parts of a conceptual belief system, or do they subdivide in some way?' (p. 62)

He concludes that the question remains open. Chomsky again speaks out against the truth-conditional (here referred to as 'verificational') theory of meaning. He says:

'I do not see what sense can be made of the claim that the truth of the statement "the book is on the table" can be conclusively established or that we know what would count as conclusive evidence, as contrasted with such statements as "it rained yesterday".' (p. 116)

He points out that, according to the verificational theory of meaning, we could not verify such a statement as The universe is constantly expanding, and, consequently, could not understand it, which is obviously wrong (p. 116). He, therefore, dismisses the theory as not viable.
CHAPTER THREE:

DECOMPOSITIONAL SEMANTIC THEORIES

In this chapter, I will discuss the best-known decompositional semantic theories — those of Katz and Fodor, Katz and Postal, and Katz (I will discuss the three in one section under the heading ‘Katz’), Bierwisch, Weinreich, and Jackendoff. The last three were developed as counterproposals to the first. In discussing these latter, I will spell out, whenever applicable, the objections that were raised against Katz and Fodor. At the end of the chapter, I will list some of the general criticisms of the decompositional approach which have appeared in literature and state my objections to this theory.

3.1 KATZ

In this section, I will start out with a discussion of Katz and Fodor (1963) (I will refer to it as KF throughout the rest of this chapter), from which Katz's latest theory is a direct descendant. Next, I will touch briefly on the version proposed in Katz and Postal (1964) (KP hereafter), and end with the theory of Katz (1972).
KF defines semantics as the description of a language minus the grammar, where a description of a language is an enumeration of the rules underlying a speaker's linguistic knowledge and grammar consists of the syntactic, morphological, and phonological part of the description. A semantic theory is defined as ‘a theory of the speaker's ability to interpret the sentences of his language.’ (p. 487) The components of a semantic theory of a language are said to be a dictionary of the lexical items of the language and a system of rules, called projection rules, ‘which operate on full grammatical description of sentences and on dictionary entries to produce semantic interpretations for every sentence of the language.’ (p. 493) The reason for the projection rules is that many lexical items in a language have more than one sense, all of which have to be listed in the dictionary. The projection rules have to select the proper sense for each lexical item to give the correct interpretation of the sentence. The form of the dictionary of a semantic theory is different from that in a dictionary designed for human use. For instance, the entry for bachelor would have the form shown in Fig. 4 (=Fig. 4).
The dictionary entry in Fig. 4 may be called a semantic-marker tree. The unenclosed elements in it are called grammatical markers, the elements enclosed in parentheses are called semantic markers, and the expressions enclosed in brackets are called distinguishers.

KF say:
'The semantic markers and distinguishers are used as means by which we can decompose the meaning of a lexical item (on one sense) into its atomic concepts, thus enabling us exhibit the semantic structure in a
dictionary entry and the semantic relations between dictionary entries.’ (p. 496)

So, for instance, the semantic relation of sex-antonymy holding between the members of such pairs of words as bachelor and spinster, man and woman, aunt and uncle, cow and bull, and so forth, will be expressed by the fact that the two members of each pair will have identical dictionary entries (‘paths’ in the semantic-marker tree of the type shown in Fig. 4), except that one will have the semantic marker (Male) and the other one (Female), in exactly the same position.

The branching under a semantic marker may be singulary but usually is dyadic. It can also be greater. The distinguishers are the terminal elements of a semantic-marker tree.

‘The distinction between markers and distinguishers is meant to coincide with the distinction between that part of the meaning of a lexical item which is systematic for a language and that part of the meaning of the item which is not. In order to describe the systematicity in the meaning of a lexical item, it is necessary to have theoretical constructs whose formal interrelations compactly represent this systematicity. The semantic markers are such theoretical constructs. The distinguishers, on the other hand, do not enter into theoretical relations.’ (p. 498)
So, grammar, in accordance with the generative-transformational theory, is a device which generates an infinite list of strings of morphemes, which constitute sentences. It also assigns each sentence a structural description. A sentence and its structural description constitute the input to a semantic theory. The output of a semantic theory is the interpretation, or reading, of each sentence. This scheme is represented in Fig. 5 (=Fig. 6, simplified).

<table>
<thead>
<tr>
<th>Grammar</th>
<th>Input Sentence and Its Grammatical Description</th>
<th>Semantic Theory</th>
<th>Readings</th>
</tr>
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<tbody>
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<td></td>
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</table>

Fig. 5

As was said, a semantic theory consists of a dictionary component and a set of projection rules. With each lexical item, which is part of the input sentence, there is associated a derivation. The dictionary component assigns to each of these pairs a finite, non-null set of paths from the dictionary entry for the lexical item (p. 504). The association of lexical item-derivation plus the set of paths is the input to the projection component consisting of
projection rules. The projection component works from the bottom to the top of the constituent-structure tree,

‘effecting series of amalgamations [...] thus assigning a set of reading to the concatenation of lexical items under that marker by associating the result of the amalgamation with the marker until the highest marker Sentence is reached and associated with a set of readings. The projection rules amalgamate sets of paths dominated by a grammatical marker by combining elements from each of them to form a new set of paths which provide a set of readings for the sequence of lexical items under the grammatical marker. Amalgamation is an operation of joining elements from different sets of paths under a given grammatical marker just in case these elements satisfy the appropriate selection restrictions represented by material in angles.’ (p. 506)

So, for instance, the sentence The man hit the colorful ball will receive one reading, even though colorful ball is ambiguous, by virtue of hit taking a concrete noun as its object. These ‘amalgamating’ rules are called type 1 projection rules. There are also type 2 projection rules, which are those that provide semantic interpretation to sentences not capable of being interpreted by type 1 rules. Type 1 rules produce interpretations for ‘kernel sentences’ and type 2 rules for sentences ‘constructed with the use of
optional transformations.’ (p. 514. See Chomsky (1957) for a definition of kernel sentences and optional transformations.)

In KP, a dictionary entry is described as consisting of ‘a subsequence of syntactic markers, followed by a subsequence of semantic markers, then, optionally, a distinguisher, and finally a selection restriction.’ (p. 13) A selection restriction is defined as ‘a formally expressed necessary and sufficient condition for [a dictionary reading] to combine with others.’ (p. 15)

The syntactic structure of a sentence determines the range of meanings the sentence can have by providing the formal relation between the lexical items.

The projection rules consist of the familiar type 1 (P1) and type 2 (P2) rules - P1 operate on the underlying (‘base-generated’) phrase markers. P2 are rules which provide

‘a means for combining the separate semantic interpretations of the set of underlying P-markers of a sentoid derived with generalized transformations into a single semantic interpretation for the sentence as a whole.’ (p. 47)

KP suggest a way of eliminating P2, by eliminating generalized transformations ‘in favor of a single substitution rule for combining underlying P-markers.’ (p. 67)
In addition to proposing some modifications to the two theories he had collaborated on, in *Semantic Theory* (Katz (1972)), Katz devotes a lot of space to general questions of semantics. I will summarize them briefly before proceeding with a discussion of the proposed changes.

For Katz, semantics is the study of linguistic meaning. Its basic goal is to answer the question ‘What is Meaning?’ (p. 1) But, in the proposed model, the general question is broken down into a number of specific questions namely ‘What are similarity and difference of meaning? What are meaningfulness and meaninglessness?’ (p. 4), and so forth. In other words, Katz proposes to define meaning in terms of the various semantic properties and relations. He proposes fifteen of these: synonymy and paraphrase, semantic similarity and semantic difference, antonymy, superordination, meaningfulness and semantic anomaly, semantic ambiguity, semantic redundancy, analytic truth, contradictoriness, syntheticity, inconsistency, entailment, presupposition, possible answer, and self-answered question (pp. 5-6). Semantic theory, then, answers questions about the semantic properties and relations enumerated above. It is to be considered part of the theory of language universals or language theory. Language theory consists of phonological, syntactic, and semantic components. Just as a phonological theory ‘must have a means for representing the phonetic shape of utterances, [and syntactic theory must] provide a
representation scheme for the syntactic organization of a sentence, [semantic theory must] provide a representation scheme for meanings, that is, a universal theory of concepts in which the notion "possible (cognitive) meaning in language" is defined by a recursive enumeration of the set of possible senses.’ (p. 32)

So, the theory must contain

‘A specification of the form of the dictionary and a specification of the form of the rules that project semantic representations for complex syntactic constituents from the dictionary’s representations of the senses of their minimal syntactic parts.’ (p. 33)

The rules are called projection rules, and the theory must state how these rules apply in assigning semantic representations. In addition to this, the theory must contain a set of definitions of the fifteen properties and relations enumerated above. A semantic theory specifies the organization of the semantic component which is the embodiment of the theory. The component, then, consists of a dictionary and a set of projection rules. The input to the semantic component are underlying phrase markers (deep structures) and the output semantic interpretation.

In the semantic component, the meaning of a morpheme, or lexical item, is represented by a dictionary entry. A lexical item may have one or more senses (‘meanings’). Semantic representation of a sense of a morpheme, word.
phrase, or clause, is a reading. A semantic marker is ‘the semantic representation of one or another of the concepts that appear as part of senses.’ (p. 37) A reading, then, is a set of semantic markers. Lexical readings are readings of dictionary entries and derived readings, those produced by projection rules. One of the definitions of a semantic marker is that it is an element ‘in terms of which semantic generalizations about senses can be made.’ (p. 41)

I will turn now to the modifications of the theories proposed in KF and KP.

The first modification is a clarification of the concept 'distinguisher.' Katz says:

‘The concept “distinguisher” in Katz and Fodor (1963) was less than adequate in a number of respects, chief of which was that the two criteria for determining distinguishers failed to give the same results.’ (p. 83)

The two criteria are the definition of semantic markers and distinguishers. Here, the definition of distinguishers is the following:

‘Distinguishers can be regarded as providing a purely denotative distinction which plays the semantic role of separating lexical items that would otherwise be fully synonymous. Unlike semantic markers, which represent conceptual components of senses of lexical items and expressions, distinguishers mark purely
perceptual distinctions among the referents of conceptually identical senses. [...] only a general theory of linguistic performance, which incorporates and integrates accounts of linguistic competence and perceptual mechanisms, can connect the distinguishers in the vocabulary of semantic theory with the constructs in the vocabulary of perceptual theory that corresponds to them.’ (p.84)

Distinguishers are used not only to mark a distinction between ‘cases that are susceptible to definition in terms of conceptual analysis and cases that are not.’ (p. 88)

A new concept which is introduced (p. 101) is that of categorial variables, which ‘designate the position in readings at which other readings can be substituted by projection rules.’ (p. 103) X and Y in (3-1) (=3.61)), which represents the common sense of chase, designate the position in which the subject and object can be inserted.

(3-1) (((Activity) ((Physical) ((Movement) ((Speed) (Fast) (Following))))((Purpose) ((To catch Y)))))) X

The second modification is the elimination of the type 2 projection rules, in accordance with the suggestion made in KP. This leaves only type 1 projection rules, which are now defined as combining

‘readings of constituents in an underlying phrase marker, working from the lowest order constituents to
the highest, and taking the readings of the subconstituents of a constituent to be the components of the derived reading of that constituent.’ (p. 114)

The projection rules (that is, the specification of their operation) are now said to reside in semantic theory rather than the semantic component. This is so because Katz maintains (p. 115) that the semantic component contains only language-specific items and mechanisms, whereas a theory contains universal specifications. The way projection rules apply, then, is to be considered a language universal.

3.2 BIEBKISCH

For Bierwisch, the goal of semantics is answering the question ‘What is the meaning of a sentence S of language L?’ (1970, p. 167) A semantic theory must

1. Make reference to the syntactic structure.

2. Systematically represent the meanings of words.

3. Show the interaction of the syntactic structure and meanings of words in determining the meaning of a sentence. (Bierwisch (1970), p. 168)
Bierwisch recognizes the fact that the study of meaning may use *meaning postulates* or decomposition. But he feels that one is convertible to the other. For instance, (3-2a) is a meaning-postulate representation of boy; (3-2b) is a decompositional representation of the same word. (For \( \rightarrow \) below, read ‘implies.’)

(3-2) a. boy \( \rightarrow \) animate, and human, and male, and not adult  
b. boy: ANIMATE and HUMAN and MALE and not ADULT

The basic difference between the two is the fact that elements like *male* in (3-2a) is a language-specific term, whereas MALE in (3-2b) is an abstract concept and it, or at least some other abstract concept into which it could be decomposed, are language universals. Such concepts ‘are not learned in any reasonable sense of the term but are rather an innate predisposition for language acquisition.’

{Bierwisch (1970), p. 182} In the theory he has developed, Bierwisch (1967, 1969, 1971) adopts the decompositional approach, taking as his starting point KF. He differs from KF and the later versions of Katz’s theory in that he eliminates the notion of distinguishers and does not permit complex markers.

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1 Meaning postulates (Carnap (1947)), or *meaning rules* (Bar-Hillel (1967)), are rules of logical inference which relate words or statements with their implications. See 5.1.1 for an explanation of logical terminology.
The basic features of Bierwisch's semantic theory are listed below:

1. A set of basic primitive terms, called features. These underlie all semantic descriptions. They must be interpreted in terms of perception and cognition.
2. A classification of the semantic features according to the number and type of arguments.
3. A set of redundancy rules, which 'impose a complex internal structure on the universal set of basic features.'
4. A set of categorized variables that serve as arguments for the semantic features.
5. A set of principles used for connecting semantic features to each other to form complex semantic structures. These are basically principles of formal logic – first-order and higher-order predicate calculus (see 5.1.1). The resultant structures correspond to, but differ from, Katz's complex semantic markers.
6. A procedure which connects semantic features according to the syntactic relations in the deep structure.
7. A set of operations acting on structures built up according to the rules 5 and 6. The operations for antonymy and negation are defined. (Bierwisch (1969), p. 181)
In Bierwisch's approach, Katz's example of chase, shown in (3-1), would look as shown in (3-3) (= (9), Bierwisch (1969)).

(3-3) \[\text{[Activity} \& \text{[Fast] Motion} \& \text{[Following} \text{]XY} \& \text{[Trying} \text{]X ([Catch] XY) \& \text{[Motion} \text{]Y.}\]

Notice that in (3-3), the predicate \textit{Motion} acts as the argument of the predicate \textit{Fast}, which violates the rules of first-order predicate logic. Another violation is the occurrence of the proposition \([\text{Catch} \text{]XY}), itself containing the predicate \textit{Catch}, as an argument of the predicate \textit{Trying}.

Bierwisch (1967) shows what he believes to be serious candidates for semantic features. He does this on the basis of an analysis of some German adjectives. Some of the features are \textit{Pol} for 'polarity,' \textit{Vert} for 'vertical,' \textit{Space} for 'physical dimension of space' (a nonbinary feature), \textit{Max} for 'maximal,' referring to the expected propositions of an object, and so forth. Inherent for whether or not spatial or temporal direction is inherent or depends on 'its normal placement with respect to its environment' (p. 17), and \textit{Second} for 'secondary dimension.' So, the lexical representation of the adjectives \textit{Glanq} 'long,' \textit{kurz} 'short,' \textit{breit} 'wide,' and \textit{schmal} 'narrow' are given in (3-4) (= (48)) and (3-5) (= (49)). Here, for \(X[Y[\ast]]\), \(X\) is to be introduced as the right dependent of \(Y\), and for \(X[\ast\{Y]\),
as the left governor of Y. Redundancy rules must apply to the entry.

(3-4) a. lang: (+Pol)[(1 Space) *[ (+Inherent) [ (+Max) ]]]
   h. kurz: (-Pol)[(1 Space) *[ (+Inherent) [ (+Max) ]]]

(3-5) a. breit: (+Pol)[(1 Space) *[ (+Second)]]
   b. schmal: (-Pol)[(1 Space) *[ (+Second)]]

Bierwisch concludes that the semantic features do not necessarily have a simple interpretation in terms of physics, genetics, biology, and so forth. The features are not isolated elements, to be learned one by one, but rather 'features of whole structures, not as normality, spaciality, verticality, etc.' (p. 34) The features are part of the innate capacity for language acquisition. Therefore, a child does not have to learn 'what a norm is, how space is structured, etc. [...] but only how and in which combinations these structures are expressed.' (p.25) And, finally, 'the formation of the primitive elements to the meanings of particular languages is governed by general principles of combination.' (p. 35)

3.3 WEINREICH

Weinreich's theory (Weinreich (1966)) was proposed as an alternative to KF, KP, and another, earlier, version of
Katz's semantic theory. The majority of criticisms are directed against KF. Weinreich feels that KF deals 'with an extremely limited part of semantic competence: the detection of semantic anomalies and the determination of the number of readings of a sentence.' (p. 397) In his opinion, the theory can neither determine the content of the readings of a sentence nor deal with figurative usage. He says that 'Katz's theory is [...] completely powerless to deal with intentional deviance as a communicative device.' (p. 416) And ‘Whether there is any point to semantic theories which are accountable only for special cases of speech — namely, humorless, prosaic, banal prose — is highly doubtful.’ (pp. 389-9)

Turning to specifics, Weinreich argues for abandoning the distinction between syntactic and semantic features with the same name, for instance Male, Female. Abstract, since it cannot be based on either functional or contents grounds. Likewise, he advocates abandoning the notion of a distinguisher, primarily because he does not feel there are clear-cut criteria for deciding when a distinguisher should be used. Further, Weinreich concludes that, in KF, there is really no distinction between paths (within a semantic marker) and selection restrictions, and that amalgamated markers are not capable of expressing order, so that Cats chase mice and Mice chase cats would not be distinguished. Turning to projection rules, Weinreich feels that, as KF
formulate them, they are unnecessary, and could be made part of the syntactic component.

Weinreich defines the goals of a semantic theory as: ‘to explicate the way in which the meaning of a sentence of specified structure is derivable from the fully specified meanings of its parts.’ (p. 417) The meaning of the components of a sentence is to be specified in terms of semantic features. A polysemous or homonymous word (for instance, ball) is represented in the theory ‘by as many entries as it has meanings.’ (p. 418) Sets of semantic features may be unordered (called clusters) or ordered (called configurations). So, the features Female and Offspring, for daughter, form a cluster. But the features Furniture and Sitting, for chair, form a configuration. Linking is a semantic process forming clusters. Such processes as nesting, delimitation, and modalization form configurations.

An important concept introduced by the theory is transfer features, listed in angled brackets, which, in Weinreich's words, correspond to Chomsky's selectional features except that they are transferred from one word onto another one, for example, from a verb onto a noun, during the process of interpretation by the mechanisms of the theory. So, for instance, the fact that educate requires an animate subject and object would be reflected in the entry for the word being (3-6) (=46)).
Weinreich’s conception of grammar is represented in Fig. 6 (=76)).

The base consists of phrase-structure rules having recursive power. The rules are defined on an alphabet consisting of category symbols, complex symbols, and dummies. A complex symbol is a category symbol paired with a matrix of semantic features. The category symbols include such symbols as Noun Phrase, Adjective, and so forth. There are three types of dummy symbols – one for the insertion of major-class (that is, open-class) morphemes, one for minor-class (that is, closed-class) morphemes, and one which is not replaced by a morpheme from the dictionary. So, the base generates preterminal strings consisting of a phrase-marker tree with its nodes labeled by category or complex symbols, and a set of associated dummy symbols. This, together with the dictionary, is the input to the lexical rule. The dictionary is an unordered set of morphemes, in which each
entry consists of a sequence of phonemes, a cluster or configuration of clusters of semantic features, and, sometimes, a semantic marker. The output of the lexical rule is a generalized phrase-marker. The generalized phrase-marker is subjected to transformational and morphophonemic rules, and is passed on to the phonological component and, separately, to two semantic processes: semantic calculator and semantic evaluator.

'The calculator distributes certain semantic features along the branches of the tree; marks the sentence for contradictions between certain semantic features; conflates redundant features and transfers some features from one morpheme to another. It also deletes certain parts of the underlying marker.

'The evaluator takes cognizance of the normality or deviance of the sentence and, depending on its "setting," emits an interpretation of the sentence to be synchronized with the phonic event, or emits a nonsense "signal" and blocks the interpretation.'

(p.445)

Weinreich’s dictionary differs from those of Katz and Bierwisch:

‘every relation that may hold between components of a sentence also occurs among the components of a meaning of a dictionary entry [...] the semantic part of a dictionary entry is a sentence – more specifically, a
deep-structure sentence, i.e. a Generalized Phrase-Marker. (p. 446)

Weinreich does not discuss the problem of establishing semantic features. He uses them frequently in his examples, however. Here are some:

Determiners: Definite, Deictic, Proximate, Question
Nouns: Noun, Count, Concrete, Animate, Human, Male, Adult, Common, Rideable-in, Motor-driven
Number: Singular, Plural
Tense: Past, Present
Verb: Have, Present, Past
Circumstance: Place, Definite, Specified, Question

As was said above, the function of the evaluator is to determine the deviance of a sentence from normality. The determined deviance is quantitative. Weinreich suggests that one way of doing this would be to divide the number of DEV (for 'deviant') symbols produced by the Construal rule of the calculator by the total number of symbols. But, in addition, the theory provides a qualitative evaluation of deviance, produced by the Construal rule, which identifies contradictory features in a sentence. A deviant sentence will be labeled as nonsense only if the computed ratio of deviance exceeds some permitted value; otherwise, it will be interpreted. The theory is, thus, designed to handle metaphorical constructions.
3.4 JACKENDOFF

*Semantic Interpretation in Generative Grammar* (Jackendoff (1972)) was the first detailed elaboration of the semantic component (or *interpretive semantics*) within the extended standard theory proposed in Chomsky (1970). It argued against the KP hypothesis that semantic representations are derived from deep structures only by adducing data which showed that surface changes in the phrase marker introduced by transformations did introduce differences in meaning. The argument that Jackendoff brings forth against the KP hypothesis stems from an analysis of negation. He points out that under the Klima (1964) analysis, which Katz and Postal adopt, the nonsynonymous sentences *Not much shrapnel hit the soldier* and *Much shrapnel didn't hit the soldier* are derived from the same deep structures, thus indicating that the two negation transformations introduce different meanings.

Jackendoff also argues against the single-level semantic representation proposed in KF by advocating a multi-level representation `for which rather different analyses are required.’ (p. 3) The structure of grammar proposed by Jackendoff is as shown in Fig. 7 (=1.2)).
Fig. 7

Functional structure, derived from deep structures, represents relations in a sentence induced by the verbs, including such notions as agency, motion, direction.

Modal structure, derived from an intermediate level, 'specifies the conditions under which a sentence corresponds to situation in real world.' (p. 3)

Table of coreference, likewise derived from an intermediate level, indicates whether pairs of noun phrases in the sentence are to be considered coreferential or not.
Focus and presupposition, derived from surface structures, ‘designate what information in the sentence is intended to be new and what is intended to be old.’ (p.3)

According to Jackendoff, the grammar of Fig. 7 must be augmented by well-formedness conditions on semantic interpretations. These conditions will determine whether or not the structures in the box in Fig. 7 are in fact meaningful. ‘Some of these conditions are parts the grammar, but others shade into pragmatics or knowledge of the real world.’ (p. 17) The conditions Jackendoff lists are selectional restrictions (permitting sentences such as *It’s crazy to talk of rocks eating* to be interpreted) and consistency condition on coreference. The latter states that two noun phrases marked for coreference must refer to the same individual.

Jackendoff’s analysis of the functional structure is based on the concept of *thematic relations* developed by Gruber (1965). Underlying this concept is the idea that in every sentence there is a noun phrase functioning as the Theme.

So, for verbs of motion, the Theme is the noun phrase undergoing the motion, for instance, *the rock* in the following two sentences *The rock rolled down the hill* and *John rolled the rock down the hill*. With verbs of location, the Theme is the noun phrase whose location is being asserted, for instance, *the rock* again in *The rock stood in*
the closet and John kept the rock in the closet. In addition to Theme, there are other thematic relations, such as Location, Source, Goal, Agent, and so forth.

Jackendoff feels that the reason the thematic-relation approach is superior to other types of semantic analyses is that the former

‘provides a way of unifying various uses of the same morphological verb [and] some very crucial generalizations about the distribution of reflexives, the possibility of performing the passive, and the possibility of antecedents for deleted complement subjects can be stated quite naturally in terms of thematic relations.’ (p. 33)

Under Jackendoff’s proposal, the syntactic component will derive the thematic relations of a sentence from its deep structure. He says:

‘Clearly, the verb of the sentence is what determines the relationship: the lexical entry of a verb must correlate grammatical and thematic relations.’ (p. 37)

As a consequence, much of Jackendoff’s effort has been devoted to developing the form of dictionary entries for verbs.

In Jackendoff's scheme, each dictionary entry consists of phonological, syntactic, and semantic properties. The lexical entries for open as adjective, intransitive verb.
and transitive verb are shown in (3-7a), (3-7b), and (3-7c) respectively (= (2.60), (2.61), (2.62), Jackendoff (1976)).

(3-3)

a. 

```
open
+A
+(NP be ___)
OPEN (NP)
```

b. 

```
open
+V
+(NP ___)
CHANCE (NP, NOT OPEN, OPEN)
physical
```

c. 

```
open
+V
+(NP ___ NP)
CAUSE (NP, CHANCE (NP, NOT OPEN, OPEN))
physical
```

Jackendoff feels that CAUSE and CHANGE are possibly semantic primitives. (He does not comment on the status of the marker physical.) He says:

'The thematic relations can now be defined in terms of these semantic subfunctions. Agent is the argument of CAUSE that is an individual; Theme is the argument of CHANGE that is an individual; Source and Goal are the initial and final state arguments of CHANGE. Location
will be defined in terms of a farther semantic function \textit{BE} that takes an individual (the Theme) and a state (the Location).’ (p. 39)

Jackendoff (1976) devotes a lot of space to decomposition of verbs. By analyzing the usages of various verbs, Jackendoff comes to the conclusion that the primitives \textit{GO}, \textit{BE}, and \textit{STAY}, used in \textit{Positional}, \textit{Possessional}, and \textit{Identificational} modes, which may be modified by \textit{CAUSE} or \textit{LET}, are capable of representing a sizable number of verbs, as shown in Tab. 1 (p. 110).

<table>
<thead>
<tr>
<th></th>
<th>Positional</th>
<th>Possessional</th>
<th>Identificational</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{GO}</td>
<td>go</td>
<td>receive</td>
<td>become</td>
</tr>
<tr>
<td>\textit{BE}</td>
<td>fall</td>
<td>inherit</td>
<td>change</td>
</tr>
<tr>
<td>\textit{STAY}</td>
<td>be</td>
<td>have</td>
<td>be</td>
</tr>
<tr>
<td></td>
<td>contain</td>
<td>own</td>
<td>seem (?)</td>
</tr>
<tr>
<td></td>
<td>stay</td>
<td>keep</td>
<td>stay</td>
</tr>
<tr>
<td></td>
<td>remain</td>
<td></td>
<td>remain</td>
</tr>
<tr>
<td>\textit{CAUSE(GO...)}</td>
<td>bring</td>
<td>obtain</td>
<td>make (e.g. make it red)</td>
</tr>
<tr>
<td></td>
<td>take</td>
<td>give</td>
<td>elect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>buy</td>
<td></td>
</tr>
<tr>
<td>\textit{CAUSE(STAY...)}</td>
<td>keep</td>
<td>keep</td>
<td>keep</td>
</tr>
<tr>
<td></td>
<td>hold</td>
<td>retain</td>
<td></td>
</tr>
<tr>
<td>\textit{LET(GO...)}</td>
<td>drop</td>
<td>accept</td>
<td></td>
</tr>
<tr>
<td></td>
<td>release</td>
<td>fritter away</td>
<td></td>
</tr>
<tr>
<td>\textit{LET(BE...)}</td>
<td>leave</td>
<td>permit</td>
<td>leave (e.g. leave it red)</td>
</tr>
<tr>
<td></td>
<td>allow</td>
<td>(e.g. permit him 5 dollars)</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 1
This scheme permits what Jackendoff (1978) calls ‘cross-field generalizations.’ (p. 218) Thus, the sentences in (3-8) – (3-10) may be represented in Jackendoff's scheme as in (3-11) – (3-13), respectively (= (26) – (31) Jackendoff (1978)). The superscripts 1, 2, and 3 stand for Positional, Identificational, and Possessional, respectively.

(3-8)  
a. The rock fell to the ground.  
b. Noga stayed sick.  
c. Dick received the money.

(3-9)  
a. Linda lowered the rock to the ground.  
b. David kept Noga sick.  
c. Dick acquired the money.

(3-10)  
a. Linda dropped the rock to the ground.  
b. David left Noga sick.  
c. Dick accepted the money.

(3-11)  
a. GO\(^1\) (THE ROCK, TO (THE GROUND))  
b. STAY\(^2\) (NOGA, DICK)  
c. GO\(^3\) (THE MONEY, TO (DICK))

(3-12)  
a. CAUSE (LINDA, GO\(^1\) (THE ROCK, TO (THE GROUND)))  
b. CAUSE (DAVID, STAY\(^2\) (NOGA, DICK))  
c. CAUSE (DICK, GO\(^3\) (THE MONEY, TO (DICK)))

(3-13)  
a. LET (LINDA, GO\(^1\) (THE ROCK, TO (THE GROUND)))  
b. LET (DAVID, STAY\(^2\) (NOGA, DICK))  
c. LET (DICK, GO\(^3\) (THE MONEY, TO (DICK)))

Jackendoff also introduces the mode (or semantic field – Jackendoff (1978), p. 223) Circumstantial, for representing implicative verbs. With this mode, the sentences of (3-14) can be represented as in (3-15) (= (34), (35), (39)). The superscript 4 stands for Circumstantial.
(3-14) a. Sheila stopped laughing.
   b. John avoided playing checkers.
   c. David allowed Laura to wash the car.

(3-15) a. \( \text{GO}^i \) (SHEILA, FROM (SHEILA LAUGH))
   b. \( \text{STAY}^i \) (JOHN, AT NOT (JOHN PLAY CHECKERS))
   c. \( \text{LET} \) (DAVID, BE\(^i \) (LAURA, AT (LAURA WASH THE CAR)))

Examples of implicative verbs and their semantic representations are shown in Tab. 2. (Jackendoff (1976), p. 133)

<table>
<thead>
<tr>
<th>Semantic Structure</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{GO}^i(x,y,z) )</td>
<td>begin, start</td>
</tr>
<tr>
<td>( \text{GO}^i(x,y,\text{NOT } z) )</td>
<td>cease, stop</td>
</tr>
<tr>
<td>( \text{STAY}^i(x,y) )</td>
<td>keep, continue</td>
</tr>
<tr>
<td>( \text{STAY}^i(x,\text{NOT } y) )</td>
<td>avoid, refrain</td>
</tr>
<tr>
<td>( \text{CAUSE}(x, \text{GO}^i(z,u,w)) )</td>
<td>cause, force, coerce</td>
</tr>
</tbody>
</table>

Tab. 2

To conclude, Jackendoff feels that 'a verb means fundamentally the same in all its senses.' (Jackendoff (1976), p. 132) The fact that the notion of Circumstantial location was discovered, he says, 'is clearly a linguistically significant generalization of the system of thematic relations: it
permits the description of a wide range of verbs and their inferences merely by following through mechanically the possibilities provided by the system, and by deriving the inferences by independently motivated inference rules. A set of heretofore classificatory features, namely those defining implicative verbs, is replaced with a motivated semantic description.’ (Jackendoff (1976), pp. 132-3)

So, the generalization from Positional to Circumstantial location explains the usage of certain verbs, as in to come to be called Max, to lead someone to believe something, and so forth. (Jackendoff (1976), p. 133). These, Jackendoff says,

‘are not "metaphors" in the usual sense — they are not used for artistic effect, and there is no clash of semantic markers characteristic of true metaphor. Rather, they are generalizations of the meaning of verbs along innately determined lines.’ (Jackendoff (1976), p. 133)

An interesting aspect of Jackendoff's theory (Jackendoff (1972)) is modal structure, which is another level of semantic representation into which a sentence is decomposed during the interpretation process. For instance, for sentence (3-16a) (=7.1)), the functional structure may be represented as (3-16b) (=32a) in J. D. Fodor (1977), ch.
5), but it will have two (partial) modal structures (3-16c1) (= (7.15))/ corresponding to the ‘specific’ reading of the sentence (which says that there is a specific fish John wants to catch), and (3-16c2) (= (7.15b)), corresponding to the ‘nonspecific’ reading (which says that John just wants to catch a fish, not caring what fish it may be).

(3-16) a. John wants to catch a fish.
   b. WANT (JOHN, (CATCH (JOHN, FISH)))
   c. 1. John, a fish, want( )
        2. John, want (a fish)

In the modal structure,

‘the linear order of elements need bear no relation to their order in the sentence. The only relevant property of this notation is whether or not an NP is within the parentheses associated with want.’ (p. 258)

Commenting on this notation, J. D. Fodor (1977), p. 186, observes that, for the noun phrase a fish, the functional structure specifies that it is the object of the verb catch. The modal structure specifies its scope.

So, a sentence may have one functional structure and more than one modal structures. The sentence A fish wants to catch John, however, will have a different functional structure from (3-16b), but the modal structure (3-16c1) (Jackendoff (1972), p. 292).

Such verbs as want (they are said to introduce opaque contexts), have, as part of their semantic representation,
the modal operator unrealized. It determines the conditions on identifiability of referents (for instance, a fish). Other modal operators Jackendoff proposes are future (John will catch a fish), possible (John may catch a fish), negative (John didn't catch a fish), multiple, introduced by quantifiers (Two boys told John a story), generic (Beavers build dams), and wh- (Who caught a fish?). All of these are introduced by lexical items (p. 292). The rule relating the modal structure of a sentence to its syntactic structure is the Modal Projection Rule (3-17) (=7.23).

(3-17) Modal Projection Rule

Given a lexical item A whose semantic representation contains a modal operator M. If an NP is within the scope of A, it is optionally [...] dependent on M in the modal structure [...]. If an NP is outside the scope of M, it is not dependent on M.

In regard to analyzing questions in terms of modal structure, Jackendoff observes:

'It will be the scope of wh, determined from the surface structure, which determines which part of the sentence is understood as questioned.' (p. 316)

Jackendoff concludes his discussion of modal structure, saying:

'the analysis of questions in terms of modal structure leads to a conjecture that the whole system of illocutionary force - the distinction between declaratives, interrogatives, imperatives,
exclamatives, and their variants and nuances – should be analyzed in terms of modal structure.’ (p. 318)

Jackendoff's treatment of negation as a modal operator results in all negative elements ('morphemes') being considered separate lexical items and not a result of neg placement by a transformation, as was postulated in early transformational schemes (for instance Klima (1964)). The modal operator neg, subject to the Modal Projection Rule (3-17), 'imposes the condition that there are no identifiable referents for NPs dependent on it and no realization of Ss dependent on it.' (p. 348) The scope of negation 'consists of everything commanded by the negative morpheme and to its right.' (p. 349) So, (3-18a) is grammatical but (3-18b) (= (8.136)) is not.

(3-18) a. The man didn't buy anything.  
   b. *The man who I didn't see bought anything.

(3-19) (= (8.28), (8.140)) and (3-20) (= (8.29), (8.141)) are more examples of sentences with negative elements and their modal structures.

(3-19) a. Not many of the arrows hit the target.  
   b. the arrows, the target, not (many(hit))

(3-20) a. Many of the arrows didn't hit the target,  
   b. the arrows, the target, many (not (hit))
(3-19) is an instance of sentence negation, since its modal structure contains negation on which all indeterminates (that is, many) and the sentence itself are dependent (p. 352). (3-20), according to this criterion, is not an instance of sentence negation, but, rather, verb-phrase negation.

Jackendoff concludes,

‘Intuitively, a sentence is an instance of sentence negation if everything that it is possible to deny is in fact denied. In particular, if it is possible to deny that a noun phrase has an intended referent, [...] then it is necessary to do so.’ (p. 352)

I will now summarize Jackendoff’s general views on semantics, expressed in ‘Toward an Explanatory Semantic Representation’ (Jackendoff (1976)) and in ‘Grammar as Evidence for Conceptual Structure’ (Jackendoff (1978)). I will begin with a summary of the position advanced in the first article.

A semantic representation of a sentence constitutes ‘a formal characterization of the information conveyed by the sentence.’ (p. 89) As was mentioned above, it is subject to various well-formedness conditions, such as selectional restrictions, conditions on required preferentiality and coreference [...] and a general condition that every
syntactic constituent must be integrated into semantic representation.’ (p. 90) Then a sentence fails one of the conditions, it is considered anomalous. The reason for having a level of semantic representation is ‘to represent the claims made by a sentence in a canonical form that is independent of the particular lexical items used.’ (p. 90) Since the level of semantic representation is part of a linguistic theory, it must be related to the syntactic level. Thus,

‘A satisfactory theory of semantic representation [...] most account not only for the information conveyed by a sentence; it must also account for the way in which the sentence conveys that information.’ (pp. 90-1)

Jackendoff continues: ‘Any semantic analysis that satisfies the desiderata [stated above] must clearly include ways to decompose the meaning of sentences into various semantic elements.’ (p. 91) He uses the term ‘semantic marker’ for elements used in semantic decomposition, be it further decomposable or not. But, he acknowledges the fact that what is a semantic primitive is a ‘tricky issue.’ (p. 91)

Projection rules combine the semantic markers of words forming certain constituents, for instance, of an adjective and noun, to form a noun phrase. This is called ‘restrictive modification.’ Some semantic markers function as variables and enter into constructions called ‘functional
composition,’ in which a semantic marker takes place of one of the variables of a semantic function to form a new marker. Subject-verb constructions are typical functional compositions. These two compositions may also appear in dictionary entries, for instance, smash may be represented as

```
- | BREAK (x,y) | (restrictive modification)
- | VIOLENTLY   |
```

and bachelor as

```
- | MAN         | (functional composition)
- | NEVER MARRIED|
```

A semantic theory must also be capable of accounting for the various semantic relations between sentences, for instance, synonymy, paraphrase, antonymy, logical and pragmatic inference, inconsistency, analyticity, syntheticity, and so forth. To account for inference (entailment between sentences), Jackendoff proposes rules of inference, which are stated in terms of semantic representations and ‘the general principle for determining entailment relations,’ (p. 110) (3-21) (=57)).

(3-21) A sentence $S^1$ entails a sentence $S^2$ if the semantic representation of $S^2$ can be derived from the semantic representation $S^1$ by means of a sequence of inference rules.
The inference rules are of the form (3-22) \((=58))\).

(3-22) \(SR^1 \rightarrow SR^2\) under conditions \(C_1, \ldots C_n\).

The following inferences are possible:

- Inference about causation (e.g. if an event is caused, it takes place)
- Inferences from \(STAY\) and \(GO\) to \(BE\)
- Inferences involving set inclusion
- Inferences with negated location (e.g. if \(X\) is not inside \(Y\) it is outside \(Y\))
- Rules of invited inference or implicature (where the inference is not necessarily true)

Jackendoff remarks that these rules are not rules of grammar but ‘cognitive primitives of some sort, being more likely part of cognitive psychology than linguistics.’ (p. 120)

Jackendoff (1978) stresses the point that the goal of linguistic semantics is to characterize semantic well-formedness rules and projection rules. This should be developed on the basis of empirical evidence and not ‘merely by appeal to traditional logic which itself originated as a possible answer to these questions.’ (p. 202) Jackendoff feels that ‘logic has become so devoid of empirical content in part because it has failed as an adequate account of natural language semantics.’ (p. 202) A theory of semantics
of natural language appears to be a subpart of the general theory of conceptual structure. So,

‘one should assume that language is a relatively efficient encoding of the information it conveys, and that theories to the contrary (such as most work in logic [...] inadegately represent the structure of language or the information it conveys, or both.’ (p. 203)

Following his dictum, Jackendoff analyzes some noun phrases and prepositions and concludes that there exist ‘such semantic entities as locations and paths, distinct from things and stuff.’ (p. 209) Likewise, discussing pictorial and verbal representations, he comes to the conclusion that ‘semantic structure must contain things that function as representations of other things.’ (p. 210)

3.5 CRITICISMS OF DECOMPOSITIONAL THEORIES

‘Atomization of Meaning’ (Bolinger (1965)) is a criticism of the theory proposed in KF. Bolinger presents arguments against the semantic marker-distinguisher distinction, as well as some of the characteristics of semantic markers. He also observes that the proposed theory is incapable of handling acquisition and extension of meaning and that the process of disambiguation followed in practice differs from that proposed by KF.
In analyzing the entry for bachelor in KF, Bolinger notes that the word young occurs in one of the distinguishes (‘young fur seal...’). He suggests that the word should be a marker rather than part of a distinguisher, and further says that it is likely that this distinguisher, like all other proposed, may be reduced until it is eliminated. The trouble with the marker-distinguisher distinction is that 'it does not appear to correspond to any clear division in natural language.' (p. 437) Considering the notion of markers, Bolinger feels that if an entry is meant to represent how speakers behave toward anomalies and ambiguities, 'each entry will be interminable.' (p. 440)

For Bolinger

'A complete semantic theory, must not only map the markers of all senses but show how markers are added and subtracted to alter the senses of words. One corroboration of a marker theory would be its ability to predict semantic shifts, much as a distinctive-feature theory accounts for phonological shifts in terms of change of one feature at a time.' (p. 441)

Further along, he says that

'A semantic theory must account for the PROCESS of metaphorical invention — all the more so, a theory that stems from generative grammar with its emphasis on creativity. It is a characteristic of natural language that no word is ever limited to its
enumerable senses, but carries within it the qualification of “something like.”’ (p. 443)

Bolinger thinks that certain words, such as inspector, bachelor, cousin, and so forth, may be amenable to being expressed through semantic markers but, he doubts whether words referring to things can.

Turning to the question of distinguishers, Bolinger suggests that the same mechanisms are at play in disambiguating shoes as in alligator shoes and horse shoes. KF would ascribe this to ‘knowledge of the world.’ But Bolinger feels that there is no clear reason why the information used in the disambiguation of shoes, above, should not be a semantic marker.

Summarizing his position, Bolinger says ‘In a framework so rigid, there is room neither for the acquisition of meaning as it actually takes place, not for extensions of meaning as they really happen.’ (p. h47)

‘Dictionaries and Meaning Rules’ (Bar-Hillel (1967)) argues against the KF conception of a semantic component as containing a dictionary and projection rules, specifically, and against the use of a dictionary for the purposes of semantic interpretation in general. That is, Bar-Hillel argues against the decompositional approach to semantics. He says:

‘the Katz-Fodor conception cannot be saved even in principle, unless one just sticks [...] to the term
“dictionary” but exempts it of any specific content, i.e. just turning it into an, at best, superfluous and, at most, quite misleading synonym for "semantic rule" (or "meaning rule").' (p. 409)

He observes that a semantic theory employing the decompositional approach is unable to account for the fact that John preceded Mary and Mary followed John are paraphrases of each other unless some complex statement will be made in the dictionary indicating, in effect, that X follows Y means Y precedes X which is nothing more than a meaning rule. Bar-Hillel feels that this information may be represented in a dictionary form (even if it is a meaning rule) in a not too cumbersome fashion. But, in general, the dictionary concept does not lend itself very well to meaning representation. Consider, for instance, the fact that X is biological father of Y entails X is older than Y. This can be easily stated in the meaning-rule form, as biological father of → older than. In a dictionary form, this would have to be stated in an ad hoc fashion. Now, since all the information that can be expressed in a dictionary can be accounted for by meaning rules, Bar-Hillel sees no reason for adhering to the dictionary approach.2

2 For other arguments favoring the inclusion of meaning postulates in a semantic theory see Fodor and Fodor (1980) and Cushing (1979). The former argues that meaning postulates should be preferred over lexical mapping rules proposed by Bresnan (1978) because of yielding a solution to the problem of quantifier scope for predicates with (cont’d.)
Introduction to Theoretical Linguistics (Lyons (1968)) devotes some space to the discussion of semantics, including componential analysis and semantic universals. Lyons illustrates the usefulness (and the principle) of componential analysis by comparing such triplets as man-woman-child, bull-cow-calf, and rooster-hen-chicken. (p. 470) Here, each triplet has something in common which the others do not. The same is true of the triplets woman-cow-hen and child-calf-chicken. The common element in the different triplets can be called a semantic marker. The ultimate analysis will produce such semantic markers as male, female, adult, human, bovine, and so forth. Lyons suggests this technique of semantic analysis

‘is inherent in the traditional method of definition by dividing genus into species and species into subspecies; and this method of definition is reflected in most of the dictionaries that have ever been compiled for particular languages, and in the organization of such works as Roget’s Thesaurus.’ (p. 472)

One of the cardinal assumptions of the decompositional approach, Lyons continues, is that the components produced by the analysis are considered to be language-independent,

____________________

syntactically unrealized arguments. The latter shows, on purely theoretical grounds, that the functional decomposition approach G. A. Miller proposes as an alternative to decomposition into semantic markers must be augmented by meaning postulates.
or universal. But, Lyons maintains that this assumption is based only on an 'anecdotal discussion of a few well-chosen examples from a handful of the world's languages and such empirical evidence as there is available would tend to refute, rather than confirm, this hypothesis.' (p. 473)

One of the apparent advantages to componential analysis, Lyons says, is that it can elegantly account for combinatorial restrictions between some lexical items. Thus, the sentence, *The woman gave birth to a child* would be judged by the grammar as acceptable, but *The man gave birth to a child* would not. But, he goes on, there might be cultural societies in which *The man cooked a meal* or *The woman lit a fire* are equally unacceptable.

‘Our own cultural prejudices and our own taxonomic classification of the physical world should not be taken as valid for the analysis of either the culture or the language of other societies, still less of any alleged "conceptual system that is part of the cognitive structure of the human mind".' (p. 479)

Another weakness of the decompositional approach, Lyons points out, is the fact that it suggests that the relationship of adult male elephant stands in the same semantic relationship to elephant as stallion does to horse. which is not the case.

In pointing out the importance of culture in the semantics of languages, Lyons quotes the well-known paper
by Conklin (1955), which shows that the ‘western’ concept of color is not universal. For instance, in the Philippine language of Hanunoo, the four main color terms are associated with lightness, darkness, wetness, and dryness. Here, the criteria underlying the last two terms would not be part of color classification in western languages.

The attitude in Semantics (Lyons (1977)) is the same as above. Lyons points out that, whereas in phonology, the principles of distinctive features appear to be consistent in languages, this is not always the case with semantic markers. Consider, for instance, the notions male and female, which are opposite of each other, so that only one is needed if the + notation is employed. On the one hand, it would be more proper to represent the relation woman-man and bitch-dog with the marker FEMALE. But this is not the case for girl-boy, ewe-ram, or mare-stallion. So, Lyons says,

‘If we take the view that there is a universal set of atomic concepts which are lexicalized in particular languages, the fact that, as far as the distinction of sex is concerned, it is sometimes MALE and sometimes FEMALE that appears to be present in the meaning of the marked element of a pair of complementaries confronts us with a dilemma.’ (pp. 322-3)

Further along, Lyons reiterates his objection to the decompositional approach by pointing out that, under it, the phrase male child should be synonymous with boy, which it
obviously is not, since the phrases an eleven-year old boy and an eleven year-old male child are not synonymous.

'Three Seasons for Not Deriving "Kill" from "Cause to Die"' (J. A. Fodor (1970)) argues against G. Layoff's suggestion that sentences such as John killed Mary derive from deep structures such as John caused Mary to die. As such, then, the arguments Fodor presents are against a syntactic theory. But, since Lakoff's suggestion is essentially semantic decomposition, it is worth mentioning Fodor's arguments here. The three arguments that Fodor presents are:

1. Kill and cause to die have different distributions. For instance, John caused Mary to die and it surprised me that she did so vs. *John killed Mary and it surprised me that she did so.

2. An event may be caused by an action that took place earlier, for instance, compare John caused Mary to die on Sunday by stabbing her on Saturday with *John killed Mary on Sunday by stabbing her on Saturday.

3. A sentence such as John killed Bill by swallowing his tongue indicates that Bill is not the subject of the verb in the deep structure but merely the object of kill.

Arguments 1 and 2 essentially reiterate Lyons' point made above that the implication of a whole concept is different from its purported decomposed equivalent, which
means that the two are not synonymous. Or, in other words, if the decompositional approach is taken, the representation of the undecomposed word must contain an element which does not occur in its purported decomposed equivalent.

The Psychology of Language (J. A. Fodor et al. (1974)) examines the decompositional theory as part of its extensive treatment of semantics. It discusses the reasons commonly given as a justification for the decompositional approach and cites some of the experimental data that are claimed to support it. But, the authors conclude,

‘even though the claim that part of the lexicon is organized into a feature hierarchy is an extremely weak one, such psychological data as have been alleged in its favor are not persuasive. [...] What the data do not show is what the lexicalists would like to prove: that the form of representation for "dog" is a feature hierarchy in which it is dominated by animal and that the form of representation of "bachelor" is a feature hierarchy in which it is dominated by male.’
(p. 209)

The Language of Thought (J. A. Fodor (1975)) takes a look at the decompositional approach in connection with discussing the vocabulary of internal representation. Fodor works through an example in which he considers the
primitive vocabulary of underlying representations. He concludes:

'for these data at least, the best solution assumes not only that there is no syntactic process of definition, but that there is no process of definition at all; i.e., that both the defined expressions and its definition appear as items in the primitive vocabulary of the representational system. [...] there is no psychologically real level of representation at which definable terms are replaced by their definitions.' (p. 133)

Fodor gives another argument against the decompositional approach, this one from the area of representation of color terms. He observes that definitions are symmetrical. Namely, ‘bachelor’ means ‘an unmarried man’ and vice versa. That is, ‘bachelor’ entails ‘unmarried.’ But there appear to be semantic relations which are not symmetrical and the definitional theory (based on analyticity) is incapable of representing them. An example of this is the relation between ‘red’ and ‘colored’. — There is no predicate P which would permit one to say that ‘red’ entails ‘colored’ because ‘red’ means ‘a color and P.’ As a result, definitional theories of analyticity either ignore this problem or ‘treat them by essentially ad hoc means (as in Katz (1972)).’ (p. 149)
The major argument of ‘The Psychological Unreality of Semantic Representations’ (J. D. Fodor et al. (1975)) is that there are no persuasive empirical grounds for there existing a level of semantic representation based on the decompositional approach which is both psychologically real and which is capable of expressing such semantic relations as synonymy, anomaly, and so forth. By ‘psychologically real,’ the authors mean ‘that given appropriate idealizations, understanding a sentence requires the recovery of its semantic representation.’ (p. 515) In other words, the authors say, ‘the semantic level as linguists have generally conceived it, does not exist.’ (p. 516) As a consequence they argue for ‘abandoning the definitional approach entirely since [...] it is inherently unable to account for a variety of pertinent facts about the way in which people understand sentences.’ (p. 518)

The authors adduce two Kinds of evidence for their thesis — intuitive and empirical.

Under the intuitive evidence, it should follow that, ‘other things being equal, the relative complexity of a pair of sentences should be a function of the relative complexity of the definitions of the words that the sentences contain.’ (p. 518) So, *Cats chase mice* should be more complex than *Cats catch mice*, since, according to Katz (1972), one of the elements into which *chase* is decomposed is *catch*. The same should be true of such phrases as *the man* and *a man*, which, according to the Russellian eliminative definition, should
differ by three logical clauses. Now, experimental data show that syntactic complexity reliably correlates with the rating of subjects. So, one would expect the same of semantic complexity. But the above conclusions are contrary to our intuition.

Empirical evidence brought forth pertains not to the number of elements in semantic representations but to which elements are present, namely the contribution of negative elements to determining the intuitive complexity of sentences. The authors consider words which do not contain the negative morpheme but in which a negative element is part of their definition, for instance, as in ‘bachelor’ which means ‘an unmarried man.’ They call these pure definitional negatives or PDNs. The authors say:

‘Arguments containing PDNs [...] were significantly easier than the paired arguments containing explicit negatives. Moreover, and most important, the difference between PDNs and explicit negatives was significantly greater than the difference between explicit negatives and either implicit or morphological negatives. We take this result to suggest strongly that PDNs do not act as though they contain a negative element in their linguistic representation; and therefore, that PDNs are not semantically analyzed at any level of linguistic representation.’ (p. 522)

As the final conclusion, the authors say:
'almost all of the recent discussion about semantics in linguistics and much of the recent discussion of semantics in psychology, has concerned the detailed arrangement of representations at the semantic level. It seems to us, however, that there is no very convincing evidence for the existence of such a level, and that there is more than little reason to believe that no such level does exist. Perhaps the reason that semantic representations have proved so elusive is simply that, after all, there aren't any.' (p. 530) The authors ask, then, what other approach could be taken to represent meaning. This is the line of reasoning they follow:

Understanding that John is a bachelor is realizing that it entails John is an unmarried man. This might mean that bachelor and unmarried man have distinct semantic representations but that the rule bachelor → unmarried man is one of the rules of inference in the semantic theory. These types of rules are meaning postulates. The authors then say:

‘our proposal is that to each morpheme of the surface vocabulary of a natural language there corresponds a primitive expression in the vocabulary of the representational system. [...] If our arguments are sound, then it appears practically mandatory to assume that meaning postulates mediate whatever entailment
relations between sentences turn upon their lexical content. That is, meaning postulates do what definitions have been supposed to do by theories which endorse [the decompositional approach]!’ (pp. 525-6)

Following are the other arguments in favor of the meaning-postulate approach which the authors give.

Experimental data show that people's comprehension of sentences is extremely fast. This would suggest that the semantic representation of sentences is very close to the surface structure. This tends to weigh against the decompositional approach.

Even if the decompositional approach is adopted, meaning postulates are still necessary in the grammar, to handle the ‘residue’ left after the decomposition.

Finally, definitions have to be symmetrical. But the relation such as red-colored mentioned above, is not. Meaning postulates appear to be the only mechanism available for solving this problem.

*Semantics: Theories of Meaning in Generative Grammar* (J. D. Fodor (1977)) gives the following line of reasoning as a motivation for the decompositional approach:

'if the meaning of a lexical item, for example father, were not analyzed into components, a grammar would have to simply list the semantic properties and relations of that item as independent facts: that father is synonymous with male parent, that it is antonymous with mother that male father is redundant;
that deciduous father is anomalous; that female father is contradictory; and so on. This would be descriptively uneconomical and, more importantly, would miss the fact that these properties are NOT independent of each other. There could be no word synonymous with elephant, antonymous with raspberry, redundant with oxidized, contradictory with sad and entailing with archeological. A componential approach to meaning guarantees this, for all the semantic properties of an item are determined on the basis of the same fixed set of meaning components.’ (p. 145)

But, Fodor goes on, there is no clear-cut answer to the question of how far the decomposition should be taken. One could stop at the point when all nonsynonymous words have distinct analyses. But then how could one express the meaning of the ‘remainders’ which distinguish nonsynonymous words? The components into which these would be analyzed might rival the number of words in the language itself. The ‘remainders’ appear to be equivalent to distinguishers in Katz's theory, and here Fodor mentions Bolinger's critique of the concept. Considering the technique of factoring out components, Fodor observes:

‘once we have factored out (Animal) and perhaps (Mammal), here seems to be nothing more we can say about the MEANING of the word cow. Of course, cows differ from horses and dogs and camels in some quite familiar ways, but it is no part of the MEANING of cow
that cows say "moo," and give milk, and look thus-and-so. These are not NECESSARY truths about cows; a cow that did not say "moo" would still be a cow, and so would one that did not give milk or was purple or looked like a horse.' (p. 148)

This, then, constitutes a problem for the decompositional approach:

'The implication is that the meaning of a word is something pretty threadbare, that (contrary to commonly received views) it does not even in principle determine the extension of the word. If this is so, then a specification of the meaning of a sentence will not always provide a complete account of its truth conditions.'

In another place, Fodor says:

'The word bachelor rather obviously means "unmarried man," and the meaning of man can perhaps be decomposed into "male" and "human." But at some point, decomposition has to stop, and the assignment of meaning to the semantic primitives must be accomplished by some other means. A second and deeper

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3 For a discussion of problems connected with word meaning see Labov (1973). Labov also criticizes the approach to meaning definition based on distinctive features as being identical to the Aristotelian categorical viewpoint, or 'scholastic.' He adduces some experimental data which show that the ability of people to recognize nonessential ('accidental') properties of objects is part of the ability of identifying objects, which is contrary to the opinion of Aristotle.
worry was whether, at the point which decomposition stops, there is anything more to meaning than merely extension.’ (p. 209)

Another argument against the decompositional approach Fodor brings up is the one concerning the relationship between ‘red’ and ‘colored’ mentioned above (J. A. Fodor (1975)). This shows that the decompositional approach cannot capture all semantic relations.

Continuing, Fodor observes that Katz's theory contains redundancy rules. These seem to provide a solution to the problem with words like ‘red.’ That is, the theory could state that ‘red’ implies ‘colored.’ This would mean that redundancy rules would be functioning like Carnap's meaning postulates. But, everything achievable by decomposition is achievable by meaning postulates. So, since the theory requires meaning postulates, the technique of decomposition can be dropped altogether and the sole mechanism used for semantic analysis could be meaning postulates. —

'Since meaning postulates are apparently required for examples like red/colored, it might be suggested that they should be the ONLY device in a grammar for capturing meaning relations. That is, even a word like kill, whose meaning is supposed to be decomposable into the concepts of causing and dying, would have a dictionary entry whose semantic component contained only meaning postulates. The only difference between
red and kill would then be that, in the latter case, the meaning postulates would represent bidirectional entailment. It is worth observing that if a case for this position could be established, it would profoundly affect the conception of a semantic representation.’ (p. 153)

But, Fodor warns, ‘it does remain to be shown that meaning relations other than entailment, such as ambiguity, redundancy, anomaly, and so on, can be adequately treated in a semantic system without lexical decomposition.’ (p. 154)

Also, ‘Once it is recognized that meaning postulates are needed in linguistic decomposition, their proper domain must be precisely determined. It may well turn out to be considerable.’ (p. 155)

Further along, Fodor asks the question whether semantic representations are necessary. She considers the structure of Jackendoff’s semantic component and concludes:

‘The usual assumption shared by theories which differ on other matters has been that there MUST be a level of semantic representation such that (i) each sentence of the language has a representation at this level, [...] and (ii) inference rules apply to this semantic representation to determine the (possibly infinite) set of entailments of the sentence. But Jackendoff’s departures from the standard theory suggest an even more radical revision, which would do without the
intermediate stage of semantic representation entirely. Instead, there would be just the syntactic derivation for a sentence, together with a set of inference rules applying to one or more of the phrase markers (deep, surface, end-of-cycle, etc.) in this derivation to generate the entailment of the sentence. [...] The idea of doing without semantic representation is, in general, an extreme instance of the growing emphasis on entailment in linguistic semantics. A grammar without semantic representations, but with a suitable body of inference rules, could apparently do everything that has traditionally been demanded — as long as it is the case that all the significant semantic properties and relations of a sentence can be captured by reference to its entailments.’ (pp. 193-4)

In connection with this proposal, Fodor discusses the treatment of semantic anomaly. She observes that in Katz's theory, it is identified with meaninglessness. But, as McCawley (1968) and Jackendoff (1972) have noted, this is clearly wrong, because sentences such as It is nonsense to speak of colorless green ideas sleeping furiously, which contain anomalous parts, are not anomalous in themselves, and, therefore, not meaningless. So, semantic anomaly does not appear to be lack of meaning but some sort of ‘defect’ in the meaning. Fodor brings forth some cases Katz himself cites, which show that some entailments cannot be
captured by reading inclusion. For instance, all entails some, even though all cannot be decomposed with some as one of its constituents. (p. 195) This shows that semantic anomaly cannot be defined in terms of semantic representations. Rather, as McCawley (1971) suggests, rules of entailment have to be used. But, Fodor observes, some problems remain with this proposal. For instance, there appear to be different degrees and types of anomaly, compare The king is axiomatic with The king is female. (p. 196) So, this problem has to be resolved successfully before the suggested approach is accepted.

In Presupposition and the Delimitation of Semantics, Kempson (1975), while discussing the problem of definition of meaning, says:

‘In the framework given above [that of Katz and Bierwisch], the semantic components are mere artifacts which churn out appropriate artifacts as meaning of sentences. There is no direct attempt to explain the relation between the abstract symbols of language and the external world these symbols describe. Yet this is surely the goal of a semantic theory, and any semantic mechanism which does not attempt to explain this relation is merely playing academic parlor games.’ (p. 31)

Further along she adds:
'It has been argued by logicians such as Montague (1970), Lewis (1972), and Bartsch and Vennemann (1972), that semantic models such as Bierwisch', which present an abstract semantic representation as an interpretation of syntactic structures, do not provide interpretation at all. They merely present the syntax of yet another metalanguage into which the syntactic constructs of the theory are translated.' (p. 35)

Kempson, however, does not agree with this criticism, as far as Bierwisch is concerned, because she feels that his theory is just a notational variant of truth-conditional (or verificational) semantics, which she subscribes to.

In *Semantic Theory*, Kempson (1977) discusses componential analysis in connection with the explanation of word meaning. She remarks that componential analysis is well suited for expressing the implicit relationships between words, for instance, *mother-aunt*, *murder-kill*, *give-take*, and so forth. But, she observes,

'In so stating the inter-relationship between words in terms of more primitive semantic components, one is transferring the burden of semantic explanation from word meaning onto the components which together, in different combinations, constitute word meanings.' (p. 19)
Saying that the proposed primitives are concepts, as Bierwisch and Katz do, she rejects as ‘vacuous.’ (p. 19) She goes on:

'in defining meaning in terms of mental concepts, Katz' theory has no apparent place for an explanation of the relation between a word and something that it may be used to refer to, or of the relation between a sentence and the state of affairs it describes. Each of these relations has been merely reduced to an untestable relation between an expression and a mental construct. And in the case of English words such as human [...] we are given no explanation at all other than the bold statement that the meaning of human is the concept represented by [HUMAN]. This is not only not explanatory as an account of meaning, but it is also quite unfalsifiable. So, while the method employed in componential analysis may be useful [...], the theoretical underpinnings provided by an account which incorporates a definition of semantic components in conceptual terms are not those of a falsifiable theory. If semantics is to be part of an empirical science, such an account must be made more substantial.’ (p. 20)

Continuing, Kempson argues that it is unsatisfactory to represent meanings by unordered sets of markers, since such words as give and take, which are converse of each other, would have the same representation. She suggests that some
form of predicate-logic notation has to be used to avoid this problem. As in her previous book, she assumes that a decompositional theory viewed as a truth-conditional variant, is a viable semantic theory.

Next, she considers the question of semantic universals. She remarks that there is one aspect of the theory that there are semantic universals which is not controversial – namely that the rules generating sentence meaning from word meanings are the same for all languages. In Chomsky's terminology, these are formal universals, and there appears to be general (implicit) agreement that this is so. As far as the semantic features are concerned (substantive universals), Kempson discusses three possible claims that can be made about them:

‘that all languages require the same set of semantic components; that all languages can be described by a universal set of semantic components of which each language requires a subset; that the description of all languages involves a certain set of semantic components, but that in addition a number of semantic components have to be set up for the description of individual languages.’ (pp. 99-100)

She concludes that the solution to this problem remains an open question. But, she remarks:

‘if componential analysis is to provide an explanatory account of lexical meaning, there must be some interpretation of the components themselves relating
the components to the properties they are said to correspond to. Yet no linguist has provided such an interpretation as part of a semantic theory.’ (p. 101) But in spite of this, and without any explanation, Kempson concludes:

‘In line, then, with the majority of linguists today, I shall assume for the remainder of this book, despite the serious problems involved in componential analysis [...] that an account of lexical meaning in terms of semantic components can be made viable.’ (p. 102)

The most important criticisms directed at the decompositional theory discussed in this chapter may be summarized by the following six points:

1. It is unlikely that a reasonably small number of semantic primitives can be found into which all words can be decomposed. (Bolinger, J. D. Fodor)
2. It is unlikely that the semantic primitives of a language, if such exist, are universal. Rather, they are culture specific. (Bolinger, Lyons)
3. The entailments for words and for their decomposed equivalents are different, as shown by their respective distributions. This constitutes empirical evidence against the decompositional theory. (Lyons, J. A. Fodor)
4. The meanings of the semantic primitives have never been defined. The theory is thus unfalsifiable and therefore vacuous. (J. D. Fodor, Kempson, Montague, Lewis, Bartsch, Venneman).

5. Psychological data supporting the decompositional theory are very weak and there are some psychological data showing it is wrong. (J. A Fodor, Bever, Garret, J. D. Fodor)

6. Decomposition alone is incapable of expressing all semantic relations. Moreover, decompositional approaches typically employ rules of entailment. Now, rules of entailment are capable of accomplishing everything that decomposition does without having its faults. They should, therefore, be the only mechanism employed by a semantic theory. (Bar-Hillel, J. A. Fodor, J. D. Fodor)

In addition, the following seventh point may be directed against at least some of the existing decompositional semantic theories:

7. The treatment of semantic anomaly is inadequate.

(Weinreich, Bolinger, J. D. Fodor)

Although attempts have been made to defend the decompositional theory from some of the criticisms directed at it (for instance, Katz (1972)), in my opinion, and to my knowledge, no conclusive evidence has been brought forth invalidating the objections listed above. In particular, nothing has been done to dispel the doubt, voiced explicitly by
Chomsky and Bolinger, and implicitly by some others, that semantic primitives can be found for words having a referent in the physical world, with its highly improbable connotation that the latter must adhere to what has been encoded in the human mind, made even more improbable by the recent advances in physics which have dramatically changed our conception of space, time, energy, and matter. I feel, therefore, that just on the force of these objections it is warranted to try searching for a mechanism other than decomposition as the basis of a linguistic semantic theory.

There is, however, another very important argument which can be used against the decompositional theory, which, again as far as I know, has never been brought up. It may be presented as follows.

It is true that objections can be raised to most, if not all, semantic primitives proposed by different decompositional theories. But this criticism could be dismissed by saying that these are not necessarily the primitives which careful work will eventually produce. So, these objections might invalidate the proposed candidates for semantic primitives but not the theory of decomposition itself. Yet at this point the theory is worthless because it is not explicit enough to be falsifiable. When will it be explicit enough? — Only when it can be shown that, one, all of the words of a language are representable by the list of primitives the theory supplies; and, two, that this list must be able to represent the words of all the languages in the world. After all, in phonology, a system of phonemes
proposed for a language is always capable of representing all the words of a language. And there is good indication that the distinctive features arrived at by phonologists are capable of accounting for all human languages studied to any reasonable degree. So, it is incumbent upon the proponents of the decompositional theory to produce such a list of semantic primitives. At this point, one cannot fail to observe that the vastness of this undertaking is overwhelming. After all, there are hundreds of thousands of words in each language, and dozens, if not hundreds, of different languages would have to be considered. (Notice that even the fact that one could raise this objection seems to point to there being something wrong with the decompositional approach. — No such difficulty exists in phonology, and our intuition tells us that no difficulty could exist. It seems apparent to everyone that the set of sounds used in human languages is quite small. But, of course, this is not a proof that the decompositional approach is wrong except, perhaps, merely a warning that it might be.) But, unless this is done, the decompositional theory cannot be accepted as definitely correct. And, since there appear to be so many serious arguments against it, unless the above task is accomplished, the theory should not be considered viable at all.

But, let us assume that the proponents of the decompositional theory were able to marshal such a vast effort and have come up with a list of words (and notice that they would have to be nothing more than words) into
which all the words of a language were decomposable and, further, into the single-word equivalent of which words all the words of some reasonably large number of world's languages would be translatable. — What would this mean? Would we be certain that we have arrived at a list of semantic primitives? — I do not know. I do not know how one would go about ascertaining that these would be semantic universals. Notice, for instance, that similar techniques of cross-language taxonomies in syntax led to nothing, even though some patterns were established (compare Greenberg (1963)). If the list of semantic primitives were reasonably small then, perhaps, one would be encouraged by the results of the effort, as one can be in phonology. But, if the list were fairly large, as it appears likely to be, then I doubt that much would be gained. The only thing that might save the theory then would be developing some psychological experimental techniques which would strongly indicate that the proposed primitives have in fact a biological basis (as again is the case in phonology and syntax). But, unless this is accomplished, the theory could not be considered to have been conclusively proven valid.

It appears, therefore, that another strong argument against the decompositional theory is that it is potentially unfalsifiable and, therefore, potentially vacuous.

But even if one were to overcome all of the difficulties I have pointed out above and come up with a list of semantic primitives which were shown to have a biological foundation, the representation of a sentences in terms of these, as I have
stated earlier, would in no way explain its meaning the way a syntactic phrase-marker explains the structure of a sentence, but would remain nothing more than a paraphrase of the original which would still have to be explained. Searching for an explanation in a definitional representation, it appears, is inescapably doomed to failure. The only useful function a semantic representation can serve is to show the semantic structure of a sentence and permit it to be compared against the information in the knowledge base.

Of course, all these arguments notwithstanding, the proponents of the decompositional theory might say that there are enough data showing that ‘there is something to it.’ — That lexicons of human languages do exhibit semantic patterns and that all speakers are aware of the various semantic relations and properties and the decompositional theory explains these very simply and neatly.

I will address myself to this issue in chapter seven, in the course of the discussion of the theory proposed in this book.
CHAPTER FOUR:

SEMANTIC THEORY

4.1 GOALS OF A SEMANTIC THEORY

Katz's contention, it will be recalled (see 3.1), is that the goal of a semantic theory is to answer the question 'What is meaning?' (Katz (1972), p. 1) which breaks down into the questions regarding the various semantic properties and relations.

Bierwisch (see 3.2) states as the goal of a semantic theory answering the question 'what is the meaning of a sentence S of language L?' (Bierwisch (1970), p. 167) in terms of the syntactic structure of the sentence and the semantic representation of the words.

Weinreich's definition of the goals of a semantic theory (see 3.3) is 'to explicate the way in which the meaning of a sentence of specified structure is derivable from the fully specified meaning of its parts.' (Weinreich (1966), p. 417)

Jackendoff does not state what he considers the goal of a semantic theory to be but, to him (see 3.4), an important part of it appears to be semantic representation. And 'A satisfactory theory of semantic representation [...] must account not only for the information conveyed by a sentence, it must also account for the way in which the sentence
conveys that information.’ (Jackendoff (1976), pp. 90-1)

J. D. Fodor (1977) states the following conditions that a linguistic semantic theory should meet:

‘It must make available some format for the precise representation of meaning both of lexical items and of phrases and sentences (as syntactic phrase markers are a format for precise representation of syntactic structure). It must specify the nature of the rules that will relate the meaning representations of phrases and sentences to representations of the meanings of the lexical items they contain and the syntactic configurations in which they appear (as syntactic theory specifies, at least ideally, the properties of syntactic transformations). And we can also expect it to provide formal definition of meaning-dependent properties (e.g. anomaly, self-contradictoriness) and meaning-dependent relations between expressions (e.g. the paraphrase relation, the entailment relation, the relation between a question and its possible answer).’ (p. 6)

For Kempson (1977), a linguistic semantic theory must meet these conditions:

‘(i) it must characterize the nature of word meaning and sentence meaning for any language, and explain the nature of the relation between them; (ii) it must give an account of ambiguity, synonymy, entailment, contradiction, logical inclusion, etc., and for any given language make the correct predictions; (iii) it
must give these characterizations in the form of a finite set of rules capturing the requisites contained in some specific infinite set of sentences.’ (p. 9)

The key word in all these definitions of semantic theory is ‘meaning’ (Jackendoff uses ‘information’ but, I believe, here it is synonymous with ‘meaning.’) This is not surprising since the traditional definition of semantics is ‘study of meaning.’ (Lyons (1968), p. 400) But, the problem is that there does not exist a generally accepted definition of meaning and, in fact, serious doubts have been raised about the possibility of such a definition (Kempson (1977), p. 33). – Notice that Katz hedges the real issue by answering his original question in terms of the various semantic relations and properties. But, surely, knowing that a sentence is ambiguous or synonymous with, or antonymous to another sentence does not specify the meaning of the sentence. Yet, even if we did have a generally accepted definition of meaning, the best we could do would be to paraphrase a sentence in terms of another language – which is in fact what all decompositional theories do. This is a completely general characteristic of the definitional approach, applying to any language in terms of which the meaning of a sentence is purportedly explained. The only thing that could possibly save a decompositional theory from being vacuous would be, as was argued in 3.5, if it were shown that its vocabulary had biological basis. Otherwise
(and, as was said, perhaps even then) the theory cannot be viewed as potentially empirical.

One must conclude, therefore, that the goal that a semantic theory define the meaning of a sentence must be abandoned if we want the theory to be empirical.

As to the frequently stated requirement that a semantic theory should explain the various semantic properties, on the surface, it looks as though the requirement is reasonable enough. After all, these are properties of the ‘contents’ of sentences, and no component of grammar other than the semantic one should have anything to say about them. But, first, we would certainly not want the theory to stop at this capability. It is clear that a person who understands a sentence knows more than how it relates to other sentences in the language, namely, he knows how it relates to the world. Second, it is probable that at least some of the semantic properties, such as ambiguity, synonymy, and hyponymy, are based on concepts that are applicable to nonlinguistic information, for instance visual. — A shape may have two or more interpretations. For instance, a two-dimensional representation of a cube may be interpreted as a view from above or below. Two shapes may mean the same thing. For instance, two circles of different dimensions are still circles. A shape may belong to a class of shapes. For instance, an isosceles triangle is a triangle although not all triangles are isosceles triangles. So, it is possible that the mechanism that is at
play in detecting the various properties and relations is a general-purpose mechanism, to be specified in a broader model of human intelligence rather than in grammar. In other words, it is possible that the information received through the medium of language goes through the same evaluative process as that received through our senses, and that the mind assigns to it the various properties. I am not claiming that this is definitely so, but it seems to me that there is a distinct possibility of this being true and that the question is worth investigating.

This question raises an issue which is important in all branches of linguistics – how to separate linguistic problems from other interesting problems which crop up in linguistics but which should be properly handled in another discipline (part of the higher discipline of, in Chomsky's words, cognitive psychology). I do not know if in semantics this problem is more intractable than, say, in syntax, but it appears to be of some importance. In addition to the question raised above, there are such questions as where does linguistic knowledge stop and world knowledge begin; should a theory of meaning extension be considered part of grammar or not; how should presupposition be looked at in a semantic theory, and probably many others. (For a discussion of the last topic see Kempson (1975).) – One of the things a semantic theory must do, then, is to define its own scope.
But, to return to the original topic, since it appears that meaning definition is not a feasible goal for semantics, what could be a feasible and nontrivial goal?

- Imagine a game in which real-life activities are imitated faithfully, with the exception that a commodity or objects playing a role in the game are replaced by some symbolic representation. For instance, a game modeling some financial process, in which real money is represented by play money. In such a game, even though no real financial transactions would take place, all the rules of real life could be modeled with absolute exactness. So, if we were interested in these rules, we could study the game and get as much information from it as from real-life transactions.

I think that the same can be done in semantics. - If we represent meaning in some arbitrary way, we still could produce the model of the semantic component which could be of interest to us, assuming that the operation of the component included rules which were not limited to ‘effecting’ the meaning of sentences in whatever its biological underpinnings may be. But, in this approach, care must be taken to insure that these symbolic representations of meaning are such that they will not distort the rules which we will be trying to describe.

How could we accomplish this? - One possible way would be to represent the meaning of a sentence in terms of another one or more sentences, saying, basically that s1
means s2, s3, s4... and so forth. The definition of meaning here would certainly be circular, for we would know what s1 means only if we know the meaning of its implications. But this should not disturb us if our theory does not try defining the meaning of a sentence but only the rules which come into play producing the meaning. It seems to me that this is a valid approach to semantics and I will follow it here. Notice, that the proposed symbolic representation of meaning coincides with the definition of meaning postulates which have received the support of many logicians and linguists.

The two general goals of a linguistic semantic theory may be listed, then, as (4-1).

(4-1) Goals of a Linguistic Semantic Theory

a. A linguistic semantic theory must define its scope, establishing criteria for separating the mechanisms of semantic component of grammar from other cognitive mechanisms which interact with it in semantic interpretation.

b. A linguistic semantic theory must specify the semantic component of grammar by describing the mechanisms and rules which come into play during the process of semantic interpretation, without attempting to define the meaning of sentences.

(4-1b), the main point of this book, constitutes a premise that a linguistic semantic theory can be constructed without a level of semantic representation which defines the meanings of sentences. This is a radical departure from all established linguistic semantic theories. The major goal of
this book, therefore, is to show how such a theory can be constructed.

In 4.2, I will concentrate on the first of the two goals, that is, the scope of a semantic theory. In 4.3, I will briefly touch upon the second goal, the nature of the semantic component. In chapter five, I will elaborate upon this goal, sketching out the semantic component within the approach outlined above. I will call this approach the knowledge-based theory or knowledge semantics. Some of the more important issues connected with knowledge semantics will be discussed in chapter six.

4.2 SCOPE OF A SEMANTIC THEORY

A thorough treatment of the scope of a linguistic semantic theory lies beyond the topic of this book. Consequently, I will merely state what the scope of such a theory should be and give some justifications for my decisions.

In 4.1, I said that it is doubtful whether the treatment of some of the semantic properties and relations properly lies within a linguistic semantic theory. I still feel this is true but, since this requirement is listed in virtually every major linguistic semantic theory, I will
show how it could be satisfied within the knowledge-based theory. This will be done in the course of the discussion, in chapter seven.

Literally every established semantic theory postulates that it should show the relationship between the syntactic structure of a sentence and its meaning. This seems to be self-evident, and I will assume this to be one of the requirements. That is, I will assume one of the subcomponents of the semantic component to be a mechanism whose input is the output of the syntactic component and whose output is a representation of the semantic structure of the sentence.

Another requirement mentioned universally is that a semantic theory should show how sentence meaning is derived from the meaning of the words making up the sentence. The reason for this is obvious – since there are potentially an infinite number of sentences with unique meanings, a viable theory must require their semantic basis to be some finite set of meanings. And, since words are obviously components from which sentences are made up, and their list is finite, they seem to be the obvious candidates. I accept the general statement of this requirement, namely, that a semantic theory must show how the meanings of sentences are derived from the meanings of their components. But, I will not assume that the components are only words. I think that it is up to the theory to define what the semantic units it
employs are. This will be done in the knowledge-based theory.

The above two requirements are the only ones on which there exists a consensus among the various established theories. In fact, the goals of most of the established theories (Weinreich's being the only exception) consists of these two requirements plus the requirement to explain the semantic properties and relations. There is one more aspect of language, however, which I feel properly falls within the scope of a linguistic semantic theory. — It is the acquisition and extension of meaning. As was said in chapter three, it is only Bolinger who argues for the treatment of both of these phenomena to be included in a linguistic semantic theory. And Weinreich argues for including the second of the two. The remaining theories, either tacitly (Bierwisch and Jackendoff) or openly (Katz and Kempson), argue against it. Katz says, for instance, ‘Sentences that do not have a sense — semantically anomalous sentences — cannot be said to express a proposition.’ (Katz (1972), p. 122) Kempson considers a theory of meaning extension as part of pragmatics, which she bases on Grice's proposal:

‘it [. . .] seems as though Grice's outline of pragmatics provides a natural basis for explaining how and why metaphorical interpretations involve the super-imposition of one interpretation (which commonly involves nonlinguistic assumptions about the
world) upon the other literal interpretation.’  
(Kempson (1977), p. 71)

I am not sure how to treat the attitudes of Chomsky and J. A. Fodor, but it seems to me that both of them are in favor of some kind of explicit treatment of semantic anomaly. — Chomsky's suggestion of developing the notion of degree of grammaticalness advanced in Chomsky (1965), even if it is made as part of a syntactic theory, is in some sense similar to Weinreich's. J. D. Fodor also appears to feel that a semantic theory should address itself to the question of meaning extension, when she says:

‘Connected with [the issue of polysemy] is a host of questions about the proper individuation of word meanings (such as when a meaning has been metaphorically extended and when a word actually acquires a new meaning) which have been given little attention by generative linguists.’ (J. D. Fodor (1977), p. 159)

She also seems to show the same attitude in discussing McCawley's proposal for the treatment of anomaly.

Actually, Jackendoff, although he implies that he is against the treatment of anomaly as part of a semantic theory, does make a step in the direction of the treatment of meaning extension by introducing the notion of Circumstantial location. Remember that he says that such expressions as to lead someone to believe something ‘are not
metaphors in the usual sense—they are not used for artistic effect.’¹ (Jackendoff (1976), p. 133) Jackendoff, obviously, is against making the treatment of novel metaphors part of a linguistic semantic theory but is for the treatment of dead metaphors, which is what lead to believe, apparently, is. This suggests that the two phenomena are interpreted by different processes. This might well be true, but is should be shown to be so rather than assumed. Moreover, if the second process is to be excluded from a linguistic semantic theory, it should be excluded on the basis of its nature—because of its not fitting in with the other processes accepted as part of the semantic component, rather than on a priori grounds. But this can be done only if the nature of the process has been established. So, this argues for including at least the initial investigation of metaphorical interpretation within the scope of a linguistic semantic theory.

Furthermore, since (I assume) lead originally had only one meaning (physical) and now it has two (physical and nonphysical), the phenomenon is semantic change. But, historical linguistics is concerned with semantic change. So, if we exclude the treatment of this topic from the area

¹ ‘Artistic effect’ seems to imply that Jackendoff feels that metaphors are used only in artistic context, which is contrary to the widely accepted notion that this is not so. Compare Mooij (1976), where it is shown that metaphors occur with great frequency in virtually all areas of discourse, including scientific writing.
of semantics, we will deny historical linguistics a tool for explaining one of the phenomena it is concerned with. Excluding semantic change from semantics, therefore, implies that it must be excluded from historical linguistics as well. But, there exist other changes in language, namely phonological and syntactic, topics studied by historical phonology and historical syntax respectively. So, if we exclude semantic change from being treated by linguistics, it appears that we should also exclude the treatment of phonological and semantic change, unless, again, there is something about the process of semantic change which makes it not fit in with the other linguistic processes. But this can be established only if the nature of the process is known, which says that the process should be studied at least initially. Notice that historical phonology gives an explanation of why the words nose and knows sound the same, that is, why [nowz] has two meanings. It appears strange to suggest off hand that linguistics should not explain why the same is true with lead.

The attitude that metaphorical interpretation is a proper topic for linguistics is shared by Loewenberg (1975) when she says: ‘Metaphors all appear to involve semantic change and therefore semantic theory is the likeliest source of a formula for identifying them.’ (p. 316)

Above, I have argued for making the treatment of meaning extension part of a semantic theory on the grounds
that, if it is reasonable to expect a semantic theory to show that a word has two meanings, it should be reasonable to expect the theory to show how this came about. There is another bit of evidence that seems to support the argument in favor of making the treatment of meaning extension part of a semantic theory. — It seems to be a universal fact that hearers always try to interpret speakers' utterances to the best of their abilities. Bendix (1971), for instance, says:

'a hearer will try to interpret or at least to account for a speaker's utterances, be will often accept and make sense even out of sentences that initially appear odd or contradictory when presented to him on semantic tests or in actual discourse, or he may reject them and then proceed to interpret them anyway.' (p. 406)

This seems to be also borne out by Grice's thesis of the Cooperative Principle, part of his theory of meaning, which says that in all communication there is a general agreement of cooperation between a speaker and a hearer (Kempson (1975), p. 142, (1977), pp. 69-71) Grice does not address himself to the problem of interpretation, that is, the 'maxims' constituting his Cooperative Principle refer to the behavior of the speaker. But, I think, the principle can be extended to the hearer, saying that, unless an utterance is overtly labeled as nonsensical, the hearer will try interpreting it to the best of his abilities. If he will
not, this will not be simply because the utterance is nonsensical but because his grammar, knowledge, and intelligence will be incapable of imposing an interpretation on the utterance. I will address myself to this problem further along.

The fact that hearers always try to interpret utterances shows that Katz's claim that anomalous sentences are meaningless is wrong unless one gives to the word 'meaningless' an interpretation other than 'not understood' which seems pointless. But, this does not settle the question of whether the mechanism handling the interpretation of anomalous sentences is best handled in grammar or in the performance model, that is, as part of pragmatics. Again, I do not think this can be answered a priori but, rather, on empirical. That is, as was said earlier, relevant data should be studied and a decision should be reached on the basis of the analysis of the data.

Still one more bit of evidence seems to support the claim that meaning extension should be part of a linguistic semantic theory, and it might be worth mentioning it here.

— As was said earlier, J. D. Fodor argues against Katz's approach to considering anomalous sentences as meaningless on the grounds that they may be part of sentences which clearly are not meaningless, such as It is nonsense to speak of colorless green ideas sleeping furiously. In other words, there is an indication that the speaker understands what the anomalous expression means but that he considers it
nonsense. Since this is accomplished as part of interpretation of a well-formed sentence, I think it is better to posit that the whole sentence is interpreted by the grammar rather than part of it by grammar and another part by the performance mechanism.

I assume, then, that a grammar (its semantic component) must account for semantically anomalous sentences not merely by labeling them anomalous or even indicating their degree of deviation but simply stating what the sentence means, the same as for non-anomalous sentences. For instance, for the sentence *The rock was thinking its hard thoughts*, the grammar must indicate, among other things, assuming that the hearer's knowledge and intelligence permit this, that the property characteristic of beings, that is the ability to think, is attributed to an object, which is not considered to possess it; or, conversely, that the concept of the word *think* is changed so that it can be predicated both of beings and objects.²

In the preceding paragraphs, a few arguments were advanced in favor of the treatment of meaning extension in a linguistic semantic theory. At the outset of the discussion, however, meaning acquisition was lumped together

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²For an extensive argumentation favoring the inclusion of meaning extension in a grammar, see Cohen (1979).
with meaning extension as a proper area of interest for such a theory. This was done because the two issues, intuitively, seem to have something in common. — After all, for an unknown word to acquire meaning, in a sense, is changing its meaning from nothing to something specific. It is true that this is just a hunch and it might turn out to be wrong. But if it is so, the fact should come out of the investigation of the topics, when the processes for the two phenomena have been established.

This concludes my discussion of the question of the scope of a linguistic semantic theory. I posit, then, that the scope of a linguistic semantic theory is as stated in (4-2).

(4-2) Scope of a Linguistic Semantic Theory
a. A linguistic semantic theory must show what role the syntactic structure of a sentence plays in the process of semantic interpretation.

b. A linguistic semantic theory must show how the meaning of a sentence is derived from the meaning of its components.

c. A linguistic semantic theory must show how the meaning of words is acquired and extended through the means of language.

Actually, as was said earlier, the first stage of (4-2c) ought to be sketching out the processes necessary for meaning acquisition and extension and determining, on the basis of how well they fit in with the other, obviously linguistic, processes constituting the semantic component,
whether or not they should, in fact, be made part of a linguistic semantic theory.

The following two chapters show how these tasks might be accomplished within the knowledge-based theory. The role of syntactic structure in semantic interpretation is discussed in 5.3.1, 6.1, and 6.3 – 6.6. The contribution of the meaning of the components of a sentence to that of the sentence is discussed in 5.3.3 and 6.2 – 6.6. Meaning acquisition and extension is discussed in 5.3.3 and 6.7.

4.3 SEMANTIC COMPONENT

In the revised extended standard theory, the semantic component consists of rules 3b, 4b, and 5b in (2-1). These are the rules of construal, interpretive rules, and conditions on binding, discussed in chapter two. As was mentioned earlier, Chomsky says that they may be regarded as dealing with the syntax of logical form. – That is, he says:

"Many of the questions that are regarded as "semantic" can be understood, I think, as questions about the syntax of LF: the notation in which it appears, the properties of this notation and the rules that relate
such representations to other elements of grammar[.]'

(Chomsky (1980b), pp. 169-70)

In earlier formulations, in fact, grammar was defined as shown in Fig. 8 (=37), Chomsky (1975a)).

\[
\text{Sentence Grammar: } \quad B \quad \rightarrow \quad \text{IPM} \quad \rightarrow \quad \text{SS} \quad \rightarrow \quad \text{LF}
\]

\[
\text{SR-2}
\]

\[
\text{Other systems : } \quad \text{LF} \quad \rightarrow \quad \text{'Meaning'}
\]

Fig. 8

Where B - Ease Component
IPM - Initial Phrase Marker
T - Transformational Component
SS - Surface Structure
SR-1 - Semantic-Representation Rules 1
LF - Logical Form
SR-2 - Semantic-Representation Rules 2

SR-1 are defined as rules involving 'bound anaphora, scope, thematic relations, etc.' (p. 169) That is, they include the rules constituting the semantic component in (2-1). SR-2 act upon logical form to produce, in interaction with other cognitive structures, 'fuller representations of meaning.' (p. 169) SR-2 were never more fully defined, but Chomsky must have included in them the type of rules and constructs employed in decompositional theories, that is, mechanisms dealing with the interpretation of words such as
chair, which have a reference in the world. But, even then, SR-2 were not considered part of 'sentence grammar.'

Later on, namely in Chomsky (1979), Chomsky takes a stronger position on rules of the SR-2 type. As was mentioned earlier, he says:

'When Fodor and Katz proposed integrating in the standard theory rules of semantic interpretation which associated semantic representations with syntactic structures, they had in mind something entirely different from what I had proposed. [...] Their rules had an intensional character which did not exist in Syntactic Structures, where no linguistic level of semantic representation was envisioned. Just as phonetic representation is based on a universal system of phonetic features, so the semantic representation would be based on a universal system of semantic categories, or "distinctive features." The universal system is supposed to represent all possible conceptual thought. [...] It is not clear that there exists such a universal semantic system. Perhaps there are semantic properties that are general, universal, of the type proposed by Katz and others. It seems reasonable to suppose that at least traditional notions like "agent of action," "instrument," "goal," "source," and so on, are part of universal semantics; then such notions would be available for semantic representation, perhaps in the
sense in which phonetic features are available for phonological representation. [...] Furthermore [...] it seems reasonable to suppose that semantic relations between words like persuade, intend, believe, can be expressed in purely linguistic terms. [. . .] Furthermore, it does seem reasonable to suppose that the functional properties of quantifiers (words like all, any, some, etc.) and anaphora [. . .] can be expressed in part on the level of semantic representation, separate from extralinguistic considerations. [. . .] Why then raise a question about the possibility of a universal semantics, which would provide an exact representation of the full meaning of each lexical item, and the meaning of expressions in which these items appear?’ (pp. 141-2)

Chomsky answers the question by saying that it is doubtful whether one can separate semantic representations of this type of words from ‘beliefs and knowledge about the world.’ (p. 142). He concludes:

‘Thus, when we use the term chair, or table, we rely on beliefs concerning the objects to which we refer. We assume that they will not disappear suddenly, that they will fall when they are let go, and so on. These assumptions are not part of the meaning of chair etc., but if the assumptions fail we might conclude that we were not referring to a chair, as we had thought. In studying semantics, we must keep in mind the role of
nonlinguistic systems of belief; we have our expectations about three dimensional space, about texture and sensation, about human behavior, inanimate objects, and so on. [...] The question: "Is that a chair or not?" would not have an answer according to strictly linguistic criteria. Admittedly, it is difficult to establish such conclusions. Too little is understood about cognitive systems and their interaction. Still, this approach seems reasonable to me; to give it some real content, it would be necessary to discover something comparable to a generative grammar in the domain of factual knowledge, which is no small task. My own speculation is that only a bare framework of semantic properties, altogether insufficient for characterizing what is ordinarily called "the meaning of a linguistic expression," can be associated with the idealization "language." (pp. 142–3)

The arguments brought forth by Chomsky are directed against decompositional theories but, also, against including SR-2 in grammar, that is in linguistic theory. I think Chomsky's arguments are sound in as far as they point out the futility of defining the meaning of words such as chair, which have a referent. But I also think that the goals of a semantic theory as defined in (4-1) escape this criticism since they postulate that a linguistic semantic
theory should not try describing the meaning of sentences but merely the mechanisms and rules at play in generating meaning. I, therefore, assume that the semantic component includes both rules SR-1 and SR-2. In the former, which I will call the indexing component, I will include the rules 3b and the conditions 5b from (2-1) (for a justification, see 5.2). The latter, which I will call the knowledge component, being an embodiment of the knowledge-based theory, is what constitutes the main topic of this book. I will be concerned with this component from here on.

In chapter five, I will sketch out the knowledge component and explain how it fits in with the mechanisms of the revised extended standard theory. In chapter six, I will discuss the most important issues raised by the model of the knowledge component defined in chapter five.
CHAPTER FIVE: 

KNOWLEDGE SEMANTICS 

5.1 KNOWLEDGE BASE 

5.1.1 GENERAL CONSIDERATIONS 

In chapter four, it was said that, in order to escape the problems connected with decomposition, one could construct a semantic theory in which the meaning of sentences would be represented in a circular fashion, stating what sentences were implied by a given sentence. This means that, for the sentence (5-1a), the meaning would be represented as in (5-1b).

(5-1) a. John loves Mary.  
b. 1. John and Mary exist.  
   2. John is a man.  
   3. Mary is a woman.  
   4. John and Mary are probably adults.  
   5. John is probably sexually attracted to Mary.  
   6. John would probably like to marry Mary if he isn’t married to her already.  
   7. John would probably do a lot for Mary.  
   8. John and Mary are probably speakers of English.  
   ... 

The list of implications in (5-1b) is obviously not complete, as ... indicates, but it would probably be generally accepted as a reasonable explanation of the meaning of (5-1a); that is, it would be accepted as a reasonable answer to the question what does the sentence mean. But notice that
the list would depend on the hearer (interpreter) of the sentence. — If the hearer were a child, even if with perfect command of the grammar of English, the list could be significantly different. Sentence (5-1b5), which mentions sexual attraction, would very likely not be included in the implications.

And even for different adults, the list could vary. This is not so apparent for the given sentence but for sentence with more esoteric words, quite different. (But even for (5-1a), it is clear that for a person to whom to love does not imply the desire to marry, the implication (5-1b6) would be omitted.) Since this is so, the fact must be accounted for by the theory.

One way we could do this is to employ a repository of the information that leads to implications and to interpret the sentences against it. Such a repository could be called a knowledge base. Notice that the theory should not be obligated to specify the knowledge base since there is nothing in the definition of the scope of a linguistic theory (4-2) which would require this. Consequently, the knowledge base may be chosen arbitrarily. This means that the list of implications produced by the mechanisms of the theory would be useless as far as the ‘true’ meaning of sentences is concerned. But this in no way detracts from the value of the theory since the theory is not supposed to define meaning. The only thing it should do is to define the
mechanisms acting upon the knowledge base which would produce the implications for the input sentence. But there is an advantage to this feature of the theory, — It could show why two hearers could interpret a sentence differently, namely by postulating two different knowledge bases to be used in the interpretation. None of the decompositional theories possess this capability.

I have been calling the list of sentences in (5-1b) ‘implications.’ This term was used in a very broad, nontechnical sense, meaning everything that can be inferred from a sentence. This means that the information implied by a sentence contains what is normally called logical entailment, factual entailment, logical presupposition, and factual presupposition. Logical entailment (see Allwood et al. (1977), p. 16) produces inferences, as in John is a bachelor. Bachelors are unmarried. Therefore John is unmarried. In (5-1b), the sentences 2, 3, and 4 (without probably) would normally be considered logical entailments of (5-1a). Factual entailment (see Dillon (1977), pp. 6-7) is entailment based on the knowledge of the facts of the world (‘world knowledge’). In (5-1b), the sentences 5-8 and perhaps 4 (with probably) would normally be considered factual entailments of (5-1a). Presupposition is best explained in terms of entailment. Presupposition differs

1 It should not be confused with logical implication (see Allwood et al. (1977), pp. 37-40), which is a connective (→), approximately equal to if ... then in natural language, used in propositional logic for connecting propositions.
from entailment in the following way. If $S_1$ entails $S_2$
then, if $S_1$ is true, $S_2$ is also true, and if $S_1$ is false, $S_2$
is also false. If, however, $S_1$ presupposes $S_2$ then, if $S_1$
is true, $S_2$ is also true but, if $S_1$ is false, $S_2$ is still
true. (See Kempson (1975), p. 48.) In (5-1b), the sentence
1 is a presupposition of (5-1a). Logical presupposition
differs from factual in the same way as logical entailment
differs from factual entailment.

As the above definition of presupposition shows, it is
possible to distinguish between it and entailment. The
distinction between logical and factual entailment and
logical and factual presupposition — that is between
factual and 'linguistic' knowledge — is much more
problematic, however, and it is not certain that one exists.
At any rate, it is quite certain that the meaning of a
sentence (or a word) cannot be separated from what is
generally known as facts of the world. This opinion is
voiced by Chomsky, as was quoted earlier:

'My own speculation is that only a bare fragment of
semantic properties, altogether insufficient for
characterizing what is ordinarily called "the meaning
of a linguistic expression," can be associated
correctly with the idealization "language".' (Chomsky
(1979), p. 143)

An even stronger stand is taken by Miller (1978):
'Table gets its meaning from its place in [the] conceptual system. Lexical knowledge [...] is not isolated from this general conceptual system: the lexicon has a cognitive structure only because it is an integral part of everything a person known and believes.' (p. 83)

In the light of this, it appears to be quite proper for implications to contain all that one may infer from a sentence. (But see 7.2 for a discussion of a way of distinguishing between the various types of information in the knowledge base.)

Let us go back to the list of implications in (5-1b). There are two things about it that may catch one's eye. First, as was said, the list is incomplete. The full list of implications is obviously very large and perhaps infinite. Second, some of the implications contain the word probably, indicating that the information implied by them is of uncertain nature. Do these characteristics of implications create a problem for the theory?

Let us look at the first characteristic – a very large and perhaps infinite number of implications. That the number of implications for most sentences is large, there can be no doubt. The suspicion that it may be infinite may be questioned but it is generally accepted to be true in logic. (See Kempson (1977), p. 39.) For the implications to be infinite, the relationship between a sentence and at
least one of its implications must be recursive, that is, the relationship must be $S \rightarrow f(S)$. One such relationship may be expressed by a statement and its doubly negated equivalent, for instance, *John loves Mary* $\rightarrow$ *John doesn’t not love Mary*. So the contention is true at least for those sentences which may be negated as shown. But, be it as it may, since the object of the theory is not to list all implications of a sentence only the mechanisms generating them, this characteristic of implications does not create a problem for the theory.

Let us look now at the second characteristic of implications – the uncertain information. Should, perhaps, this type of information not be included in the knowledge base? In (5-1b), the uncertain implications are 4 – 8. This means that they include what is generally considered logical entailment and factual entailment. So, it does not appear that we could get away with excluding this type of information even if we limited the knowledge base to logically entailed implications. But, looking at the sentence (5-1a), we can see that it is not the implied information that is the reason for its being uncertain. It is the sentence (5-1a) itself, the fact that we do not know enough about *John* and *Mary*, and that the word *loves* (at least in this knowledge base) presupposes a relationship between adults. If, instead of *John* in (5-1a) we had the *old man*, then we would be certain that at least the man in
the sentence was an adult.

So, one of the problems with the uncertainty of the implications in (5-1b) is the fact that the sentence contains proper names, from which, apparently, we can infer very little. This is a well-known property of proper names—compare Kempson (1977), pp. 12-5 or Searle (1967), pp. 162-74. Searle, for instance, says: 'a proper name predicates nothing and consequently does not have a sense.' (p. 163) So, in order to interpret (5-1a) more fully and with greater certainty than in (5-1b), the knowledge base must contain more information about the two proper names. The implications for the sentence, then, would be derived from the implications of the two proper names, which must exist in the knowledge base.\(^2\) A similar problem would exist if (5-1a) were \textit{He loves her}. Here, we could only infer with certainty the gender of the two persons. All of the above, then, applies also to extrasentential anaphors—pronouns whose antecedents lie outside the sentence. Again, since specifying this type of information does not lie within the scope of the theory, it has to be assumed in the knowledge base. I assume that, in practice, this type of information is provided by some nonlinguistic mechanism.

\(^2\) Naturally, if we want to show how a person interprets a sentence with the name of an unknown person in it, then the knowledge base would not contain any information about the person.
Let us return to the problem of uncertainty of implications. If, in (5-1a), John and Mary were replaced by the rich old man and the beautiful young girl, as in (5-2a), the uncertainty in (5-1b) would disappear only in respect to the adulthood of the man, in 4. But, in addition, new implications could be specified, some with absolute certainty, others with a degree of uncertainty, as in (5-2b).

(5-2) a. The rich old man loves the beautiful young girl,
   b. 1. The man has a lot of money.
   2. The man was born before the girl.
   3. The person who loves the girl is male.
   4. The person who the man loves is female.
   5. The man would probably give the girl quite a lot of money.
   6. The girl could probably be rich if she wanted to.
   7. The man will probably die before the girl.
   8. The man probably has gray hair.
   9. The girl's complexion is probably better than the man's.
  10. The man probably loves the girl because of her youth and beauty.

What we see from (5-2) is that introducing the words rich, old, man, beautiful, young, and girl permits us to make some definite inferences — rich implies a lot of money, old vs. young gives some information about the respective birthdays, man implies male, and so forth. In addition, some uncertain inferences are also possible. So it is not that the uncertain implied information is due to 'senseless' words only. Apparently, any sentence implies some information that is certain and some that is uncertain.
Moreover, the degree of uncertainty might vary. For instance, the sentence *The generous rich old man loves the beautiful young girl* implies $(5\text{-}2\text{b}5)$ with greater certainty than $(5\text{-}2\text{a})$ does. Also, uncertain implications can become certain when enough information is provided in the input sentence. For instance, if, in $(5\text{-}2\text{a})$, *the beautiful young girl with the finest complexion in the world* is used, then $(5\text{-}2\text{b}9)$ will have probably removed from it. The issue, then, depends on how much information is provided by the sentence being interpreted and what type of information is contained in the knowledge base. For instance, if *old persons usually die before young ones* is part of the knowledge base, then $(5\text{-}2\text{b}2)$ would be one of the implications. If no information were contained in the knowledge base about the relative death dates of old vs. young people, then no inference regarding this could be made. If, however, it were stated in the knowledge base that old people always die before young ones, then the implied information would be certain. The question, then, ultimately hinges on what type of information is contained in the knowledge base and it is clear that the knowledge base must contain this type of information.

Consider now the sentence $(5\text{-}3\text{a})$. The certain information implied by it could refer only to the amount of sunshine falling on the bank, as, for instance, is stated in $(5\text{-}3\text{b})$. 
(5-3) a. The bank is in the shade.
   b. The sun isn't shining at least on part of the bank.

The sentence tells us nothing more definite because we do not know whether the bank in question is a financial institution or land bordering on water. But this is true of this particular sentence only in isolation. Because, when accompanied by pointing or by linguistic context — for instance, as It's so hot.... Let's go and cash the travelers checks in the other bank because it takes a long time and the other bank is in the shade, — the uncertainty disappears. Depending on what the knowledge base is, then, the word bank may or may not be ambiguous (imply two or more sets of information). We could view, then, the knowledge base as containing two separate words, bank (f) (for 'financial') and bank (r) (for 'river'), both of which occur in sentences which have different implications. If we view the knowledge base as a dynamic collection of information, then it is possible that only one or the other word may figure in it, the selection having been made either on the basis of linguistic or extra-linguistic context. Otherwise, if the sentence is to receive one meaning, something in it must lead the interpretation mechanism to either one or the other word being selected. If there is nothing in the sentence to insure this, two separate interpretations will be generated.
5.1.2 METHOD OF REPRESENTATION

We saw from (5-2) that when John and Mary of (5-1a) were replaced by the noun phrases the rich old man and the beautiful young girl a number of certain inferences could be drawn which could not have been drawn before. This must mean that the information that we were able to deduce was contributed by the two noun phrases. Now, the sentences implied in (5-2b) by (5-2a) had the form they did not only due to the two noun phrases but, also, to the verb loves in the sentence. If the verb had been killed, the implied sentences would have been significantly different. Consider, for instance, (5-4).

(5-4) a. The rich old man killed the beautiful young girl,
b. 1. The man has a lot of money.
   2. The man was born before the girl.
   3. The person who killed the girl is male.
   4. The person whom the man killed was female.
   5. The man probably didn't kill the girl for money.
   6. The man possibly killed the girl out of jealousy, assuming he didn't kill her accidentally.
   7. The girl could possibly be alive if she had acted as the man had wanted her to, assuming the man didn't kill her accidentally.
   8. The man will probably be punished by the law for his deed.
   9. The girl died before the man.
  10. The man will live much longer than the girl did.
  11. The man probably has gray hair.
  12. The girl's complexion was probably better at the time of her death than the man's.
  13. Ten years from now there probably won't be much left of the girl's body.
Here, some of the implied sentences, namely 1-4 and 11, or those that have to do with the characteristics of the persons described by the noun phrases are the same as in (5-2b). (5-4b12) is essentially the same as (5-2b9), except for the tense and the pinpointing of time in (5-4b12). But, both sentences have the same point in time as the sentence implying them — ‘now’ in (5-2a) and the time the killing took place in (5-4a). The implied sentences differ significantly only when they talk about the nature of the verb. In (5-2b), they are 5 and 6, and in (5-4b), 5-10, 12, and 13. These sentences, then, could be said to have been contributed, to some degree at least, by the verbs. To love, then, implies to be willing to do something for the object of one’s love. To be loved implies to have the option of having something done for oneself. To kill implies to be liable to be punished by the law. To be killed implies to have died before someone who is alive, and so forth. In some of the implied sentences, the contribution of the noun phrases and the verb seems not to be completely separable, for instance in (5-2b5) it is because the man is rich and old and, perhaps, the girl young and beautiful, and because the man loves her that implies that the man would give the girl money. In (5-4b6) it is again the characteristic of the man and the girl plus the verb that imply jealousy on the part of the man. Notice also that in the implied sentences in which the verb is a
contributor of meaning the subject and object of the original sentence appear in certain positions. — To love implies for the subject to be willing to do something for the object. To kill implies for the subject to be liable to be punished by law and for the object to have died, and so forth. In the case of noun phrases, on the other hand, it is the head of the phrase and the modifiers that appear in different positions in the implied sentences. — A rich man implies the man has a lot of money. An old man implies the man was born before a person who is young, and so forth.

Now, we could construct a theory in which the knowledge is represented by sentences such as (5–2a). But this would be totally unrevealing. Such a theory would be observationally adequate, being capable of representing all knowledge, but it would fail descriptively since it would not account for our intuition that the meaning of a sentence is built up of its parts.³ (In addition, we would not satisfy the requirement (4–2b) of the scope of a semantic theory.) This would essentially be equivalent to the syntactic component consisting of a list of all possible phrase markers. But, from the discussion of the preceding examples, we saw that the different parts of sentences seem to make tangible separate contributions to the meaning of

³ 3ee Chomsky (1965), pp. 24–6, for a discussion of the different types of adequacies of grammars.
the sentences. So, it would be advisable to represent the knowledge along these lines.

How should we proceed to do this? On what grounds can we decide what should be the semantic constituents of sentences from which their meanings are built up? Should we start with words (or perhaps morphemes) or should we consider more complex syntactic units, for instance noun phrases and verb phrases? This is clearly an empirical issue and I will devote some space to it in chapter six. Here, I would like to make some preliminary observations.

From the examples (5-1), (5-2), and (5-4), we can conclude that the implied information is contributed by nouns with their modifiers and ty verbs. In the case of verbs, however, as was said, one has to make references to the subject and object, even if these are not specified. That is, for verbs, the implications may be viewed as having been derived from sentences with variable subjects and objects, for instance, X loves y and X killed y.

Let us look at the sentence (5-2a) again. Its phrase marker, simplified somewhat, is as shown in (5-2a').
According to what was said above, this syntactic phrase marker corresponds to seven semantic units — the man, (the) rich man, (the) old man, the girl, (the) beautiful girl, (the) young girl, and (the) man loves (the! girl). From which separate implications could be derived, which would be combined into those in (5-2b). Looking at these units, it becomes apparent that they could be represented the way propositions are in logic, as in (5-5).

(5-5) a. the (man)
    b. rich (man)
    c. old (man)
    d. the (girl)
    e. beautiful (girl)
    f. young (girl)
    g. loves (man, girl)

4 The parentheses indicate that the words in them have already been included in other semantic units with one of the other words.
It is true that the units in (5-5) — I will call them propositions — probably may serve as a representation of the semantic structure of (5-2a), the way they are shown, that is, as an unordered list. But, there are sentences when such a representation would not be satisfactory. For instance, for a complex sentence, it is necessary to indicate which of the propositions underlying it is the one representing the main clause and which the embedded one. Also, for some modifiers, the order is important — compare dirty old man and old dirty man. So, in general, the propositions underlying a sentence should be combined in such a way as to reflect the syntactic nesting and word order of the input sentence in the semantic representation.

It is widely acknowledged (for instance in Allwood et al. (1977), pp. 168-71) that ordinary, first-order predicate-logic notation, which is what the propositions in (5-5) are expressed in, is not sufficiently powerful to express the semantic complexity of natural-language sentences. In Reichenbach (1947), pp. 214-354, an attempt was made to upgrade predicate logic so as to make it suitable for representing natural language. This is known as second-order or higher-order predicate logic. In it, the sentence John loves Mary madly would be expressed, essentially, as madly(loves) (John,Mary) (Reichenbach (1947), p. 301). There are undoubtedly other ways in which one could combine the propositions in (5-5) to represent the semantic structure of (5-2a). It appears, however, that the
higher-order predicate-logic notation is suitable for this task.\(^5\) In this notation, the semantic structure of the sentence (5-2a) would be represented as in (5-2c).

\[
(5-2) \quad \text{c. loves ((the,rich,old) (man), (the,beautiful,young)(girl))}
\]

(5-2c) constitutes a complex proposition, consisting of simple ones. Each proposition consists of a predicate and one or more arguments, in the following parentheses. Multiple arguments are separated by commas. Multiple predicate are also enclosed in parentheses and separated by commas. Some propositions act as arguments of other propositions.

I will rely on this notation, which I will call the predicate-logic notation, for representing the semantic structure of sentences. It should be understood, then, that when the term ‘proposition, predicate,’ or ‘argument’ is used, they refer to the higher-order predicate logic rather than the ordinary, first-order. An expression in the predicate-logic notation, or a proposition, may be called a semantic phrase marker or, simplified, a semantic marker. The semantic structure of a sentence (input sentence), then, constitutes

\(^5\)This view is shared by other linguists, for instance. Baker (1978), pp. 223-6, where the notation is used for semantic representation. An alternative to the higher-order predicate-logic notation for representing natural-language sentences might be the lambda-operator notation. See Allwood et al., pp. 155-7.
a semantic marker (*input semantic marker*). Because, as will become clear from the following, it is necessary to compare the input semantic marker against the knowledge base, to produce the implications of the input sentence, it is convenient to represent the knowledge base in the same language as the input semantic marker, or in the predicate-logic notation. The knowledge base, then, also contains propositions. It must also contain, however, information necessary for deriving the implications of the input sentence. The pairing of the proposition with the implications associated with it constitutes a knowledge-base entry. Now, the implications of a proposition may be expressed as other propositions in the knowledge base. If we assign a unique identifying number to each entry, then the implications of the proposition in an entry may be represented by the identifying numbers of the entries in which the implied propositions occur. The format of a knowledge-base entry, then, may be represented as in (5-6).

(5-6) m; n; p, q, r ...

Where

- m is the number of the entry,
- n is a proposition,
- p, q, r... constitute the implications of the proposition, each variable being the number of an existing knowledge-base entry, or the proposition directly implied by n.
I will return to the question of knowledge-base structure in chapter six.

5.2 COMPOSITION OF THE KNOWLEDGE COMPONENT

As was said in 4.3, the semantic component consists of the indexing component and the knowledge component. The output of the former constitutes the input to the latter.

Under the revised extended standard theory, as shown in (2-1), the semantic component consists of rules of construal (3b), interpretive rules (4b), and conditions on binding (5b), which govern the operation of rules of construal. Rules of construal (see 2.2.3) relate anaphors to antecedents or, in other words, perform coindexing. Interpretive rules (see 2.2.4), which apply after the rules of construal, are of two types — lexically-determined structure-building rules, and rules interpreting quantifiers. These rules give the final shape to logical form, converting, for instance, the phrase marker underlying (2-18a) into (2-18b), which are repeated below.

(2-18) a. Everyone betrayed the woman he loved.
    b. for every person x, x betrayed the woman he loved

One of the things these rules do, then, is to paraphrase the surface-structure in a formalized version of
English, for instance, replacing everyone, in (2-18), by for every person, x. The objections, therefore, made in chapter three, to the decompositional theories apply to this form of representation.

These objections cannot be directed against the semantic phrase marker produced under the knowledge-based theory because, under the theory, the semantic phrase marker does not constitute the representation of the meaning of the sentence, as is claimed of logical form under the revised extended standard theory, but merely a representation of the semantic structure of the sentence. The representation of the meaning, as was said, is a pairing of the semantic phrase marker and the implications produced by mapping the phrase marker onto the knowledge base.

To return to the question of logical form, since, under the knowledge-based theory, the interpretation of a sentence is accomplished by mapping the semantic phrase marker expressed in the predicate-logic notation onto the knowledge base, expressed in the same notation, it would be pointless to translate the syntactic phrase marker into logical form and then logical form into the semantic phrase marker. What

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6Actually, logical form and the semantic phrase marker expressed in the predicate-logic notation are equivalent. In fact, the notation used for representing logical form under the revised extended standard theory is a variant of the predicate-logic notation. The main difference between the two is that the former, as was said, contains some paraphrases of the lexical items in the surface structure, whereas the latter does not. The notation used in logical form, also, appears to belong to the first-order logic.
is required for the process of interpretation to take place, however, is to relate the anaphors to their antecedents, in the syntactic phrase marker. Now, this is accomplished by rules of construal. I, therefore, assume that the input to the knowledge component is what is produced by the rules of construal \((3b)\) in \((2-1)\). The interpretive rules \((4b)\) are unnecessary and should be excluded from a grammar relying on the knowledge-based approach. Thus, the indexing component consists of rules \((3b)\) and conditions \((5b)\) in \((2-1)\). The output of this component, which is the input to the knowledge component, has the form of a syntactic phrase marker or surface structure enriched by traces, with all anaphors in it related to their antecedents by means of indices.

The fact that all anaphoric elements in the syntactic phrase marker are coindexed with their antecedents (true anaphors, such as pronouns, by rules of construal and traces by movement rules) insures that the identity of all anaphoric elements is known (that is, all but those anaphors controlled by antecedents outside the sentence, the indexing of which must be accomplished by mechanisms outside of sentence grammar), so that, in effect, the anaphoric elements may be looked at as having been replaced by their antecedents. This makes it possible for the knowledge base, as was said in 5.1.1, to be free of anaphoric elements. (Dougherty (1969), p. 511, observes that those pronouns that may be interpreted anaphorically may also have an
nonanaphoric interpretation; that is, that pronouns with intrasentential antecedents may also have extrasentential antecedents. Dougherty calls this the anaporn relation. This implies that sentences with intrasentential anaphors should have two sets of implications generated as a result of their interpretation. In practice, however, such sentences are not always ambiguous, since the context will indicate which type of reading should be chosen. This, I will consider to be achieved by the composition of the knowledge base, which, for the unambiguous situations, will contain either the intrasentential or extrasentential anaphors, but for ambiguous both. See the paragraph below. This situation brings to mind the problem of interpreting identical noun phrases with different antecedents, as in *John doesn’t like John*. Lasnik (1976) proposes a rule of *disjoint reference*. (38), which states when two identical nonanaphoric noun phrases must be noncoreferential. I will assume this rule to be part of the rules of construal. For sentences such as the above, then, the two occurrences of a noun phrase will be treated as two different words in the knowledge base.)

Given the above assumption, the operation of the knowledge component may be described as follows.

The input to the knowledge component, which has the form of an indexed surface structure (ISSI enriched by
traces, constitutes the input sentence. The indexed surface structure is converted to its equivalent in the predicate-logic notation by an autonomous subcomponent which I will call the *semantic-marker structuring component* (*SMStC*). The output of this subcomponent is the input semantic marker (*ISM*), which was already mentioned in 5.1.2. The input semantic marker next has to be mapped onto the knowledge base. I assume that the knowledge base has been modified to the proper degree by some other mechanism of human intelligence on the basis of the physical and linguistic context of the sentence. So, in it, the word *ban*, or an intrasentential anaphor, may no longer be ambiguous, as was suggested above, and identical noun phrases marked noncoreferential will be treated as distinct words. I will call this knowledge base the *pertinent knowledge base* (*PKB*). This information, then, and the input semantic marker constitute the input to the subcomponent which maps the latter onto the former. This subcomponent I will call the *semantic-marker mapping component* (*SMMcC*). The semantic-marker mapping component maps the input semantic marker onto the pertinent knowledge base, producing a trace of the mapping (*TMp*). The mapping consists of overlaying arguments and predicates of the input semantic marker over those of the pertinent knowledge base. If the structure of the input semantic marker corresponds to that of the knowledge base, then the mapping is an exact overlay of the first over the second and the trace is identical to the input semantic marker. Otherwise, some discrepancy is
discovered — either one or more arguments and/or predicates are not found at all or certain arguments are not found occurring with certain predicates. The semantic-marker mapping component indicates this on the trace, which constitutes its output. The trace is sent to the next subcomponent of the knowledge-semantic component, which I will call the logical component (LC).

Part of the logical component represents the linguistic intelligence of the hearer. Because it is not certain that there is a clear-cut difference between linguistic and general intelligence, until a clear indication to the contrary is established, I will assume that at least some of the intelligence mechanisms are shared between linguistic and general problems. For instance, I assume that the pertinent knowledge base is produced by the logical component from the full knowledge base, which I will call the input knowledge base (IKB), and from the utterance context (UCt) (that is, the sentence context). The logical component is the last subcomponent of the knowledge component. Its inputs, as was said, are the input knowledge base, the utterance context, and the trace of the mapping. The logical component overlays the trace over the input knowledge base from which it had originally produced the pertinent knowledge base. If the trace of the mapping contains no indication of any unknown elements or anomalies, or if the input semantic marker does not carry any information not present in the knowledge base, the logical component simply combines the implications associated with
all the propositions of the semantic marker constituting the trace into one. The implications of a proposition may be called its implicational clause \((IpCl)\). The implicational clauses of all propositions underlying a sentence combined into one may be called the output implicational clause \((OIpCl)\). The pairing of the output implicational clause with the trace of the mapping superimposed over the input knowledge base is the interpretation of the input sentence. I will call the knowledge base containing the trace the output knowledge base \((OKB)\). So, the output of the logical component and, by the same token, the knowledge component, which is what constitutes the interpretation of the input sentence, is the output knowledge base and the output implicational clause.

If the trace of the mapping contains no unknown elements or anomalies and the input semantic marker carries no new information, then the structure of the output knowledge base, that is the output knowledge base without the trace, is the same as the input knowledge base. If some unknown elements or anomalies are present in the trace of the mapping, the logical component tries to modify the input knowledge base so as to resolve the problems. If it is able to do this, the knowledge base is modified. The output knowledge base is then different from the input knowledge base. In case the logical component is unable to resolve the problems in the trace of the mapping, no combined
implicational clause is generated, the output knowledge base contains a trace with indications of unknown elements or anomalies in it, and the input sentence remains uninterpreted as a whole (but parts of it will be interpreted, as we know from personal experience). If the input semantic marker carries information not present in the knowledge base, the logical component inserts the information, in the form of an implication, in the appropriate entry in the knowledge base. The output knowledge base, thus, again differs from the input knowledge base.

The scheme sketched out above is represented in Fig. 9. In the next section, I will discuss in some detail the operation of the three subcomponents of the knowledge component.
Where

SS - Surface Structure Enriched by Traces
IC - Indexing Component
ISS - Indexed Surface Structure Enriched by Traces
KC - Knowledge Component
SMStC - Semantic-Marker Structuring Component
ISM - Input Semantic Marker
SMMpC - Semantic-Marker Mapping Component
 TMP - Trace of the Mapping
PKB - Pertinent Knowledge Base
LC - Logical Component
OIpCl - Output Implicational Clause
OKB - Output Knowledge Base
IKE - Input Knowledge Base
UCt - Utterance Context
5.3 OPERATION OF THE KNOWLEDGE COMPONENT

I will describe the operation of each of the three subcomponents of the knowledge component in a separate section, relying, primarily, on examples. Some of the more problematic issues connected with the three subcomponents will not be discussed here, however, but will be postponed until chapter six.

5.3.1 SEMANTIC–MARKER STRUCTURING COMPONENT

The semantic-marker structuring component satisfies the requirement (4-2a) of the scope of a linguistic semantic theory. That is, it specifies the role of the syntactic structure of a sentence in semantic interpretation.

The input to the semantic-marker structuring component, as was said, is surface structure enriched by traces, with all anaphors coindexed with their antecedents, or indexed surface structure. The semantic-marker structuring component converts this structure into its equivalent in the predicate-logic notation, or the input semantic marker. It is in this notation, it will be recalled, that the knowledge base is represented. So, it is possible to map the input semantic marker onto the knowledge base and, from this, derive the implicational clause of the sentence. Because of
the coindexing of anaphors and antecedents, it is as if all noun phrases in the surface structure were filled by nonanaphoric vocabulary. Under the revised extended standard theory (see 2.1), the grammatical or thematic relations are determined by deep structure, all other aspects of semantic representation being derived from surface structure. This means that, for a sentence such as (5-7a), whose surface structure is (5-7b) and deep structure (5-7c), the fact that Mary is the object of John’s love is derived from (5-7c), whereas the fact that this fact is being stressed or contrasted with another fact, comes from (5-7b).

(5-7) a. Mary, John loves.
   b. $S[S'[NP\ Mary_i ]][S [NP John][VP[V loves][NP t_i ]]]$
   c. $S[NP John][VP[V loves][NP Mary]]$

So, the proposition $loves(John,Mary)$, which will be part of the input semantic marker, must come from the deep structure (5-7c). But the identification that the sentence is of the topicalized type, which is the other part of the input

7 Traditionally, the fronted elements are assumed to fill the COMP node. Baltin (1978), pp. 154-71, argues, however, that, for topicalization, the fronted element is attached to the S node and, for wh questions, to the S' node. Since this issue is not crucial to the arguments in this work, I will rely on the traditional analysis throughout the examples.
semantic marker, must derive from the surface structure (5–7b).

Similarly, for the question (5–8a), the fact that it is the object of John’s affection that is unknown must come from the deep structure (5–8c), but the fact that the sentence is a question comes from the surface structure (5–8b).

(5–8b)  
a. Who does John love?  
b. [s[SP [NP who][s[NP John][VP [v loves][NP t1]]]]]  
c. [s[NP John][VP [v loves][NP who]]]

The semantic-marker structuring component, then, must have the capability to reconstruct the deep structure from the surface structure; it must deduce the form of the sentence (necessary for determining the type of the overall semantic marker, the scope of logical elements, and so forth) from the surface structure; and it must generate the basic propositions from the deduced deep structure.

As was said, the issue of how to map the indexed surface structure onto the input semantic marker is an empirical one and I will return to it in chapter six. But, on the basis of the example (5–2), which was used in discussing the structure of the knowledge base ((5–2c) being the semantic marker for the surface structure in (5–2a’)),
the following rules may he tentatively assumed to be part of the semantic-marker structuring component.

1. A sentence may be represented by a simple proposition or a complex proposition consisting of simple propositions.
2. A proposition may have one or mere predicates.
3. Verbs, articles, and adjectives constitute predicates.
4. Nouns and propositions constitute arguments.
5. For verb predicates, the arguments are the semantic equivalents of the subject and object noun phrases. They may be single words or propositions with article or adjective predicates.
6. For article and adjective predicates, the arguments are the heads of the noun phrases.

5.3.2 SEMANTIC-MARKER MAPPING COMPONENT

The semantic-marker mapping component satisfies part of the requirement (4-2b) of the scope of a linguistic semantic theory. That is, it identifies the semantic components of a sentence.

As was said, the input semantic marker, generated by the semantic-marker structuring component, and the knowledge base are expressed in the same language, or in the
predicate-logic notation. The mapping of the input semantic marker, therefore, consists of overlaying it over the propositions of the pertinent knowledge base, which produces the trace of the mapping. The mapping is done proposition by proposition. Every time a proposition of the input semantic marker is mapped onto the knowledge base, a trace is left on the knowledge base, indicating a successful mapping. If a sentence is semantically structured fully in agreement with the knowledge base, then the trace on the knowledge base is identical to the input semantic marker. If an argument in the input semantic marker does not appear anywhere in the knowledge base, it is copied into the knowledge base where it belongs in respect to the predicate with which it occurs in the input semantic marker, with an indication that it is unknown. For instance, if the knowledge base does not contain (5-9b), corresponding to the input semantic marker that represents (5-9a), then the trace of the mapping is (5-9c), where ? marks the unknown word.

(5-9) a. Boys love kutya.
    b. love (boys,kutya)
    c. love (boys, ?kutya)

An unknown predicate is similarly marked, as, for instance, in (5-10c).

(5-10) a. The boys fulged the porridge.
    b. fulged (the (boys),the(porridge))
    c. ?fulged (the(boys),the(porridge))
Another situation might be that all the arguments and predicates in the input semantic marker occur in the knowledge base, but not in the same propositions. The input semantic marker, for instance, may be (5-11b), corresponding to (5-11a), whereas the knowledge base contains the propositions in (5-11c), but not in (5-11b). (By ‘contains,’ here and below, I do not necessarily mean that the propositions appear in the knowledge base as shown but that they are derivable from some existing propositions by the mechanisms of the knowledge component; see 6.2.)

(5-11) a. The man ate the wine.
   b. ate (the (man),the (wine) )
   c. 1. ate (the (man),the (bread))
      2. drank (the (man),the (wine))
   d. *ate(the (man),the (*wine))

What happens here is that one argument is not permitted to occur with a predicate. As a consequence, an indication must be made that this is the case. (5-11d) shows the trace of the mapping of (5-11b). The asterisks state that the marked argument and predicate do not occur together in the knowledge base. We are faced with a similar situation with the sentence in (5-12a). For most speakers of English its trace of the mapping will be (5-12b).

(5-12) a. The wine drank the man.
   b. *drank (the (*wine),the (*man))
Before concluding this section, I would like to briefly touch upon the question of ambiguity resolution.

As I mentioned earlier, I assume that, in many cases, the ambiguity of a word may be resolved outside the semantic component, on the basis of the utterance context. This would be reflected in the pertinent knowledge base representing only one meaning of the ambiguous word, for instance, either bank (f) or bank (r), but not both. It is possible, however that the pertinent knowledge base contains both words. Now, these are phonetically identical and, therefore, will pose a problem to the semantic component, since both of them could be matched up with the word in the input semantic marker. Assume that the input sentence is (5-13).

(5-13) The man is the president of the bank.

Also assume that the knowledge base contains the proposition (5-14b), corresponding to the semantic marker underlying (5-14a) (the treatment of prepositional phrases will be discussed in chapter six).

(5-14) a. the president of the tank (f)
    b. of(the(president),the (bank (f)))

The knowledge base does not contain the proposition underlying the anomalous *the president of the bank (r). By
virtue of this, bank \((f)\) is selected in producing the trace of the mapping, insuring a unique interpretation for the sentence. If, however, the input sentence is (5-15) and the knowledge base contains (5-16b), underlying (5-16a), and (5-17b), underlying (5-17a), then the ambiguity cannot be resolved.

(5-15) Let’s go over to the other bank.

(5-16) a. We go to the bank\((f)\).
   b. go to(we, the \((\text{bank}(f))\))

(5-17) a. We go to the \((\text{bank}(r))\).
   b. go to(we, the \((\text{bank}(r))\))

The trace of the mapping then contains both propositions and two separate output implicational clauses are generated, indicating that the input sentence is ambiguous.

### 5.3.3 LOGICAL COMPONENT

The logical component satisfies the rest of the requirement (4-2b) of the scope of a linguistic semantic theory. That is, it identifies the contributions of the semantic components of the sentence to its meaning. The logical component also satisfies the requirement (4-2c) of the scope of a linguistic semantic theory in that it defines the processes of meaning acquisition and meaning extension through the means of language.
The trace of the mapping may be viewed as a subset of the knowledge base on which an indication was made how the input semantic marker fits onto it. The propositions in the knowledge base which correspond to those of the input semantic marker are marked as having been overlaid by the arguments and predicates of the input semantic marker. Those arguments and predicates which appear in the input semantic marker but not in the knowledge base are copied into the knowledge base into the appropriate spots, with an indication that they are unknown. The propositions which appear in the input semantic marker but not in the knowledge base are traced out with an indication that they are anomalous. This constitutes the input to the logical component.

Another input to the logical component, it will be recalled, is the input knowledge base which the logical component used to produce the pertinent knowledge base on the basis of the utterance context. The logical component now transfers the trace of the mapping onto the input knowledge base. If the trace contains no unknown elements or anomalous propositions, then the logical component proceeds to generate the output implicational clause for the input sentence.

In generating the output implicational clause for the input sentence, the logical component uses the implicational
clauses associated with all the propositions of the trace of the mapping in the knowledgebase. Now, since the relationship between a proposition and implicational clause is that of implication, and since it is true that, if \( a \rightarrow b \) and \( b \rightarrow c \), then \( a \rightarrow c \) (that is, the relationship of implication is transitive), the implicational clauses associated with the implied propositions also have to be used. This must be continued to the next level of propositions, and then the next, and so on. As can be seen, the process is infinite for cases when a proposition implies, in addition to other propositions, itself. The factors that limit the size of the output implicational clause, in some cases at least, must be some performance factors, such as time, memory, and so forth.

But, an input sentence will not always correspond to a single proposition. The logical component, then, must have the ability to produce valid implicational clauses for the complex proposition corresponding to the input sentence from all the propositions underlying it. For instance, for the input sentence (5-2a), one of the implications is (5-2b1), as is shown repeated below.

(5-2) a. The rich old man loves the beautiful young girl,
b. 1. The man has a lot of money.
Now, one of the propositions underlying (5-2a) is (5-18b), corresponding to (5-18a); and p, one of the members of the implicational clause of (5-18b), is (5-19b), corresponding to (5-19a).^8

(5-18) a. rich man
   b. m; rich (man); ...p...

(5-19) a. The man has a lot of money.
   b. p; has (the (man), (a lot of money)); ...

So, during the process of mapping, the semantic-marker mapping component must be capable of generating, out of the simple propositions of the kind shown in (5-18b) and (5-19b), a complex proposition such as (5-2c). It is this process that satisfies part of the requirement (4-2b) of the scope of a linguistic semantic theory, which says that such a theory must show how the meaning of a sentence is derived from the meaning of its components. — The process identifies the semantic components of the input sentence. This issue will be discussed in greater detail in chapter six.

If the trace of the mapping contains unknown elements or anomalous propositions, the logical component must perform additional operations before proceeding with the

^8In the representation, I am following the full format of knowledge-base entries, as specified in (5-6). In (5-19b), I am postponing the issue of how to represent a lot of money.
generation of the output implicational clause. In the case of an unknown element or elements in the trace, the logical component attempts to generate whatever implications are possible from the propositions in the trace. This depends on the nature of the propositions. In all of the sentences of (5-20), for instance, the word kutyà is unknown but, going from a to d, progressively more information can be deduced from the sentences.

(5-20)  a. Kutyà is good.
    b. Kutyà is delicious.
    c. Kutyà is a Ukrainian dish.
    d. Kutyà is Ukrainian Christmas porridge made from wheat, poppy seeds, nuts, raisins, and honey.

In (5-20a), not much could be deduced about kutyà, since good occurs in the knowledge base in the propositions underlying such sentences as The guy is good. The weather is good. The idea is good, and, ultimately, Anything can be good. Thus, the logical component must be able to use this type of information to reach the conclusion that not much can be inferred about the unknown word. In (5-20b), however, if we assume that the knowledge base contains a proposition underlying the sentence Only food can be delicious, then the logical component could deduce that kutyà is food. (5-20c) tells a little more about kutyà – that it is cooked, edible, and Ukrainian in origin. (5-20d) is a fairly satisfactory definition of the unknown word.
On the basis of the information implied by the input sentence, therefore, the knowledge base may be updated. This updating consists of creating new propositions with their implicational clauses. For instance, for (5-20b), the new proposition may be the one underlying the sentence Kutya is food, with its appropriate implicational clause. The ‘unknown’ label then is removed from the argument and the implicational clause is generated as above.

If no inferences may be drawn from the input sentence, as in (5-20a), then the ‘unknown’ label is not removed from the argument and no implicational clause is generated. The sentence, thus, remains uninterpreted as a whole although parts of it are interpreted. In (5-20a), for instance, the inferences of the words is and good is known.

The same process is followed for unknown predicates.

When the trace of the mapping contains an anomalous proposition, the logical component again tries to modify the knowledge base in order to interpret the input sentence. Take (5-11a), for example. If the knowledge base contains propositions underlying the sentences One can eat only solid food and Wine is normally liquid. the result of the modification may be the creation of the proposition underlying the sentence The wine was solid, leading, further, perhaps, to The wine was frozen or The wine was
jelled. If the knowledge base does not contain the above propositions (perhaps due to performance reasons, for instance, concentration), then no interpretation might take place and extra-linguistic intelligence might assign the interpretation *The man drank the wine* to the sentence, on the basis of the assumption that the speaker used the word *ate* erroneously (this would be especially likely if the person spoke with a foreign accent). But, this type of interpretation should not be accounted for by a linguistic theory.

As was said in 5.2, there is one more situation when the knowledge base may be modified as a result of the interpretation of the input sentence — when the sentence carries information not present in the knowledge base. Consider a situation when the hearer knows some things about a person named John but does not know John’s profession. If the input sentence is *John is a doctor*, then, even though the sentence is perfectly well formed and contains no unknown words, *John is a doctor* will be added to the implicational clause of *John*. The knowledge base, thus, will have been modified. This will be done because the input knowledge base, again, differs from the trace of the mapping in that it does not contain one of the propositions underlying the sentence. Generally speaking, then, it may be said that the output knowledge base differs from the input knowledge base by the trace of the mapping having been incorporated in the former.
What the above discussion suggest is that interpretation of a sentence is a function of the knowledge base and the intelligence of the hearer, which must follow deductive reasoning in modifying the knowledge base and generating the output implicational clause. This coincides with our intuition about interpretation, but there remain many unclear issues — for instance, what type of deductive rules are at play during the processes, should the intelligence be part of a linguistic semantic theory or should it be considered part of performance, and so forth. I will return to these issues in chapter six.

Summarizing, the output of the logical component, which constitutes the interpretation of the input sentence, is a pairing of the output implicational clause and the output knowledge base, which is the input knowledge base with the input semantic marker superimposed on it. The output knowledge base is the same as the input knowledge base if the input semantic marker does not differ in any way from the knowledge base and carries no new information. The output knowledge base is different from the input knowledge base if the input semantic marker differs from the structure of the input knowledge base or if it carries some new information, in which case the knowledge base has been modified so as to permit an output implicational clause to be generated. If no full output implicational clause is generated and the output knowledge base contains ‘unknown’
or ‘anomalous’ labels, then the sentence is considered uninterpreted as a whole, although parts of it may be interpreted. If the output contains two or more full implicational clauses, then the input sentence is ambiguous.
CHAPTER SIX:

ISSUES IN KNOWLEDGE SEMANTICS

In chapter five, in the course of sketching out the knowledge-based theory, a number of issues came up which were left unresolved. They may be grouped into the following three areas, which appear to be central to knowledge semantics: semantic representation, implicational-clause generation (I will use this term to mean output-implicational-clause generation), and meaning acquisition and extension. In this chapter, I will return to these issues, examining as much relevant data as space permits, and try to reach at least tentative conclusions about the problems in knowledge semantics.

6.1 SEMANTIC REPRESENTATION

In chapter five, in the course of discussing the knowledge component, it was concluded that it is possible to represent the semantic structure of the input sentence in the (higher-order) predicate-logic notation. It was also concluded that it is convenient to represent the knowledge base in the same notation, so as to simplify the mapping of the semantic representation of the input sentence — the input semantic marker — onto the knowledge base, which is
needed for generating the output implicational clause that, it will be recalled, constitutes part of the representation of the meaning of the input sentence. Thus, resolving the issues connected with semantic representation also resolves those connected with the structure of the knowledge base. That is, determining how to map the indexed surface structure, which represents the syntactic structure of the input sentence, onto the semantic phrase marker also determines how to represent the syntactic constructions, present in the input sentence, in the knowledge base. The discussion in this section, therefore, as well as the discussion in the other sections of this chapter which deals with semantic representation, has as much relevance to knowledge-base structure as to the issues connected with the mapping of indexed surface structure onto the input semantic phrase marker.

To return to some examples, in chapter five, it was suggested that in (6-1) – (6-3) the semantic structure of a may be represented as in b.

(6-1) a. the old man
    b. (the,old) (man)

(6-2) a. The man loves the girl.
    b. loves (the (man),the (girl))

(6-3) a. The man sleeps.
    b. sleeps (the (man))
It was also suggested that an adverb modifying a verb forms a proposition, as in (6-4).

(6-4) a. The man loves the girl madly.
   b. madly (loves) (the (man),the (girl))

Actually, here, two possibilities present themselves — the predicate madly may have as its argument the predicate loves. as in (6-4b), or the proposition, of which loves is the predicate, as in (6-4c).

(6-4) c. madly (loves (the (man),the (girl))))

I think there is good reason to choose the representation in (6-4b) over the one in (6-4c), for this sentence. Notice that there are two different types of syntactic constructions containing adverbs — one, where the adverb is attached to the VP node, and another one where it is attached to the S node. The second appears in such sentences as (6-5a), the first one in such as (6-4a). I will assume, then, that the semantic structure of (6-4a) is (6-4b), not (6-4c), and that (6-5a) has the structure (6-5b), corresponding to (6-4c). The semantic structure of (6-5a), then, is as in (6-5b).

(6-5) a. Suddenly, the noise stopped.
   b. suddenly (stopped (the (noise))))
It is possible that for some speakers *Suddenly, the noise stopped* has a different connotation from that of *The noise stopped suddenly*, which could be accounted for by the difference in the semantic structure of the two sentences. It will be up to the logical component to generate the implicational clause from the two different semantic markers.¹ (See Miller (1978), pp. 67-8, for a discussion of this problem.)

Consider now (6-6a). One way of representing its semantic structure is as in (6-6b).

(6-6) a. The book on the table burned.
    b. burned (on (the (book),the (table)))

In other words, in this representation, the preposition *on* is treated as a predicate of the proposition representing the subject noun phrase. This seems reasonable, but consider (6-7a). Here, *on* is part of the verb phrase and forms a prepositional phrase with *the table*. There are various ways of representing the semantic structure of this sentence, some of which are shown in (6-7b) – (6-7d).

(6-7) a. The book is on the table.
    b. on(is) (the (book),the (table))
    c. on (is,the (table)) (the (book) )
    d. is (the (book),on (the (table)))

¹I will use the term ‘implicational clause’ to mean ‘output implicational clause’ whenever it cannot be confused with the implicational clause of a proposition.
Bear in mind that in the verb phrase, the proposition binds the verb to the noun phrase, analogously to the way two noun phrases are bound by it in (6-6a). Now, since the binding is represented as a predicate dominating the two arguments, (6-7d) is not consistent with the established convention. Superficially, then, only (6-7c) seems the proper way of representing the semantic structure of the sentence. But notice that in (6-7b), on does have as its arguments *is* as well as *the(table)*, since it dominates both of them. (See below for a discussion of this aspect of representation.) It is true that it also dominates *the(book)* but it should be possible to establish the fact that on binds only *is* and the *table* in the knowledge-base entry used for interpreting the sentence. (This will be discussed in 6.2, in connection with implicational-clause generation.) (6-7b) and (6-7c), therefore, seem notational variants of each other.

But, the representation (6-7b) receives some support from the example (6-8a). Here, the adverb *up* is attached to the VP node. The proper way of representing the semantic structure of the sentence, then, is as in (6-8b), according to the convention established above, for the example in (6-4a).

(6-8) a. The man picked up the book.
    b. up (picked) (the (man),the (book) )
This representation, in turn, is supported by the fact that pick up acts as a semantic unit, that is, as if it were a single word pick-up. So, the two words should form a semantic unit in the representation, that is, a proposition. But, is on also forms a semantic unit, very similar to on. That is, the meanings of The book is on the table and the book on the table have very much in common. It seems reasonable, therefore, to expect the two syntactic constructions to have similar semantic structures. We could then identify in the knowledge base that on(is) (...) has an implication similar to on(...) and different from is (...).

I think this is the correct approach, and I will select (6-7b) as the proper representation of (6-7a).

Let us look now at (6-9a). Its semantic representation, according to the convention just established, is (6-9b).

(6-9) a. The book burned on the table.
    b. on(burned) (the (book), the (table))

But, burned on does not constitute a semantic unit. – Is this a problem? No. Notice, that we already had similar constructions above, in (6-4b), with madly(loves). – The burden will be on the logical component (that is, the knowledge base itself) that up (pick) and on (is) constitute semantic units, whereas madly (loves) and on (burned) do not.
This issue will be discussed in 6.2, in connection with implicational-clause generation.

Consider now (6-10a), whose simplified syntactic structure is (6-10a). It is not obvious how its semantic structure should be represented. One possibility is as in (6-10b); another one as in (6-10c).

(6-10)  
a. The man who came stayed.  
   a'  [S [NP [NP the man]] [S' [COMP [NP who]] [S t came]]]  
   [VP stayed]]  
b. stayed(came(the(man)))  
c. stayed(the(man),came(the(man)))

One of the arguments favoring (6-10c) is the fact that who, the surface realization of PRO, since it is coindexed with the man, is in effect replaced by it. This implies that the man should be represented twice in the semantic phrase marker. But the fact that the proposition came(the(man)) occurs as an argument in the higher proposition is not a desirable choice. — The construction suggests that the embedded clause acts as the object of the verb, which is not the case. (Stay is not a two-place predicate since it is not a transitive verb.) In (6-10b), on the other hand, the semantic equivalent of the man, which is the subject of

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*Notice that a proposition with who in it is not, according to the theory, a possibility, since pronouns, except, as was said earlier, those with antecedents outside the sentence, are not permitted in the knowledge base.*
stayed, is embedded within another proposition, which appears to be a more complex construction, since one occurrence of the two noun phrases in the input is not represented in it. But, I think, the complexity is apparent rather than real. — We could make it a convention that the arguments of any proposition are the ones which are dominated by its predicate {that is, embedded within the proposition, with no argument intervening), no matter how far removed, as in (6-11).

(6-11) pl (p2... (pn(a1,a2,...an)...)...)

That is, under the convention, a1, a2, ... an are the arguments of p1, p2, ... pn. The burden, now, will be on the semantic-marker mapping component to recognize that the complex proposition of (6-11) consists of the simple propositions pl (a1,a2...an), p2 (a1,a2...an), all the way to pn (a1,a2...an). And it will be up to the logical component to determine the proper output implicational clause from the nesting structure of the propositions. For instance, the logical component must determine that the man came before staying, on the basis of come being dominated in the semantic phrase marker by stayed. Thus, for the sentence The girl who stayed came, the order of the two predicates would be reversed, that is, came{stayed...). I assume, then, that (6-10b) is the proper semantic marker for (6-10a). This means that, without the convention (6-11),
the semantic marker for the sentence would be stayed((the (man), came (the (man))))), the double parentheses enclosing the arguments of stay indicating that it is a one-place predicate. Note that the semantic marker for I know the man who/that saw John will be know (I, (the (man), saw (the (man),John))) because of I intervening between know and saw. This indicates that there may be two types of structure for a complex argument — one involving nesting and one involving coordination (separation by commas).

The example (6-10a) constitutes a complex sentence with an embedded relative clause. (6-12a) is an instance of a sentence with an embedded verb complement. Its simplified syntactic structure is shown in (6-12a’). Again, two possibilities present themselves as to how to represent its semantic structure — as in (6-12b) or (6-12c).

(6-12)  a.  John said that Mary loves Peter.
       a’. [S John[VP said[S’ [COMP that ][S Mary loves Peter]]]]
       b.  said(John,that(loves(Mary,Peter)))
       c.  that(said)(John,loves(Mary,Peter))

They also appear to be notational variants. I will opt for the one in (6-12b), however, since it seems to receive some support from the analysis of nondeclaratives. (I will return to this issue in 6.5.) Notice that the fact, suggested by the semantic structure, that the embedded clause acts as the
object of the verb, is borne out by the syntactic structure as well as our intuition – the sentence introduced by that could be replaced, for instance, by the noun phrase a word, producing John said a word, its semantic representation being said(John,a(word)), which is similar to (6-12b). This, in my mind, supports the decision to represent verb complements as in (6-12b).

I have included that in the semantic phrase marker in (6-12b) even though the word does not seem to contribute anything to the meaning of the sentence since (6-12a) and John said Mary loves Peter have the same meaning. Actually, I am not completely sure if the meanings of the two sentences (that is, all their implications) are the same. But, even if they are, I do not think it would be advisable to have the semantic-marker structuring component delete lexical matter. — It seems more advisable to represent in the semantic marker all lexical matter present in the surface structure, with the exception of intrasentential anaphors, and to rely on the knowledge base to indicate that a lexical item contributes nothing to the implicational clause of a sentence. This appears to be more consistent with the overall structure of the knowledge component since it is the logical component, acting on the knowledge base, that determines the contribution of the elements of a semantic marker to the output implicational clause of a sentence. So, if, in fact, that does not contribute anything to the meaning of the sentence, then the
implicational clause of that, at least in the given environment, will be null. It is in this fashion, then, that the two sentences may receive the same interpretation.

Returning for a second to the subject of pronouns, notice that, in (6-10a), who, actually, was not deleted but, effectively, replaced by its antecedent under the assumed convention on interpretation of semantic markers, (6-11).

(6-13a) is another example of complement construction, its syntactic structure being (6-13a').

(6-13)  a. John wants to sing.
       a'. \[s \text{John}_i \text{wants} [s', [s \text{PRO}_i \text{to sing}]] \]
       b. wants(to sing(John))

Under the convention on pronoun representation I have assumed, the semantic representation of the sentence is as in (6-13b). (6-14) – (6-19) show related constructions, b being the semantic representation of a. All of these representations follow naturally from the conventions established so far.

(6-14)  a. John wants to sing a song.
        b. wants (to sing (John, a (song)))

(6-15)  a. John wants Mary to sing.
        b. wants (John, to sing(Mary))

(6-16)  a. John wants Mary to sing a song.
        b. wants (John, to sing (Mary, a (song)))
(6–17) a. John wants for Mary to sing.
b. wants (John, for (to sing (Mary)))

(6–18) a. John likes Mary's singing.
b. likes (John, Poss (Mary) (Ing(sing)))

(6–19) a. John likes to hear Mary singing.
b. likes (to hear (John, Ing (sing) (Mary)))

In the two above examples, Poss and Ing stand for ‘Possessive’ and ‘Ing form’ respectively. See below for a discussion of the representation of inflected forms.

The sentence (6–20a) is an instance of noun-phrase complementation.

(6–20) a. John got the news that Mary graduated.
b. got (John, that (the (news) (graduated (Mary))))

Its semantic representation is as in (6–20b). It follows naturally from the conventions established for verb-phrase complementation. — It is the noun phrase the news which is the head of the complement construction, just as a verb is the head of a verb-phrase complement construction. Thus, the head noun phrase becomes the predicate of the proposition representing the complement construction. And it is the proposition representing this complement construction which is the argument of the predicate that, the same as in the case of a verb-phrase complement construction.
The interesting thing about (6-20b) is that the news, a noun that acts as an argument for one proposition, acts as a predicate for another proposition. This, coupled with the many instances of verbs acting as arguments, shows that there is no one-to-one relationship between parts of speech and semantic functions, a fact that must play an important role in the implicational-clause generation process.³ (See Grimshaw (1979), where it is shown that subcategorization restriction and semantic restriction must be expressed by separate frames in the lexicon.)

All of the above examples involved propositions with one- or two-place predicates. (6-21a) is a sentence that should be represented with a three-place predicate, as in (6-21b).

(6-21) a. John hit the nail with a hammer.
   b. with(hit) (John, the(nail), a(hammer))

John got the package with a hammer would have the same structure. As was the case above, the burden will be on the logical component to identify that hit ... with forms a semantic unit and got ... with does not. (I am avoiding the issue that the last sentence is ambiguous.)

³Notice that, in the above examples, to should not present a problem of the type prepositions do since it is part of the tense of the verb. That is, to sing can be treated as one word by the semantic-marker structuring component. But see below, for a discussion of tense representation.
So far, I have dealt with syntactic structures composed of words and have represented various verb forms as single predicates. This would mean that all inflected forms in English are represented as different words in the knowledge base. But it is clear that it would be preferable for the theory to represent the words as semantic constructions since it would coincide with our intuition that inflected forms and words derived through word formation have something in common with the parts of which they are made up. This could be done as in the following examples, assuming that the implicational-clause generating mechanism is able to take advantage of it.

(6-22) a. to go; go; goes; went; going
    b. Inf (go); Pres (go); Pres (go); Past (go); Ing (go)

Where the meaning of the predicate stands for infinitive, and so forth.

(6-23) a. man; men
    b. Singular (man); Plural (man)

(6-24) a. darkly; menacingly
    b. Adv (dark); Adv (Ing (menace))

What I am proposing, then, is that the result of the morphological processes of inflection and word formation be treated as propositions so that the implicational-clause generating mechanism derives the combined implicational
clause of the word from the contribution of the members of the propositions (see 6-2).

This creates a problem, however, since, under the knowledge-based theory, implicational clauses can be generated only from propositions, which appears to mean that they cannot be generated from isolated words, that is, that isolated words should not have their own implicational clauses. But there are counterexamples to this contention in English. For instance, words such as God, America, Boston, mass nouns, and so forth, as well as plural forms are noun phrases (that is equivalents of propositions), just as much as the chair, the city, and so forth. Other examples are proper names as well as other forms, for instance man, as in Man is an animal. Moreover, the same is true of languages without articles.

There are two ways of handling this problem — to abandon the restriction that implicational clauses are associated with propositions only or to posit that, for such nouns as above and languages not having articles, the underlying structures are propositions with predicates that do not have any surface-structure realization. This could be represented as above, with the number, for instance Singular, as the predicate, and entries such as Singular(God) occurring in the knowledge base but not for words such as chair. So, in other words, the input semantic marker would break down all words capable of being inflected
into propositions, but for some no entries would be found without an article, whereas for others there would.

For inflected languages without articles, the case may be treated as a predicate, for instance as for *ljudyna* ‘man’ in Ukrainian, in (6-25).

(6-25) a. ljudyna; ljudyny; ljudyni  
    b. Nom(ljudyna); Gen(ljudyna); Dat(ljudyna)

I will opt for this method of representation of inflected forms.

This concludes my discussion of the question of semantic representation. In the above, I have touched upon some of the more common and interesting constructions in English. But, the topic, obviously, is far from having been exhaustively treated. In sections 6.3, 6.4, and 6.5, I will return to the questions of semantic representation, discussing the interpretation of quantifiers and negation, conjunction, and nondeclaratives. I am postponing these topics until after discussing the problem of implicational-clause generation since understanding the issues connected with the semantic representation of these constructions is inextricably linked with the problem of implicational-clause generation. In 6.6, I will once more return to the topic of semantic representation by discussing
the rules that map the indexed surface structure onto the input semantic marker.

6.2 IMPLICATIONAL-CLAUSE GENERATION

In (5-2b), I listed some of the sentences that may be implied by (5-2a). The examples are repeated below as (6-26).

(6-26) a. The rich old man loves the beautiful young girl,
b. 1. The man has a lot of money.
   2. The man was born before the girl.
   3. The person who loves the girl is male,
   h. The person who the man loves is female.
   5. The man would probably give the girl a substantial amount of money.
   6. The girl could probably be rich if she wanted to.
   7. The man will probably die before the girl.
   8. The man probably has gray hair.
   9. The girl's complexion is probably better than the man's.
   10. The man probably loves the girl because of her youth and beauty.

The semantic structure of (5-2a), in the predicate-logic notations, was given in (5-2c). It is repeated below as (6-26c). The propositions it consists of are listed in (6-26d). I am continuing to use the simpler notation, in which, for instance, nouns are represented as single words instead of propositions with the number as the predicate.
(6-26) c. loves((the,rich,old)(man),(the,beautiful,young)(girl))
d. 1. loves (man,girl)
   2. the (man)
   3. rich (man)
   4. old(man)
   5. the (girl)
   6. young (girl)
   7. beautiful (girl)

Each of the seven propositions in (6-26d) has an implicational clause associated with it and, on the knowledge-based theory, the resultant implicational clause for (6-26a) should be (6-26b). (6-26e) shows some of the implicational clauses that may be associated with each of the propositions of (6-26d). They are listed as English sentences.

(6-26) e. 1. a. The man would probably give the girl much of what he has.
   b. The man probably loves the girl for her outstanding qualities.
2. a. The man is a person,
   b. The person is male.
3. The man has a lot of money.
4. a. The man was born before each young person.
   b. The man will probably die before each young person.
   c. The man probably has gray hair.
   d. The man probably has bad complexion.
5. a. The girl is a person,
   b. The person is female.
6. a. The girl was born after each old person.
   b. The girl will probably die after each old person,
   c. The girl probably has good complexion.
   d. One of the girl's outstanding qualities is her youth.
7. One of the girl's outstanding qualities is her beauty.
We can see how, semantically speaking, each simple proposition contributes to the combined implicational clause of the complex proposition. — (6-26b1) derives from (6-26e3) through direct copying. This suggests that what is implied by a simple proposition is implied by the proposition of which the simple proposition is part; or, in other words, that the implicational-clause generation process is a process of compounding of the implicational clauses of the member propositions.

(6-26b2) derives from (6-26e5a) and (6-26e4a). The former equates girl with person, permitting the latter to be used. So, here, in addition to the copying process which enables the implication associated with old (man) to be added to the implicational clause of the sentence, there is used a process of ‘translation’ which permits substituting one word for another. But this process, apparently, is a form of the process of copying. Notice, however, that, in generating the implication (6-26b2), there is a third process at play, namely some kind of ‘reasoning’ which permits to identify that the girl (that is the person) is each person. I will return to this issue below.

(6-26b3) derives from (6-26e2b) through copying. (6-26e2a) permits man to be replaced by person. This is very likely a stylistic phenomenon, designed at avoiding the redundant The man is male. The function of the relative clause who loves the girl serves the purpose of identifying the person. I think it derives also through copying. —
Note that, according to the rules of semantic-marker structuring component given in 6.1, both The man loves the girl and The man who loves the girl are represented as loves (the (man), the (girl)).

(6-26b4) is derived in essentially the same way as 6-26b3).

(6-26b5) is derived from (6-26e1a) and (6-26e3). On the surface, the process involves replacing much of what he has by quite a lot of money. So, here, a translation takes place. I think it can be accounted for by the knowledge base containing the proposition underlying Much of a lot of money is a substantial amount of money, or something similar. This process, then, is copying that is further removed.

(6-26b6) seems to be derived directly from the above implication (6-26b5), that is, from the fact that the girl could have quite a lot of money. This is an example of compounding of implications. The knowledge base could imply that, if a person has quite a lot of money, he is rich. The process, then, again is copying.

The remaining sentences in (6-26b) involve the same processes as above.

Earlier, it was said that (6-26c) consists of the propositions in (6-26d). What this means is that the semantic-marker mapping component must generate the simple propositions in (6-26d) from the complex propositions.
constituting the semantic marker of (6-26c). This means that loves [...man....girl] is equivalent to loves (man,girl) and (the,rich,old) (man) is equivalent to the(man), rich (man), and old (man), and so forth. Likewise, for such complex propositions as wants (to sing(John)), underlying John wants to sing, the equivalent simple propositions are wants (John) and to sing (John), as was suggested in 6.1.

It is imperative that the semantic-marker mapping component possess this ‘decompositional’ capability for, otherwise, the knowledge base would have to contain all possible complex semantic markers, which would have unpleasant theoretical consequences.

Although the processes sketched out above seem fairly straightforward, there are a few problems associated with them. – First, as was already mentioned, there are many phenomena in the implicational clauses that appear to be ‘surface’ or ‘stylistic,’ as, for instance, in (6-26b3), where man is replaced by person who loves the girl. I think that it is correct to say that the phenomenon is not part of sentence grammar but, nonetheless, problems such as this require further clarification. Another problem is in assigning implicational clauses to propositions. It seems to me that there is no obvious way of saying when an implication is direct and when indirect, through a proposition implied directly. I think that this will become
apparent when a sizable chunk of the knowledge base is described and the criteria of elegance, or economy (which itself has to be defined), are brought into play. It is not inconceivable that one will run, in connection with this, into some of the difficulties that the decompositional theories have run into. But, since the knowledge-based theory does not have as its goal defining a real knowledge base, perhaps this problem can be overcome. For instance, it is possible that some of the choices can be made arbitrarily, without invalidating the whole approach, since what the theory is trying to do is to identify the processes generating the implicational clauses but not the implicational clauses themselves.

I would like to return now to the question of simple-proposition representation. In the above examples, it was suggested that such sentences as John loves Mary have as their representation in the knowledge base a simple proposition, namely, loves(John, Mary). This could be the case, but then the knowledge base still would have to be vast if not infinite; moreover, with this approach, it would probably be difficult to identify that Peter loves Jane involves the same process (predicate) as in the preceding sentence, except that the individuals (arguments) are different. Clearly, what one would like to do is to have in the knowledge base the three elements, with the proper
implicational clauses associated with them, and combine the three into one.⁴

With the arguments, the solution is obvious. — Use the implicational clause underlying them, that is, the implicational clauses associated with Singular (John) and Singular (Mary). With the predicate, however, we need to refer to variables to express the implications. *X loves y*, for instance, means that *X would probably give y much of what he has*, and so forth. It would be convenient, therefore, if the knowledge base consisted of such generic propositions, which the semantic-marker mapping component would convert to the specific ones, corresponding to the input semantic marker, replacing the variables in both the proposition itself and in its implicational clause by the arguments of the input semantic marker.

Generic propositions appear to be equivalent to Tarski’s *sentential functions* with free variables. (See Tarski (1944), p. 24.) They are also similar to *functional structures* which Bresnan (1978) proposes to be derived through lexical rules. For instance, the functional structure of *hit* is $NP^1 \text{hit} \, NP^2$. (As was said earlier, Fodor and Fodor (1980), p. 769, argue against Bresnan’s proposal of introducing quantification as part of functional structure, maintaining that quantificational structure is

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⁴I am sidestepping the issue that *loves* is really a proposition in itself, namely, *Pres (love)*, as I suggested above, as are *John* and *Mary*. 
inseparable from logical inference and, thus, should be derived from sentences and not from lexical items.)

It is obvious, though, that it will not be possible to always follow the generic-proposition approach, namely in the case of idioms or other syntactic constructions which form semantic units. Compare, for instance, John kicked the computer and John kicked the bucket. We will need two propositions in the knowledge base to handle these—kicked \((x,y)\) and kicked \((x,\text{the (bucket)})\)—the latter having two implicational clauses—one similar to the preceding, and the other one corresponding to to die (see below). Similarly, John hit the nail with the hammer and John got the package with the hammer may be derived from \((6\text{-}27\text{a})\) and \((6\text{-}27\text{b})\) respectively.

\((6\text{-}27)\)
\(\text{a. with (hit) } (x,y,z)\)
\(\text{b. with (package, x)}\)

Generic propositions give us a convenient tool to handle such constructions as with each in the example \((6\text{-}26\text{b2})\). — The proposition each \((x)\) will have as its implicational clause \(y(x)\), which will enable the logical component to select the young girl as the replacement for each young girl.

To summarize, generic propositions may be used in the knowledge base whenever the implicational clause of a
A proposition is derivable through the normal processes (still to be fully defined) of the constituents of the proposition. Fully or partly specific propositions have to be used when the implicational clause may not be derived using the normal processes.

The question of economy brings to mind another problem. Compare, for instance, sentences a and b of (6-28) and (6-29).

(6-28) a. John works hard.
b. John's work is hard.

(6-29) a. Work is unpleasant.
b. To work is unpleasant.

I think that a and b, in each case, imply slightly different things. (John's work may be easy but he still may work hard.) Nonetheless, I feel that a sizeable portion of the implicational clauses for each pair is the same. The question is whether we should repeat this information twice or try to derive it from a common source. The first approach would also suggest that the duplication of information is an accident, which I do not think is the case. So, the theory should account for the fact that the two words are semantically related. The mechanism for doing this remains to be worked out but, basically, one could posit that some word-formation process is at play, which is reflected as a predicate in semantics—noun to verb or
verb to noun. It could be the predicate, then, that accounts for the difference in implication, or at least part of it. The problem deserves further study.\footnote{See Aronoff (1980), p. 755, for a discussion, where he introduces the term 'morphological semantics.'}

Before proceeding with other topics, I would like to touch upon the issue of implication representation for knowledge-base entries.

In 5.1, it was suggested that the basic form of a knowledge-base entry is (5-6), which is repeated below.

\[(5-6) \ m; \ n; \ p,q,r...\]

Where \(m\) is the identifying number of the entry and \(p,q,r...\), which constitute the implicational clause of the proposition, are identifying numbers of the entries directly implied by \(n\), which serve as pointers.

In the above examples, for the sake of simplicity, English sentences have been used for implicational clauses. This would be perfectly acceptable if the knowledge base contained only fully specific propositions. But, since generic propositions may occur in it and since the implicational clauses constitute complex propositions which may be fully or partly specific, in practice, implicational clauses in the knowledge-base entries must contain some...
rules as to how the pointers to the entries implied by the proposition in the entry are to be combined. The simplest solution to this problem would be to make these rules the rules according to which the semantic phrase markers are formed or, the syntax rules of the predicate-logic notation. I assume this to be the case. That is, I assume that \( p, q, r \ldots \) in (5-6) are numbers of entries in the knowledge base if the entries are specific propositions. If they are not, then for each number in the implicational clause there appears a semantic phrase marker with numbers of the entries in the knowledge base whose propositions act as constants (lexical matter) in the semantic phrase marker. For the sake of simplicity, I will continue using English sentences whenever describing implications for knowledge-base entries.

There is one more topic that properly belongs under the subject of implicational-clause generation, namely ambiguity. In 5.3.2, in discussing the properties of the word bank, it was suggested that it should be represented by two knowledge-base entries, \( \text{bank}(f) \), and \( \text{bank}(r) \). as if they were two distinct words. For sentences such as The \textit{man} is the \textit{president} of the \textit{bank} (= (5-13)), the \( \text{bank}(f) \) entry will be selected because the knowledge base contains the entry underlying the phrase the \textit{president} of the \textit{bank}(f) (= (5-14)). In case the knowledge base does not contain entries which permit ambiguity resolution, two implicational clauses will be generated, one for matching on \( \text{bank}(f) \) and the other one on \( \text{bank}(r) \). This seems reasonable and I will
continue to assume this to be true. But, consider such words as lead, as in Jackendoff's example, to lead someone to believe something, mentioned in 4.2. It would be possible for the knowledge base to have two entries for the word lead and for the logical component to generate the correct interpretation. But, it would probably be more revealing to have only one entry for the word with two separate implicational clauses derivable from it. This would agree with our intuition that there is something in common between the two meanings of the word and, potentially, might be able to describe the process of how the second meaning came about. This situation will be analyzed in greater detail in 6.7, during the discussion of meaning extension.

I will return to the topic of implicational-clause generation in the following sections, while discussing the treatment of quantifiers and negation, conjunction, nondeclaratives, and meaning acquisition and extension. Before proceeding, however, I would like to make the following observation.

It was suggested earlier that deriving the implicational clauses for idioms should be accomplished by fully or partly specific propositions. This will work if the syntactic structure of the idiom obeys the syntactic rules of the language, as is generally assumed to be true (Bresnan (1978), p. 31). There seem to be counterexamples
to this, however, for instance in Spanish, where such phrases as cuando la guerra ‘during the war’ (literally ‘when the war’), or cuando la seguía ‘during the drought’ are permissible, whereas such as cuando la paz ‘when the peace’ or cuando la enfermedad ‘when the illness’ are not, and cuando, in general, is not permitted to appear alone with noun phrases. What this means is that some idioms may present a problem to the semantic-marker structuring component. But these cases are problematic for any theory trying to map syntactic structure onto semantic and, in fact, they constitute a problem for the syntactic component, where, properly speaking, they should be handled.

6.3 QUANTIFIERS AND NEGATION

Consider the sentence (6-30a). There is no ambiguity in it as to how many girls the boy kissed or how many boys the girl was kissed by.

(6-30) a. A boy kissed a girl.
    b. One boy kissed one girl.

- The boy-girl kissing relationship is as indicated in (6-30b). But consider (6-31a). The possible interpretations of this sentence are given in (6-31b).
(6-31) a. Two boys kissed three girls.
b. 1. There were two boys. Each kissed three girls. Each girl could have been kissed by both boys. The maximum number of girls could have been six, the minimum three.
2. There were three girls. Each was kissed by two boys. The boys could have been different for each girl. The maximum number of boys could have been six, the minimum two.
3. There were two boys and three girls. One boy kissed two girls, the other one.
4. There were two boys and three girls. The boys, collectively, kissed the girls as a group.

It is true that (6-31b4) might be impossible to accomplish physically if one adheres to a strict definition of kissing but, with a looser definition (or if we substitute hug for kiss), the interpretation is possible. This is a general property of quantifiers—such words as two and three—and it is not restricted to numerals. Compare (6-32a), which has the same four types of interpretation.

(6-32) a. A few boys kissed many girls.
b. 1. There was a small number of boys. Each kissed a large number of girls.
2. There was a large number of girls. Each was kissed by a small number of boys.
3. Some small number of boys kissed a number of girls, so that, when added together, the number of girls was large.
4. A small number of boys, collectively, kissed a large number of girls, as a group.

Now, this type of ambiguity arises only when there is more than one quantifier in a sentence and when the quantifiers are of a special kind. The article a, for instance, is also a quantifier but, although there are two of them in (6-30a),
the sentence is not ambiguous. In (6-33a), which contains the quantifiers many and the, there are only two possible interpretations, as (6-33b) shows.

(6-33)  

(a) Many boys kissed the girl.  
(b)  
1. There was a large number of boys. Each of them, separately, kissed the girl.  
2. There was a large number of boys. They, collectively, kissed the girl.

Substituting hug for kiss again makes the interpretation (6-33b2) more natural.

The quantifiers that reduce or eliminate ambiguity are not limited to the articles a and the. — The numeral one, for instance, acts the same way, as can be seen from (6-30b). Every is another quantifier that acts the same way, as (6-34) shows.

(6-34)  

(a) Every boy likes to go out with many girls.  
(b)  
1. For all boys, each of them likes to go out with a girl and likes to do it with a great number of girls.  
2. For all boys, each of them likes to go out with a great number of girls at a time.

The characteristic of quantifiers to introduce ‘numbering’ ambiguity, when occurring in pairs or larger numbers, is a well-known fact. In linguistic literature, however, only the reading types 1 and 2 of (6-31b) have been generally recognized to exist. This is probably due to the fact that few verbs permit the interpretations 3 and 4 and.
possibly, because it has been universally assumed that the ambiguity arises from assigning the relative scope of the quantifiers in the semantic interpretation of sentences. J. D. Fodor (1977), for instance says:

‘quantifier scope ambiguities must be captured at the semantic level by the relative position of two quantifiers. (This general principle is accepted by virtually all semantic theories, even those which disagree with Layoff’s analysis of quantifiers as the verbs of higher clauses.)’ (p. 132)

Fodor is referring to the generative-semantics proposal to represent quantifiers as higher verbs in the deep structure, which was assumed to be the semantic representation. (See Lakoff (1971), p. 239.) She observes that a sentence with one quantifier, such as One boy wrote his name, receives one interpretation. One with two quantifiers, such as One boy wrote his name on each page, receives two interpretations, and one with three quantifiers, such as One boy wrote many names on each page, receives six interpretations (p. 185).

In accordance with the predicate-logic (also known as the quantifier-logic) notation, two different interpretations of (6-35a) are accounted for by the relative position of the two quantifiers, as shown in (6-35b) (= (26), (27), and (28), respectively, in J. D. Fodor (1977), ch. 5). The meaning of (6-35b) and (6-35c1) are expressed in formalized English in (6-35c) and (6-35c2), respectively.
(6-35)  a. One boy wrote his name on each page.
   b. 1. (3x)(∃y)(boy x wrote x’s name on page y)
       2. (∃y)(3x) (boy x wrote x’s name on page y)
   c. 1. There exists an x such that for all y (boy x
       wrote x’s name on page y).
       2. For all y there exists an x such that (boy x
          wrote x’s name on page y).

In (6-35b), ∃ stands for the existential quantifier and ∀ for the universal quantifier (see Allwood et al. (1977), p. 65 and p. 62, respectively). In (6-35b1), one has the wider scope; in (6-35b2), every does. Chomsky’s logical form, as was said earlier, has ‘basic properties of some variant of predicate calculus in familiar notation’ (Chomsky (1980a), p. 4). So, the sentence (6-35a), under the revised extended standard theory, would be represented essentially as in (6-35b) (actually, very similar to (6-35c); see 6.5).

The contention advanced by Fodor, above, that the number of numbering readings for sentences with two quantifiers is two, with three six, and so forth, is wrong, as the examples (6-31) and (6-32) show. As a general rule, the number of possible readings is two to the power n, where n is the number of quantifiers. The number of actual readings may be smaller if the verb or another word in the sentence excludes some of the possibilities (see below), as well as for quantifiers such as a, the, one, and so forth. This fact is accounted for very simply under the knowledge-based theory, as follows. Quantifiers acting as modifiers of nouns appear in the input semantic marker in
the simple propositions of the type \( q(n) \), where \( q \) is a quantifier and \( n \) a noun. In accordance with the approach sketched out above, these prepositions will have their implicational clauses derived from two generic propositions, \( q(x) \) and \( x(n) \), for each \( n \) and \( q \) in the knowledge base. The implicational clause for each quantifier must state the correct reading for any \( x \). Now, there appear to be three types of quantifiers in English, as far as their ability to influence numbering readings of sentences:

1. **Individual quantifiers**, for instance, \( a, the, one, every, \) and so forth. These permit the reading in which the modified noun acts individually.
2. **Collective quantifiers**, for instance, \( a \) pair (of), \( a \) threesome (of) and so forth (in some dialects, these may belong to the third type). These permit the readings in which the modified noun acts collectively.
3. **Ambiguous quantifiers**, for instance, \( many, a \) few, \( some, two, three, \) and so forth. These permit the readings in which the modified noun acts both individually and collectively.

Most of the quantifiers are of the ambiguous type. For sentences with one such quantifier, the number of readings will be two – one individual and one collective. For sentences with two such quantifiers, there will be four readings – individual-individual, individual-collective,
collective-individual, and collective-collective. This is confirmed by the above examples. In (6-31b), for instance. reading 1 constitutes the individual-individual reading; reading 2, the individual-collective; reading 3, the collective-individual; and reading 4, the collective-collective. (6-30a) had only the individual-individual reading, since the quantifier a belongs to the individual category. (6-33a) has two readings, 1, corresponding to the individual-individual and 2, corresponding to the collective-individual. This is so because many belongs to the ambiguous category of quantifiers, and the to the individual.

The numbering-reading property of quantifiers could be represented in knowledge-based theory as in (6-36).

(6-36) a. a (x); X acts individually.  
b. the(x); X acts individually.  
c. one (x); X acts individually.  
d. every (x); X acts individually.  
e. two (x); 1. X’s act individually.  
               2. X's act collectively.  
f. three(x); 1. X's act individually.  
               2. X's act collectively.  
g. many(x); 1. X's act individually.  
               2. X's act collectively.  
h. few(x); 1. X's act individually.  
               2. X's act collectively.  
i. all (x); 1. X's act individually.  
               2. X's act collectively.  
j. a couple of (x); X’s act collectively.  
k. a threesome of (x); X’s act collectively.

In (6-36), in accordance with the basic form of knowledge-base entries (5-6), the partial implicational clause for each proposition follows the semicolon. If there is only one clause, then the numbering reading of the
proposition is unambiguous. Two clauses indicate that the numbering reading is ambiguous and that either, or both, may be used. The logical component, whose task it is to generate the output implicational clause, depending on whether the clause contains the word ‘individually’ or ‘collectively,’ generates the proper reading for the sentence. For quantifiers with two clauses, two readings (output implicational clauses) are generated. If the sentence contains more quantifiers, then all possible (two to the n-th power) readings are generated. I will not speculate as to how the actual meanings of quantifiers are derived, for instance, what many or few may mean, what do one or two signify, and so forth. (But see 6.4.) Presumably the mechanisms of the knowledge semantic component sketched out earlier are capable of dealing with this problem.

Above, it was said that it is generally assumed that two quantifiers produce two readings, and so forth. There are instances, however, when mere readings have been recognized. Jackendoff (1972), pp. 307-8, talking about the example I told three stories to many of the men, observes that it can have three readings. Jackendoff uses this fact as an argument against the standard predicate-logic notation of quantifier representation which, he says, is capable only of deriving two readings. J. D. Fodor (1972), commenting on this contention, however, says:

‘it is clear from Jackendoff’s own paraphrase that
reference is being made in [the quoted sentence] both to SETS (of stories and of men), and to the MEMBERS of these sets. So, even though they do not show up clearly in the SURFACE form of [the quoted sentence], there must actually be FOUR quantifiers in the semantic structure of the sentence — one for the set of stories, one for its members, one for the set of men, and one for its members.’ (p. 189)

I am not sure if, as Fodor claims, the standard predicate-logic notation can correctly account for the four readings. (Agreeing with Jackendoff, she claims there are only three.) But, both she and Jackendoff concur that three and many may have the individual and collective readings, as is postulated under the knowledge-based theory.

Consider next the sentence (6-37a).

(6-37) a. Two boys kissed three girls each.
    b. 1. There were two boys. Each kissed three girls.
        Each girl could have been kissed by both boys.
        The maximum number of girls could have been six, the minimum three.
        2. There were three girls. Each was kissed by two boys. The boys could have been different for each girl. The maximum number of boys could have been six, the minimum two.

The sentence has two readings, as is shown in (6-37b). As can be seen, they correspond to (6-31b1) and (6-31b2), or, in other words, to the individual-individual and individual-collective readings. So, introducing each, into
the sentence (6-31a), as in (6-37a), eliminates the collective readings for the subject noun phrase.

Each in (6-37a) is clearly not part of the noun phrase three girls. — It can be left behind when the noun phrase is moved to the front of the sentence, as in How many girls did two boys kiss each? I assume, then, that each is attached to the VP node in the surface structure underlying (6-37a) and that it is translated into a predicate having as its argument the verb in the verb phrase, that is kissed. and, thus, that it is part of the main predicate of the proposition underlying the sentence. When each is a modifier of the noun phrase two toys, that is, when it is part of the argument of the proposition underlying the sentence, the numbering readings are different. Compare the sentence (6-3Ba) and its readings (6-38b).

(6-38) a. Each two boys kissed three girls.
    b. 1. There were groups of two boys. One boy in each group kissed two girls, the other one one.
        2. There were groups of two boys and there were three girls. The boys in each group, collectively, kissed the girls as a group.

Here, the readings correspond to (6-31b3) and (6-31b4), or to the collective-individual and collective-collective readings. In other words, introducing each as the modifier of the verb in the sentence (6-31a) eliminates the collective readings for the noun phrase and introducing it as the modifier of the subject noun phrase eliminates the
individual readings for the subject noun phrase. (But Each of two boys kissed three girls will have the same readings as (6-37a). The semantic structure of this sentence is different from that of (6-37a), which means that the two sentences will receive the same numbering-reading interpretation through two different knowledge-base entries.)

Under the convention for representing verb modifiers in the semantic phrase marker, established in 6.1, the semantic structure of (6-37a) is (6-37c).

(6-37) c. each (kissed) (two (boys), three (girls))

Given this semantic representation, the interpretations in (6-37b) will be derived with the aid of the entry in (6-37d).

(6-37) d. each(x) ; X acts individually.
   Where each is not within an argument.

Notice that, under the convention (6-11), the form of the proposition in (6-37d) permits boys to be matched against it.

Let us look now at the sentence (6-38a). Under the convention for representing noun modifiers, its semantic structure is (6-38c) and it will be interpreted with the aid of the entry (6-38d).
(6-38) c. kissed ((each,two) (boys), three (girls))
    d. each (x); X acts collectively.
    Where each is within an argument.

Notice that neither of the two input semantic markers will be able to match against a wrong each entry because of the specified conditions. It appears, then, that this type of information must be available to the logical component. I will say a little more about this topic in section 6.6.

The crucial thing about the above analysis is that the semantic function of each — whether it is part of a predicate or an argument — produces different readings for the sentences.

In the two above examples, it was shown how introducing a quantifier into a sentence modifies the numbering readings of a sentence containing quantifiers. The same can be achieved by introducing an adverb. — Two boys kissed three girls apiece is synonymous with (6-37a). So, it is not only what is normally considered quantifiers that affect the numbering readings of sentences. There are many other words and constructions that do the same. (See Lewis (1975) for a discussion of the so-called adverbs of quantification.) Likewise, modifying the object noun phrase may change the numbering readings of a sentence, not only the subject noun

\(^6\)Postal (1974), p. 207, also notes that each and apiece are interchangeable in some contexts. His examples are I gave them ten dollars each and I gave them ten dollars apiece.
phrase. Examples (6-39) – (6-41) show some of the possibilities.

(6-39) a. Two boys acting together kissed three girls.
    b. 1. Two boys collectively kissed three different girls.
        2. Two boys collectively kissed a group of three girls.

(6-40) a. Two boys kissed three separate girls.
    b. 1. Two boys individually kissed three different girls.
        2. Two boys collectively kissed three different girls.

(6-41) a. Two boys as a group kissed a group of three girls.
    b. Two boys collectively kissed three girls collectively.

The readings for these sentences could be derived with the aid of knowledge-base entries similar to (6-37d) and (6-38d). Thus, the knowledge-based approach seems to account very simply for a variety of quantificational structures. It remains to be seen if the same could be said about the standard predicate-logic quantifier representation and Jackendoff's modal structure once they were extended to handle the data brought forth above.

So far, in this section, I have talked about the interpretation of quantifiers under the knowledge-based theory. Let us look now at negation. The treatment of negation under the revised extended standard theory is that of Jackendoff (1972). Jackendoff's position is summarized in 3.4. His arguments, developed in earlier publications, were directed against the standard theory, which maintains
that rules of semantic interpretation act on deep structures only and, thus, that transformations preserve meaning. Jackendoff's, and Chomsky's, suggestion that semantic-interpretation rules act on both deep and surface structures constituted the extended standard theory, which is, as was said in chapter two, the predecessor of the revised extended standard theory. One of Jackendoff's arguments against the standard theory was based on data involving negation. He observed that sentences (3-19a) and (3-20a), which are repeated below as (6-42a) and (6-43a), are not synonymous.

(6-42) a. Not many of the arrows hit the target.
(6-43) a. Many of the arrows didn't hit the target.

Now, if the two sentences are derived from the same deep structure by different transformations, then the tenet of the standard theory is violated since two nonsynonymous sentences would be derived from the same deep structure. If, on the other hand, the deep structures of the two sentences differ, neg being in the first sentence a daughter of the S node and in the second of the VP node, then the closest passive equivalent of the sentence (6-43a), which is The target wasn't hit by many of the arrows, should be synonymous with the sentence itself. But it is not. It is synonymous with (6-42a) only, to which it is also the closest passive (pp. 326-7). This proves, then, for
sentences containing negative elements and quantifiers (for it is then that sentence and verb-phrase negation differ in meaning), that surface structure must be available for the rules of semantic interpretation to act upon. — The 'understood’ order of quantifiers and negation is their order in surface structure (p. 332). Jackendoff expresses the interpretation of negation and quantifiers using his modal structure. For the two above examples, the modal structure is as in (6-42b) and (£“43t), respectively.

(6-42) b. the arrows, the target, not (many(hit))
(6-43) b. the arrows, the target, many (not (hit))

Jackendoff's ‘surface-order’ approach to negation interpretation has been widely adopted. Baker (1978), for instance, lists the following as his Left-to-Right Convention:

'In interpreting a sentence containing quantity words and negation, apply the interpretive rules to the relevant words in the order these words appear in the surface structure of the sentence.’ (p. 365)

The interaction of negation and quantifiers is, again, generally viewed as a problem of scope. Chomsky (1973), pp. 95-6, observes that the sentence (6-44a) (= (46a)) has two readings, given in (6-44b).
(6-44) a. I didn't see many of the pictures,
b. 1. I saw few of the pictures.
   2. Many of the pictures are such that I didn't see them.

That is, in the first one, *not* is associated with *many*. In the second one, it is associated with *see*. This, Chomsky considers a problem of the assignment of the scope of negation, part of the semantic interpretation rules. In other words, Chomsky says that, once the scope of negation and quantifiers is determined, it should be represented in the standard fashion in logical form.

Under the knowledge-based theory, the semantic markers for the sentences (6-42a) – (6-44a) are listed as c, below. I am assuming that *not* modifies the noun phrase *many of the arrows*, and *many*, the prepositional phrases with *of*.

(6-42) c. hit (not (many,of) (the (arrows),the (target)))
(6-43) c. didn't (hit) ((many,of) (the(arrows),the(target)))
(6-44) c. didn't (see) (I, (many,of) (the (pictures)))

Some of the entries in the knowledge base which will be used for interpreting these sentences are given in (6-45).

(6-45) a. not(x(y)); Y has the property opposite to x.
b. (many,of) (x); X is large in number.
c. (few,of) (x); X is small in number.
d. few (x); Opposite of x large in number.
e. didn't(x) (y,z); Z is such that y didn't x it.
f. didn't (x) (y, (many, cf) (z)); Y x-ed few of z.

(6-42a) receives the interpretation Few of the arrows hit the target, by (6-45a) and (6-45b) leading to (6-45d), which in turn leads to (6-45c). (6-43a) receives the interpretation The target is such that many of the arrows didn't hit it, which is the one that Jackendoff assigns it, through (6-45b) and (6-45e). For (6-44a), the reading (6-44b1) can be derived with the aid of the entry (6-45f). The reading (6-44b2) can be derived through the entries (6-45b) and (6-45e), the same as for Jackendoff's second example. But, this means that sentence (6-43a) can also have the reading Few of the arrows hit the target. Jackendoff suggests that it does not but to my ear, the sentence does carry the second meaning, especially with many stressed — for instance, as in Many of the arrows didn’t hit the target, few did. An interesting point about the entries (6-45e’) and (6-45f) is that the latter is longer and contains more lexical items, namely didn’t and many of as compared with didn't. Chomsky observes that the reading (6-44b1) seems to be the more natural (‘less sophisticated’) one. It could be that this is due to the more specific nature of the entry (6-45f), and that some kind of ‘longest match’ principle is at play here. That is, it could be that

7Jackendoff, however, does observe that the passive The target wasn't hit by many of the arrows is ambiguous with stress on many (p. 327).
implicational clauses produced by matching longer substrings of the input semantic marker receive a preferred reading over those produced by matching shorter substrings.

If this is so, then it is a point in favor of the knowledge-based theory since it may have an explanation for preferred readings.

6.4 CONJUNCTION

So far, in none of the examples, have I dealt with conjoined elements. It is true that in examples such as the rich old man the modifiers of the head noun received a representation in the semantic phrase marker which made them look as if they were conjoined, that is, (the, rich, old) (man). But, there was no explicit conjunction that joined these elements. In this section, I will deal with such constructions, which I will call phrasal conjunction, as well as constructions in which conjunctions join sentences, which I will call sentence conjunction. (By these terms I am referring to the surface appearance of the constructions and not necessarily to the way they are derived.) I will deal with phrasal conjunction first.

Consider the sentence (6-46a). A reasonable way of representing it would be as in (6-46b).
(6-46) a. John and Peter love Mary.
   b. love (and (John, Peter), Mary)

This assumes that the deep and surface structure of (6-46a) are identical since, under the revised extended standard theory, only the scope of logical elements, focus, and so forth, are derived from surface structure, so that (6-46b) must be derived from the deep structure. This assumption is in the spirit of the Phrase-Structure Rule Hypothesis of Dougherty (1970). Under it, for instance, the sentence John and Bill are erudite and John is erudite and Bill is erudite are derived from distinct deep structures (p. 851). Dougherty argues convincingly against theories that derive the two above sentences from the same deep structure.\(^8\) I will, therefore, assume his approach to underlie all conjoined structures discussed in this section.

Given this assumption and the convention of representing conjunctions as predicates, followed in (6-46), the representation of the sentence (6-47a) is as in (6-47b).

(6-47) a. John loves and supports Mary.
   b. and (loves, supports) (John, Mary)

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\(^8\) Dougherty calls this the Conjunction Reduction Hypothesis. It is advanced by Gleitman (1965) and Lakoff and Peters (1966).
But, the question arises how to represent such constructions as (6-48a) and (6-49a). Should and be the predicate of the three noun phrases or just the last two? That is, should the representation be as in the b or the c version below?

(6-48)  a. John loves Mary, Jane, and Sue.
        b. loves(John, and((Mary, Jane), Sue))
        c. loves(John, and(Mary, Jane, Sue))

(6-49) a. John loves, supports, and abets Mary.
        b. and((loves, supports), abets) (John, Mary)
        c. and(loves, supports, abets) (John, Mary)

I think that b is the correct representation, since the practice of putting in parentheses elements of the same syntactic category which appear as daughters of a node has already been followed above. Moreover, we would not want to suggest by the semantic representation that Jane and Sue in (6-50a) stand in the same relationship to Mary as Lisa. That is, the semantic representation of the sentence should be as in (6-50b), not (6-50c).

(6-50) a. John loves Mary, Jane, Sue, but not Lisa.
        b. loves(John, but((Mary, Jane, Sue), not(Lisa)))
        c.*loves(John, but(Mary, Jane, Sue, not Lisa))

Furthermore, consider the sentences (6-51a) and (6-52a).

(6-51) a. John loves Mary, Jane, Sue, and Nancy.
        b. loves(John, and((Mary, Jane, Sue), Nancy))
        c.*loves (John, and (Mary, Jane, Sue, Nancy) )
(6-52)  
a. John loves Mary, and Jane, and Sue, and Nancy,  
b. loves(John,and(Mary,Jane,Sue,Nancy))

There appears to be some difference in the meaning of the two sentences ((6-52) implies that the speaker feels that John loves great many girls, which is not the case with (6-51)) and we would not want the possibility to represent it eliminated from the semantic representation. That is, (6-51c) is definitely the wrong representation for (6-51a), if (6-52a) differs in meaning from (6-51a) as appears to be the case.

Given this assumption on conjunction representation, the semantic marker of (6-53a) is as shown in (6-53b).

(6-53)  
a. We have juice, tea and coffee, and soda. 
b. have (we, and ((juice, and (tea, coffee)), soda))

Consider now the sentence (6-54a). It is ambiguous, as the two readings in (6-54b) show.

(6-54)  
a. John and Peter have taken a course in linguistics,  
b. 1. John has taken one course in linguistics and Peter another one.  
   2. John and Peter have taken the same course in linguistics.

The ambiguity is the same as for quantifiers discussed above. That is, in (6-54b1), John and Peter act individually, in (6-54b2), collectively.
One of the implications of \( \text{and}(x,y) \), then, is \( x \) and \( y \) act individually, and another one \( x \) and \( y \) act collectively. Allwood et al. (1977), p. 35, Gleitman (1965), p. 87, Lakoff and Peters (1966), p. 115, and Smith (1969), p. 75, all observe this fact. Smith actually says that one of the readings ‘interprets the compound subject (or object) as a unit; [the other one] interprets it as a conjunction of separate entities.’ (p. 75) This coincides with the analysis of quantifiers of the ambiguous type proposed in section 6.3.

Let us return now to the implication of conjoined elements given above, repeated as (6-55).

\[
(6-55) \quad \text{and}(x,y) \ ; \ 1. \ X \ \text{and} \ y \ \text{act individually.} \\
2. \ X \ \text{and} \ y \ \text{act collectively.} \\
\text{Where and is within an argument.}
\]

The interesting thing about this entry is that here \( \text{and} \) appears both in the proposition and in its implication. Now, even for an approach to meaning representation such as the knowledge-based theory, this is disturbing since the recursive relationship appears in the entry itself and all implications generated by the logical component will have the recursive property.\(^9\) It is true that there are ways of rephrasing this implication. The second one, for instance,

\[^9\text{This is not true of the recursive relationship involving double negation mentioned in chapter five.}\]
could be rephrased as \(X\) acts together with \(y\). I am not sure about this, but it is very likely that the implication of together will eventually refer to and. If this is so, then the only way out of the dilemma would be to posit that and (or some other lexical unit it would imply) is a semantic primitive, part of the logical component, which is necessary for interpretation. (The same may be true of other conjunctions as well as other words; see below.) I do not claim that the evidence I have brought forth is conclusive, but it is possible that the phenomenon of circularity—a proposition which eventually implies itself—may be used as a criterion for identifying semantic primitives.

The fact that the implications of and in (6-55) are the same as for ambiguous quantifiers might mean that ambiguous quantifiers are interpreted in terms of and. For instance, the implicational clause of three \(x\)’s might be \(X\) and \(x\) and \(x\). If this is so, then, for quantifiers such as many or few, the number of and’s is not precisely defined, as for numerals, but merely as larger or smaller than some other number. It is not clear, however, if such quantifiers as every and some could be interpreted the same way. Representing large numbers under this scheme, naturally, would also present a problem.

The entry in (6-55) will serve for interpreting such sentences as (6-46) but not (6-47). That is, it serves for interpreting conjoined noun phrases, not verbs. For verbs the entry in (6-56) with a null implicational clause should be used.
I do not seem to be able to come up with an implication of two verbs being conjoined, but there could conceivably be one. If none exists, it is possible that such syntactic construction does not occur; that is, that the semantic representation is incorrect. This would mean that every entry in the knowledge base must have a meaning. I do not know if this is true. But, if it is, then this could be a criterion for deciding on the form of semantic markers. {The fact that the complementizer that in verb-phrase complements does not seem to introduce any meaning appears to indicate that entries without implicational clauses may exist in the knowledge base, however.)

The above examples were instances of phrasal conjunction. Let us look now at sentence conjunction. Consider the sentence (6-57a). According to the convention followed above, its semantic representation is as in (6-57b).

(6-57)  a. John loves Mary, and Peter loves Susan.
         b. and (loves (John,Mary),loves (Peter,Susan))

The sentence will not be interpreted with the entry in (6-55) but, rather, the one in (6-56). This implies that, semantically, sentence conjunction is identical with verb
conjunction. If this is so, it might have some value for syntactic theory. For instance, it might imply that, contrary to my assumption, verb conjunction is, in fact, sentence conjunction to which a deletion transformation has applied, as has been posited in some syntactic theories. But there are too many unclear issues here for one to reach a firm conclusion.

Actually, there is another possibility as to how to represent the semantic structure of (6-57a), namely as in (6-57c).

(6-57) c. and (loves ((John,Mary,(Peter,Susan))))

This would be in tune with the representations in which the second occurrence of a noun phrase is eliminated in the semantic representation, as, for instance, in (6-13). This is a possibility, and I am not ruling it out. But, notice that in all the examples of eliminating the second representation of a noun phrase in semantic phrase markers, there was only one lexical realization of the noun phrase in the surface structure. This might imply that semantic representations should represent all lexical matter in surface structures and not to introduce additional lexical matter. The issue is unclear, and I am not ruling out (6-57c) as a possibility but, tentatively, I lean toward the representation in (6-57b).
In (6-57a), the conjunction *and* was a coordinating conjunction, the same as in the examples of phrasal conjunction. The examples (6-58a) – (6-61a) are instances of sentences with subordinating conductions — *if, unless* and *although*. The semantic representations or the sentences are given in the b versions.

(6-58) a. John will marry Clary if she loves him.
    b. if (will (marry) (John,Mary),loves (Mary,John))

(6-59) a. John will not marry Mary, unless she loves him.
    b. unless(not (will (marry))) (John,Mary),loves (Mary,John))

(6-60) a. Unless Mary loves John, he will not marry her.
    b. unless (not (will (marry))) (John,Mary),loves (Mary,John))

(6-61) a. Although Sue loves John, he will not marry her.
    b. although (not (will (marry))) (John,Sue),loves (Sue,John))

Following Emonds (1976), pp. 58, 172-8, I assume that, in these constructions, the subordinate clause is introduced as a prepositional phrase, with the conjunction as the preposition and an S in place of an NP. This means that the conjunction is represented as the predicate with the two sentences as its arguments — the main clause as the first, and the subordinate clause as the second. These structures are, again, derived from the deep structures of the sentences. It is because of this that the representations for (6-59a) and (6-60a) are the same. Notice that (6-61b) has the same bracketing structure as for the preceding two sentences. This is so again because, in deep structure, the subordinate clause follows the main one.
The entries in the knowledge base underlying the interpretation of the above sentences are shown in (6-62).

(6-62)  a. if \((x,y)\); X takes place if \(y\) is true.
       b. unless\((x,y)\); X takes place if \(y\) is false.
       c. although \((x,y)\); Contrary to expectation, \(y\) takes
           place if \(x\) is true.

The entry for \textit{if}, as was the case with \textit{and}, suggests that the word may be a semantic primitive. As can be seen, \textit{unless} and \textit{although} seem to be interpretable in terms of \textit{if}.

Notice that, even though the syntactic structure of these examples is different from that of the example of conjoined sentences in (6-57a), semantically, the role of the conjunctions is the same – they are predicates. The difference, however, between the two constructions is that, in the entry for the coordinating conjunction \textit{and}, (6-56), the order of the variables (even if the entry did have an implicational clause) is immaterial, whereas in the entries for the subordinating conjunctions, (6-62), the order of the variables is important. Thus, the semantic representation shows the similarities and differences between the two types of constructions.
6.5 NONDECLARATIVES

So far, all of the examples I have dealt with were of the declarative syntactic type. In this section, I will investigate how nondeclaratives might be handled under the knowledge-based theory.

Consider the sentences (6-63a) – (6-65a).

(6-63) a. John loves Mary.
(6-64) a. Does John love Mary?
(6-65) a. John, love Mary!

Clearly, the semantic markers of the three sentences must be different. Yet there must be some similarities between the three semantic markers. — After all, the three sentences contain the words John, Mary, and love. Moreover, the same relationship of love is being expressed in the three sentences between the same two persons, John and Mary, even if different things are being said about the relationship. — In the first sentence it is (supposedly) a fact; in the second one, the fact is being questioned; in the third it is ordered to take place. But, if we replace John in the three sentences by Peter, we would expect their meanings and, therefore, semantic markers to change in exactly the same way. — The relationship of love would now be expressed in the three sentences between Peter and Mary, rather than John and Mary. Further, if John and Mary were replaced by the
rich old man and the beautiful young girl, respectively, then the meaning of the three sentences would be changed by the meanings of the two noun phrases—It seems intuitively correct to say that the meaning of a noun phrase does not depend on whether it occurs in a declarative sentence (statement), a question, or a command. And, finally, if we replace love in the three sentences by hate, again, we would expect their meanings and semantic markers to change in exactly the same way.—The relationship between the two persons expressed in the three sentences would now be hate rather than love.

Now, the method of representing the semantic structure of (6-63a) has already been established.—It is as shown in (6-63b).

(6-63) b. loves (John, Mary)

This representation conveys both the nature of the persons and the nature of the relationship between them.

We could, then, modify this representation by adding to it an indication that the sentence it represents is a statement, as in (6-63b'), where . stands for ‘statement.’

(6-63) b'. . (loves (John, Mary))
The sentences (6-6ia) and (6-65a) could then be represented as in (6-64b) and (6-65b), ? and ! standing for ‘question’ and ‘command.’

(6-64) b. ?(love(John, Mary))
(6-65) b. !(love(John, Mary))

(These two representations differ from the one for the declarative sentence in the form of the verb. Remember, however, that, in the full representation, the verb will be represented as a proposition whose predicate is the tense and the argument love. So, the proposition love(John, Mary) will appear in the three representations. See 6.6)

Now, changing John, Mary and love in the three sentences will produce exactly the same changes without impacting the information as to the type of sentence. I will adopt this method of representation, then, with the exception that, for declaratives, I will not use the (6-63b’) notation but, rather, the original one in (6-63b). In other words, a proposition is considered representing the declarative form of a sentence unless having the predicates ? and ! in which case the sentence is a question or a command, respectively. This fact is reflected in the implicational clause for predicates such as loves. That is, the implicational clause for loves(x,y) consists of all the
implications for the declarative sentence X loves y. The implicational clauses for ? and ! then, are as in (6-66).

(6-66) a. ?(x(y,z)); The sentence asks whether y x z....
b. !(x(y,z)); The sentence commands y to x z....

I have indicated by ... that the two implicational clauses should be extended to whatever a question and command may imply, which, presumably, can be done. I say 'presumably' because the tasks is not an obvious one; one reason being that, as is well known (Kempson (1977), pp. 61-2), questions are not always requests for information, commands are not always requests for action, and declarative sentences are not always statements of fact. I will return to the problem of specifying implicational clauses for nondeclaratives below.

Let us return now to the representation of nondeclaratives. — Where should the information come from that the predicate ? should be placed in the representation of a question and ! in that of a command? — Under the revised extended standard theory, as was said in 5.3.1, the information should be derived from the surface structure. That is, in (6-64a), the semantic-marker structuring component must deduce from the fact that the auxiliary does precedes the noun phrase John that the sentence is a question. In (6-65a), it must deduce the fact that the
sentence is a command from the tense in the auxiliary being null. (This is true also of the deep structure.) This is the origin of the ? and ! predicates. The rest of the information, that is, love(John,Mary). is derived from the deep structure.

Consider now the sentence (5-8a), which is repeated below as (6-67a).

(6-67) a. Who does John love?
   b. ?(love (John, who))

Under the proposed scheme, its semantic marker is (6-67b). The sentence will be interpreted with the aid of the entry (6-68a). Who loves John? will be interpreted with the aid of the entry (6-68b). The fact that these sentences are questions will be derived from their COMP nodes being filled with who.

(6-68) a. ?(x(y,who)); The sentence asks for the identity of the person whom y x.
   b. ?(x(who,y)); The sentence asks for the identity of the person who x y.

Notice, first, that the fact that who is fronted in (6-67a) does not influence the structure of the proposition whose predicate is love, since it is derived from deep structure. Second, notice that, under this scheme, the echo
question *John loves who?* will receive a different representation than (6-67a), namely *loves (John, who)*, which, I think, is right, since the two questions carry different implications.

Let us look now at the sentence (6-69a).

(6-69) a. Peter asked whether John loves Mary.

Embedded clauses such as in (6-69a) are considered to be indirect questions (Baker (1970b)). Assuming, after Bresnan (1970), that the subordinate clause acts as the complement of the verb *ask*, with *whether* as the complementizer, the semantic structure of the sentence is (6-69b); that is, it has the same structure as that of (6-12a), or *John said that Mary loves Peter*.

(6-69) b. asked (Peter,whether (loves (John,Mary)))

Now, the question arises if an explicit *?* should appear in the semantic marker of (6-69a). I don't feel it should since *?* is implied in *whether*, which always introduces embedded questions and which can never occur in a direct question (Baker (1970b), p. 202). So, it is the entry in (6-70) which insures that the inner proposition in (6-69b) will be interpreted as a question.

(6-70) whether (x,(y,z)); The sentence asks whether y x z....
Under this approach, indirect questions are interpreted with a knowledge-base entry identical to the one used for direct questions except that the predicate *whether* is used instead of ?. I think this is right, since this shows the similarity between the two types of questions as well as the difference. Thus, the approach of treating complementizers such as *that* and *for* as predicates having for their arguments the embedded clauses, as in examples (6-12), (6-17), and (6-20), receives support from the proposed analysis of nondeclaratives. This is so because, in this representation, *whether*, being a complementizer, will dominate in the semantic phrase marker only the embedded sentence and indicate that only this sentence constitutes a question.

But notice that, as was the case with some of the conjunctions, *whether* appears in its own implicational clause. I think that the implication could be rephrased, so that the actual word *whether* is not used, for instance as in *The question asked is: x y z*, but, I don't believe we can avoid referring to the concept of question in the implication. This implies, then, if my suspicion about circularity in the relationship between a proposition and its implicational clause is correct, that the concept of a question is a semantic primitive. The same appears to be true of the concept of a command. — Notice that the implication in (6-66b) contains the word *command*, which ultimately must imply the concept of command.
This is corroborated by such sentences as (6-7 la), which, by analogy with indirect questions, may be said to contain indirect commands.

(6-71) a. Peter told John to love Mary.
     b. told(Peter, to (love) (John, Mary))

Here, it is in told that the command predicate resides, and the sentence is interpreted with the aid of the knowledge-base entry in (6-72).

(6-72) told(o,p, (q,r)); O commanded q to p r.

(The sentence Peter told John that Mary loves Bill would be interpreted with a different entry, in which told does not imply command. The proposition part of this entry would be told(o,p,that(q(r,s))).) So, there appears to be some indication that the concept of question and command (and, by the same token, of statement) are semantic primitives. The same is suggested by Kempson (1975), p. 46. See below.

The method of representing and interpreting nondeclaratives such as questions and commands is capable of handling other types of nondeclaratives, such as exclamations, hortatives, and so forth. (For these, special predicates must be defined.) This method is also capable of handling without any new mechanism sentences containing
modals which, although syntactically having the form of declaratives, semantically are nonassertive (not statements), for instance, *It may rain tomorrow*, *It is possible that it will rain tomorrow*, *John must marry Mary*, *If John loves Mary, then he will marry her*. (The method of representing the semantic structure of this last type of sentence was discussed above, but not the way its modality might be interpreted.) In all such cases, it is the implicational clause of the modal word, or words, that insures the correct, nonassertive interpretation of the sentence.

The idea that interpretation of nondeclaratives should have as its basis that of declaratives is widespread. Partee (1975a), for instance, says: ‘it seems clear that any theory of interrogatives, imperatives, performatives, and whatever else is nonassertive will require an analysis of ordinary declaratives as a foundation.’ (p. 209) This is the approach taken in those logical systems which have been extended to handle nondeclaratives.

Hiz (1978), for instance, summarizing the work of Ajdukiewicz, indicates that the sentence *Who is reading a book?* might be represented informally as *For what x, x is reading a book*, and formally (‘symbolically’) as (?x)[x is reading a book] (pp. IX-X). The sentence *Is Jean reading a book?* may be represented formally as(?(x)[x (Jean is reading a book)] (p. XI).
Reichenbach (1947) proposes \((\forall x)f(x)\) as the representation for \(wh\) questions and \(\exists p\) as that for yes/no questions. An imperative sentence would be represented as \(!p\) and a modal such as \(I\ wish\ that\ you\ would\ go\ out\) as \(w\ (I,p)\) (pp. 340-2).

Lewis (1972) considers two possible ways of representing nondeclaratives. The first one is

‘to analyze all sentences, declaratives and non-declaratives, into two components: a sentence radical that specifies a state of affairs and a modal that determines whether the speaker is declaring that the state of affairs holds, commanding that it hold, asking whether it holds, or not.’ (pp. 205-6)

Lewis points out that the sentence radical is not the declarative sentence – it would have the surface realization of a that clause (p. 206). But it is the sentence radical that has truth values and not the combination of mood and sentence radical. The second method Lewis proposes is to represent questions and commands by performative sentences, that is, by having in the semantic representation the subject \(I\), indirect object \(you\), and the verb \(ask\), followed by \(whether\) or \(command\). Lewis then considers performatives to be declaratives (pp. 207-8).

Kempson (1975), pp. 41-6, discusses the problem of nondeclaratives in connection with the truth-based semantics which she adopts. The apparent limitations of truth-based semantics is that it seems to be incapable of handling
performative sentences such as *I warn you*... *I order you*... and so forth, and nondeclaratives. This is so because, in truth-based semantics, the meaning of a sentence is defined by the conditions under which it is true, which, according to the normal interpretation of the concept ‘condition’ can apply only to statements. Kempson considers various ways out of the truth-conditional approach dilemma and settles on the following one. — Under the theory, there are three semantic primitives: one for assertions, one for questions, and one for imperatives. Questions and commands are defined with the aid of the proper primitives, as well as sentences containing *ask* and *order*. The meaning of questions and imperatives are defined in terms of propositions underlying them which then are prefixed by the proper semantic primitive.

Kempson's approach is an attempt to integrate logical theory of truth-based semantics with linguistics. Below, are two of the more prominent linguistic theories dealing with nondeclaratives.

Boss (1970) and Lakoff (1972), pp. 550-69, adopt the performative approach discussed above in connection with Lewis. Boss's article deals with declaratives. He says:

‘declarative sentences [...] must be analyzed as being implicit performatives and must be derived from deep structures containing an explicitly represented performative main verb.’ (p. 223)
Lakoff says: ‘The illocutionary force of a sentence is to be represented in logical form by the presence of a performative verb.’ (p. 560) The logical form of a sentence, then, for Lakoff, is a predicate consisting of the performative verbs order, ask and state or say, followed by I, you. and the deep structure of the sentence, the three acting as arguments of the predicate which is the main performative verb (p. 560).

A totally different position is that of Jackendoff (1972), which was discussed in 3.4. As was said, Jackendoff analyzes questions in terms of his modal structure, using wh as the modal operator (p. 314). He suggests that it will be the scope of wh obtained from the surface structure which will determine which part of the sentence is questioned (p. 316). He concludes that, since questions are capable of being handled in terms of modal structure, it is likely that the same can be said of other nondeclaratives (p. 318).

As can be seen, all of the proposals for handling nondeclaratives are similar to the knowledge-base approach in that they all rely on the declarative equivalent of the sentence as part of the representation. But, the knowledge-base approach is the closest to that proposed by Kempson. That is, the knowledge-base approach is identical to Kempson’s except that, instead of defining the meaning in terms of truth conditions, as Kempson does, the implicational-clause generating mechanism is used to produce
the implications. Also, whereas Kempson leaves the semantic primitives representing questions and commands unanalyzed, under the knowledge-based approach, it is possible, as was said above, that some overt implications may be derived from the nondeclarative predicates. — For instance, a question implies a request for information, and a request for information implies that one should provide the information, and so forth.

The systems proposed by Ajdukiewicz (it is this system that Chomsky follows in his logical form) and Reichenbach appear essentially adequate for representing the semantic structure of sentences but, they provide no indication what role the representation plays in interpretation. The same is true of the sentence-radical approach discussed by Lewis. But, the representation itself is very similar to that of Kempson and the knowledge-base approach.

The performative approach adopted by Lewis, Ross, and Lakoff seems obviously incorrect. Under it, apparently, the sentence pairs John loves Mary/I say to you that John loves Mary, Does John love Mary?/I ask you whether John loves Mary? and John, love Mary!/I order John to love Mary will receive the same representations. Now, the sentences in each pair have obviously different implications, and an approach that is incapable of distinguishing between them cannot be considered a valid alternative. Kempson (1975), p. 42, makes the same criticism of the performative approach.
Jackendoff's proposal to handle nondeclaratives as part of his modal structure appears reasonable except it is not fully developed. — His handling of questions is limited to the wh type and he provides no analysis of commands. I will discuss Jackendoff's multi-level semantic representation in some detail in chapter seven.

6.6 Translation Rules

In the above examples, I have used the predicate-logic notation for representing semantic phrase markers. Another way of representing them would be using the labeled-bracketing or phrase-marker tree notations. Thus, the semantic structure of the sentence (6-4a) may be expressed in the predicate-logic notation as (6-4b), in the labeled-bracketing notation as in (6-4c), and in the phrase-marker tree notation as in (6-4d).

(6-4)  a. The man loves the girl madly.
       b. madly(loves)(the(man),the(girl))
       c. \[PP [PD [PD madly][AR loves]]][AR [AR [PP [PD the][AR man]]]
          [AR [PP [PD the][AR girl]]]]
d.

```
PP
  |
  |
PP
  |
  |
PP
  |
  |
](PD AR)
    |
  |
](PD AR)
    |
  |
madly
loves
  |
  |
](PP PP)
    |
  |
](PP PP)
    |
  |
](PD AR PD AR)
    |
  |
the man
the girl
```

Where PP — Proposition
PD — Predicate
AR — Argument

Although the predicate-logic notation has been adequate for all the needs we have had so far, the other two notations are better suited for the purposes of representing the rules (translation rules) that map the surface structure onto the input semantic marker. This is particularly true of the labeled-bracketing notation, which is generally used for describing transformations. I will, therefore, use this notation for stating the translation rules.

Since both the surface structure (syntactic phrase marker) and the input semantic marker can be represented as phrase-marker trees, the translation rules may be looked at as rewrite rules. Following, are the translation rules which can be formulated on the basis of the examples discussed in
this chapter. It seems convenient to subdivide them into three major categories:

1. Argument-formation rules
2. Predicate-formation rules
3. Preposition-formation rules

Except where explicitly defined, the symbols used in the rules are those normally employed in syntax.

PP, PD, AR are as defined above
X, Y, Z stand for variables (may be null)
() enclose optional constituents
... represents optional repetition of the preceding constituent; for instance, ADJ... stands for ADJ ADJ...

Argument-Formation Rules

(AR-1) N NUMBER →
[AR [PP [PD NUMBER][AR N]]]

NUMBER — Singular, Plural

(AR-2) [N V ING] →
[AR [PP [PD ING][AR V]]]

ING — -ing

(AR-3) [NP AR] →
AR
(AR-4) \[ (NP \times PP) \rightarrow (NP \times [\text{AR} \ PP]) \]

(AR-5) \[ (S \ [NP \ AR_1 \ [s' \ [\text{COMP} \ AR_1^2] \ [PP \ PD \ [AR \ AR_1^1 \ (AR^2)]]])] \rightarrow (S \ [NP \ [AR \ PP \ PD \ [AR \ AR_1^1 \ (AR^2)]]]) \]

(AR-6) \[ (NP \times AR[\text{s'} \ PD \ PP]) \rightarrow (NP \times [\text{AR} \ PP \ PD \ [AR \ [\text{PD} \ AR \ PP]])]) \]

(AR-7) \[ (NP \times AR^1 \ \text{CONJ} \ AR^2) \rightarrow (NP \times [\text{AR} \ [\text{PD} \ \text{CONJ} \ [AR \ AR_1^1 \ AR^2]])] \]

\text{CONJ}— \text{and, but, etc.} \]

(AR-8) \[ (NP \times AR^1 \ AR \ [PP \ [PD \ \text{CONJ} \ AR_1^1 \ AR^2 \ AR_3]])] \rightarrow (NP \times [AR \ [PP \ [PD \ \text{CONJ} \ AR_1^1 \ AR^2 \ AR_3]])] \]

(AR-9) \[ (NP \times AR^1 \ and \ [AR \ [PP \ [PD \ and] \ [AR \ AR_1^2 \ AR^3]])] \rightarrow (NP \times [AR \ [PP \ [PD \ and] \ [AR \ AR_1^2 \ AR^3]])] \]

\text{Predicate-Formation Rules} \]

(PD-1) \[ [\text{AUX} \times TNS][VP \ Y \ V \ Z] \rightarrow [\text{AUX} \times [VP \ Y \ [PD \ [PP \ [PD \ TNS][AR \ V]]] Z]] \]

\text{TNS}— \text{Present, Past, Future(=will), Infinitive, ING, Imperative (=0)} \]

(PD-2) \[ [\text{AUX} \times DO] \ (not) \ [VP \ Y \ V \ Z] \rightarrow [\text{AUX} \times [VP \ Y \ [PD \ [PP \ [PD \ DO \ (not)] \ [AR \ V]]] Z]] \]

\text{DO}— \text{do, does, did} \]

(PD-3) \[ [\text{AUX} \times DO] \ AR \ [VP \ Y \ V \ Z] \rightarrow [\text{AUX} \times AR \ [VP \ Y \ [PD \ [PP \ [PD \ ?]\ [AR \ V]]] Z]] \]

(PD-4) \[ [s' \ [\text{COMP} \ AR \ who]] \ [PP \ PD \ AR]] \rightarrow [PP \ [PD \ [PP \ [PD \ ?]\ [AR \ PD]] AR]] \]

(PD-5) \[ [V \ V_1 \ and \ V_2] \rightarrow [V \times [PP \ [PD \ and] \ [AR \ V_1 \ V_2 \ V_3]]] \]

(PD-6) \[ [V \times V_1 \ PP \ [PD \ and] \ [AR \ V_1 \ V_2 \ V_3]]] \rightarrow [V \times [PP \ [PD \ and] \ [AR \ [AR \ V_1 \ V_2 ] V_3]]] \]

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(PD-7)  DET →
       [PD DET]

       DET = the, a

(PD-8)  [DET AR POSS] →
       [PD [PP [PD POSS] AR]]

       POSS = ‘s, -s'

(PD-9)  ADJ... →
       [PD ADJ...]

(PD-10) Q... →
       [PD Q...]

       Q = quantifier

(PD-11) ADV... →
       [PD ADV...]

(PD-12) [COMP COMP] →
       [PD COMP]

       COMP = complementizer (node label);
            - that, for, 0, whether, etc. (lexical matter)

(PD-13)  [NP X PD[^1 AR [PP PD[^2] AR]]] →

(PD-14)  [PRP PR X] →
       [PD PR] X

       PRP = prepositional phrase
       PR = preposition

(PD-15)  [NP X not [AR [PP PD AR]]] →
       [NP X [AR [PP [PD [PP not ]AR PD]] AR]]]

(PD-16)  [VP PD (AR)] →
       PD (AR)

(PD-17)  [VP X PD[^1 (AR[^1]) (PD[^2]) (AR[^2]) (PD[^3]) (AR[^3]) ] →
(AR^1) (AR^2) (AR^3)]

(PD-18) [VP X_s' (PD) PP] →
[VP X_{AR} [PP (PD) [AR PP]]]]

Proposition-Formation Rules

(PP-1) AR^1 (AUX) PD (AR^2) →
(AUX) [PP PD_{AR} AR^1 (AR^2)]]

(PP-2) [NP X (AR^1) PD AR^2] →
[NP X_{PP} PD_{AR} (AR^1) AR^2]]

(PP-3) [s (AUX^1) PP^1 (PD^1) (AUX^2) [PP^2]] →
(AUX^1) (AUX^2) [PP (PD) [AR [AR PP^1] [AR (PP^2)]]]

(PP-4) [s (AUX^1) PP^1 CONJ (AUX^2) PP^2] →
(AUX^1) (AUX^2) [PP [PD CONJ] [AR [AR PP^1] [AR PP^2]]]

(PP-5) [s (AUX) [PP [PD [PD ?] AR^1]] AR^2]] →
(AUX) [PP [PD ?] [AR [PD AR^1]] AR^2]]

(PP-6) [s (AUX) [PP [PD [PD !] AR^1]] AR^2]] →
(AUX) [PP [PD !] [AR [PD AR^1]] AR^2]]

(PP-7) [s AR^1 (AUX^1) [VP PD^1 [s' (AUX^2) [PP PD^2 [AR (AR^2)]]]]] →
(AUX^1) (AUX^2) [PP PD^1 [PP PD^2 [AR AR^1 (AR^2)]]]

(PP-8) [AR PP] → (Optional) PP

In addition, the following conventions, analogous to the 'pruning' conventions in syntax, are used in generating the input semantic marker.

Conventions

(C-1) [xx 0] →
0
XX−AUX, PP, PD, AR
0−null

(C-2) [AR [AR X]] →
The filter (F-1) can be used for sentences with ADX residue.

Filter

(F-1)  #AUX... PP → 
  * 
    #  - space(begning of sentence)
    ADX not null

The translation rules are all obligatory, except for (PP-8), which can be used for interpreting nonsentences, for instance noun phrases. The rules are (extrinsically) unordered, but apply cyclically, as do the rules of syntax, starting with the most deeply embedded constituents and moving up the syntactic phrase marker. I will now go through the more interesting examples to show how the rules operate to generate the semantic representations. I will list the examples with their semantic representations and then describe the operation of the rules.

(6-1)  a. the old man
       b. (the,old) (man)
       b'. (the,old,Singular) (man)
The actual semantic representation of (6-1a) is (6-1b'), with the number Singular acting as a predicate.

(AR-1) produces the proposition (Singular) (man). (PD-9) labels old a predicate. (PD-7) labels the a predicate. (PD-13) produces the proposition (old, Singular) (man). (PD-13) produces the proposition (the, old, Singular) (man). (AR-3) erases the NP brackets. (PP-8) applies to permit the phrase to be interpreted, since, otherwise, only sentences can be interpreted.

From here on, I will continue using the simpler representation, disregarding numbers for nouns and, whenever possible, tenses for verbs.

(6-4) a. The man loves the girl madly.
   b. madly (loves) (the (man), the (girl))

After the initial argument-formation and predicate-formation rules, (PD-17) applies, producing the complex predicate madly (loves). (PD-16) applies, erasing the VP brackets. What is left is the argument the (man), followed by the predicate madly (loves), followed by the argument the (girl). (PP-1) applies, followed by (PP-3), which produces the final proposition.

I will mention only the more interesting rules from now on.

(6-6) a. The book on the table burned.
b. burned(on(the(book),the(table)))

(PD-14) applies, to create a predicate out of on, erasing the PRP brackets. (PP-2) applies to the three elements in the subject noun phrase — the argument the book, the predicate on, and the argument the(table), forming the proposition on(the(book),the(table)). Then, (AR-4), (AR-3), (PP-1), and (PP-3) apply, forming the final proposition.

(6-7) a. The book is on the table.
b. on(is)(the(book),the(table))

(PD-14) applies, to label on a predicate and erasing the PRP brackets. (PD-17) applies, with AR1 being null, to produce the predicate on(is) and the argument the (table). (PD-16) erases the VP brackets. (PP-1) and (PP-3) produce the final proposition.

(6-10) a. The man who came stayed,
b. stayed(came (the (man)))

(PP-1) and (PP-3) produce the proposition came (the (man)), representing the embedded clause in the subject noun phrase. (AR-5) applies on the subject noun phrase, erasing one occurrence of the (man). (PP-1) and (PP-3) eventually produce the final proposition.

(6-12) a. John said that Mary loves Peter.
b. said(John,that (loves(Mary,Peter)))
(PP-1) and (PP-3) produce the proposition \( \text{loves}(\text{Mary}, \text{Peter}) \), representing the embedded clause in the verb phrase. (PD-12) labels the complementizer that a predicate. (PD-18) then applies, producing the proposition that \( \text{loves}(\text{Mary}, \text{Peter}) \). (PD-16), with \textit{said} being the predicate, (PP-1), and (PP-3) produce the final proposition.

(6-13) a. John wants to sing.
    b. wants (to sing(John))

(PP-1) and (PP-3) produce the proposition to \( \text{sing}(\text{John}) \), representing the embedded clause in the verb phrase. (PP-7) eventually erases the first occurrence of the argument \textit{John}, producing the final proposition.

(6-15) a. John wants Mary to sing.
    b. wants (John, to sing (Mary))

(PP-1), (PP-3), and (PD-18), with null complementizer, apply as in (6-12). (PD-16) then applies, erasing the VP brackets. (PP-1) and (PP-3) produce the final proposition.

(6-18) a. John likes Mary's singing.
    b. likes (John, Poss (Mary) (Ing(sing)))

(AR-2) produces the argument \( \text{Ing}(\text{sing}) \). (PD-8) creates the predicate \( \text{Poss}(\text{Mary}) \), erasing the DET brackets. (PP-2) applies on the object noun phrase, producing the proposition \( \text{Poss}(\text{Mary}) (\text{Ing}(\text{sing})) \). (AR-4), (AP-3), (PD-16), (PP-1) and (PP-3) apply, producing the final preposition.
(6-19) a. John likes to hear Mary singing.
   b. likes (to hear (John, Ing (sing) (Mary)))

After (PP-1) and (PP-3) produce the proposition

\[ \text{Ing (sing) (Mary)} \]

representing the second-level embedded clause in the verb phrase, (PD-18) applies, with PD being null. The convention (C-4) performs the pruning on the resultant structure. (PD-16), (PP-1), (PP-3), and (C-3) apply, producing the proposition to hear (John, Ing (sing) (Mary)), representing the first-level embedded clause in the verb phrase. (PP-7) then applies, erasing one occurrence of John and producing the final proposition.

(6-20) a. John got the news that Mary graduated.
   b. got (John, that (the (news) (graduated (Mary))))

After (PP-1) and (PP-3) produce the proposition

\[ \text{graduated (Mary)} \]

representing the noun-complement embedded clause in the verb phrase, (AR-6) applies, producing the argument that (the (news) (graduated (Mary))). (PD-16), (PP-1), and (PP-3) then produce the final proposition.

(6-21) a. John hit the nail with a hammer.
   b. with (hit) (John, the (nail), a (hammer))

(PD-14) applies on the prepositional phrase, labeling with a predicate and erasing the PRP brackets. (PD-17) produces the
predicate with(hit) and the argument the(nail,a(hammer)). (PD-16), (PP-1), and (PP-3) produce the final proposition.

(6-12) a. Not many of the arrows hit the target.
   c. hit (not (many,of) (the (arrows),the (target)))

(PD-14) applies, labeling of a predicate and erasing the PRP brackets. (PP-2) produces the proposition of(the(arrows)). After (AR-4) and (AR-3) apply, (PD-13) produces the proposition (many,of)(the (arrows)). (PD-15) then applies, producing the proposition not (many,of) (the (arrows)). (As was said, I am assuming that not is a modifier of the noun phrase many of the arrows.) (AR-4), (AR-3), (PD-16), (PP-1), and (PP-3) produce the final proposition.

(6-43) a. Many of the arrows didn't hit the target.
   c. didn't(hit) ((many,of) (the (arrows),the(target)))

(PD-14), (PP-2), (AR-4), (AR-3), and (PD-13) apply as in (6-42). (PP-2), (AR-4), and (AR-3) convert the subject noun phrase into an argument. (PD-2) produces the predicate didn't (hit). (PD-16), (PP-1), and (PP-3) apply, producing the final proposition.

(6-46) a. John and Peter love Mary.
   b. love (and (John,Peter),Mary)

(AR-7) applies for the subject noun phrase, then (AR-3).

(6-47) a. John loves and supports Mary.
   b. and (loves,supports) (John,Mary)
(PD-5) applies for the verb, followed by (PD-1). I am assuming that the structure in the verb phrase is:

\[
[v \text{ and } V]
\]

(6-48) a. John loves Mary, Jane, and Sue.
    b. loves (John, and ((Mary, Jane), Sue))

For the object noun phrase, (AR-7) applies, followed by (AR-8), then by (AR-3).

(6-49) a. John loves, supports, and abets Mary.
    b. and ((loves, supports), abets) (John, Mary)

For the verbs, (PD-5) applies, followed by (PD-6) and (PD-1).

(6-50) a. John loves Mary, Jane, Sue, but not Lisa.
    b. loves (John, but ((Mary, Jane, Sue), not (Lisa)))

For the object noun phrase, (AR-7) applies, followed by (AR-8) twice, (C-5), then (AR-3).

(6-52) a. John loves Mary, and Jane, and Sue, and Nancy,
    b. loves (John, and (Mary, Jane, Sue, Nancy))

For the object noun phrase, (AR-7) applies, followed by (AR-9) twice, then (AR-3).

(6-53) a. We have juice, tea and coffee, and soda.
    b. have (we, and ((juice, and (tea, coffee), soda)))

(AR-7) applies, creating the argument and (tea, coffee).
(AR-7) applies again, creating the argument
and (and(tea,coffee),soda). (AR-8) applies, creating and ((juice,and (tea,coffee),soda)).

(6-57) a. John loves Mary, and Peter loves Susan.  
   b. and (loves(John,Mary),loves(Peter,Susan))

After (PP-1) and (PP-3) apply for the two conjoined sentences, (PP-4) applies, producing the final proposition.

(6-58) a. John will marry Mary if she loves him.  
   b. if (will (marry) (John,Mary),loves (Mary,John))

As was said, I am assuming that if is introduced as a conjunction dominating the subordinate clause. (PP-1) and (PP-3) apply twice to produce the propositions representing the two sentences. (PD-14) applies, labeling if a predicate and erasing the PRP brackets. (PP-3) applies then, with if being the predicate, producing the final proposition.

(6-64) a. Does John love Mary?  
   b. ? (love(John,Mary))

(PD-3) applies to produce the ? predicate. The final proposition is produced by (PP-5).

(6-65) a. John, love Mary!  
   b. ! (love (John, Mary))
It is (PD-1) that establishes that the sentence is of the imperative type by virtue of the tense being null. (C-2) erases the empty PD. The final proposition is produced by (PP-6).

(6-67) a. Who does John love?  
    b. ? (love (John, who))

(PD-3) applies to produce the ? predicate. Since the COMP node is filled with who, (PD-4) applies to produce a second ? predicate. One of these is eliminated by the convention (C-6). The final proposition is produced by (PP-5).

(6-69) a. Peter asked whether John loves Mary.  
    b. asked (Peter, whether (loves (John, Mary)))

As was said, whether is assumed to introduce a verb-complement subordinate clause. (PP-1) and (PP-3) apply on the main and subordinate clause to produce the two propositions. (PD-12) applies, labeling whether a predicate and erasing the COMP brackets. (PD-18) then applies, followed by (PD-16), with ask being PD, which erases the VP brackets. (PP-1) and (PP-3) apply next, producing the final proposition.

(6-71) a. Peter told John to love Mary.  
    b. told (Peter, to love (John, Mary)}
The sequence of rules is the same as for (6-69) except that here COMP is null for (PD-12) and (PD-18), so that (C-4) applies.

In some of the examples of knowledge-base entries, it was necessary to state a restriction as to whether or not the entry occurred within an argument, as for instance in examples (6-37d), (6-38d), (6-55), and (6-56). Since the entries were represented in the predicate-logic notation, it was necessary to specify the restrictions separately. With the labeled bracketing notation, the restrictions could be stated directly in the entries. The four entries, then, could be represented as the primed versions below.

(6-37) d’. [\[PP [PD [PD each]AR\]] [AR x]]; X acts individually.

(6-38) d’. [\[AR [PP [PD each]] [AR x]]]; X acts collectively.

(6-55’) [\[AR [PP [PD and] [AR [AR x] [AR y]]]]]; 1. X acts individually.
   2. X acts collectively.

(6-65’) [\[PP [PD and] [AR [AR [PP x]] [AR [PP y]]]]];

Now, only the proper input strings with each and and will match on each of the entries, insuring the correct interpretation. Bear in mind, however, that, in general, it is possible for an input string to match on more than one
knowledge-base entry. When this happens, it means that the string is ambiguous. Those idiomatic phrases which also have a nonidiomatic meaning are examples of such strings. For instance, the sentence John kicked the bucket, mentioned earlier, is ambiguous, meaning that John kicked an object which was a bucket and that John died. This is accounted for by the semantic marker underlying the sentence matching on the generic entry kicked \((x,y)\) and the specific \(\text{the(bucket)}\) on the one hand, and the partly specific entry kicked\((x,\text{the (bucket)}1\) on the other. For this input sentence, then, the logical component will generate two implicational clauses, resulting from the two sets of matches.

**6.7 MEANING ACQUISITION AND EXTENSION**

Consider (6-73), which is a slightly modified version of (5-20).

(6-73)  
\begin{align*}  
a. \text{Kutya is good.} \\
b. \text{Kutya is food.} \\
c. \text{Kutya is a Ukrainian dish.} \\
d. \text{Kutya is Ukrainian Christmas porridge made from wheat, poppy seeds, nuts, raisins, and honey.} \\
\end{align*}

The sentence (6-73a), as was said earlier, tells us very little about the word kutya. The sentence (6-73b) tells us a little more, (6-73c) still more, and (6-73d)
defines the word fairly accurately. Further specification as to how the ingredients are prepared and introduced into the dish would tell us even more, so that eventually we might be able to prepare it. Elaborating on what Christmas porridge means to Ukrainians would give us the symbolic importance of the dish, and so forth. Now, with each addition of information about the sentence, connotations are introduced. For instance, specifying that the dish is part of the Christmas tradition tells us that it is probably ancient, and so forth. The fact that it is a porridge tells us that it is not hard or completely liquid, and so forth. As can be seen, the building up of information is an adding up of implications, as is done during the process of implicational-clause generation. — When kutya is equated to food, through the proposition is (kutya, food), everything implied by food is implied by kutya. For instance, Kutya is edible. Kutya is digestible. Kutya is nourishing, and so forth.

Let us look now at (6-74a). Its trace of the mapping is (6-74b), ? indicating that the word kutya is unknown.

(6-74) a. Hrytsko ate the kutya.
b. ate (Hrytsko, the (?kutya))
c. 1. is (Hrytsko, a (man)); Men eat food through the mouth.
   2. ate (x, y); Y is probably food. Y is inside x.

(6-74c) shows two of the knowledge-base entries which
play a role in interpreting (6-74a). On the basis of these entries, we can infer that kutya is probably food, that it was eaten by a man orally, and that it is inside the man. This shows that it is not only the definitional types of sentences, such as in (6-73), that permit the ‘transfer’ of meaning from the known elements of a sentence to the unknown.

Let us look now at (6-75a), involving an unknown predicate. (6-75b) shows the trace of the mapping and (6-74c) contains part of the knowledge base needed for interpreting the sentence (represented in English).

(6-75) a. Hrytsko fulged his Christmas porridge.
    b. ?fulged(Hrytsko,his(Christmas (porridge)))
    c. 1. Porridge is a substance.
       2. A substance can be eaten.
       3. A substance can be vomited up.
       4. A substance can be thrown.
       5. A substance can be flushed down the toilet.
       6. A substance cannot be thought.

On the basis of this information (plus other, not given), again through the process of implication, it can be deduced that fulge can mean to eat, to vomit up, to throw, or to flush down the toilet, but not to think. In this case, the information provided seems much less than in the preceding example, when the unknown word was an argument. But I do not think that this is always true of unknown predicates. Consider, for instance. The cloud abced the
sun. Since a cloud can do only a few specific things to the sun, information conveyed by the sentence may be significant (for instance, obscured, cleared, passed, approached, and so forth, depending on the knowledge base).

The processes at play here are very similar, if not identical, to those in implicational-clause generation. That is, the basic process consists of copying of implicational clauses. So, for the sentence (6-73a) to be interpreted, the entry in (6-74c3) has to be created in the knowledge base. (I am assuming that the knowledge base contains the entries necessary for generating the second implication.)

(6-74) c. 3. Singular(kutya); Kutya is probably food. Kutya is inside the person who ate it.

The above examples showed the processes at play in meaning acquisition through language. Let us look now at meaning extension.

Consider the sentence (5-11a) and its trace of the mapping (5-11d), which are repeated below as (6-76a) and (6-76b). As was said earlier, the asterisks indicate that the predicate and arguments do not occur together in the knowledge base.

(6-76) a. The man ate the wine.
   b. *ate(the (man),the (*wine))
Assume that the knowledge base contains the entries in (6-77).

(6-77) a. \text{ate}(x, y); Y is solid.
b. \text{is}(x, \text{liquid}); X may be frozen.
c. \text{is}(x, \text{frozen}); X is solid.
d. the (wine); Wine is liquid.

On the basis of (6-77), it may be inferred that the vine in (6-76a) was frozen when the man consumed it. It can be seen that, if the connection between (6-77b) and (6-77c) is not made, then the sentence will not receive the above interpretation. Or, the same thing may happen if in (6-77a), instead of \textit{Y is solid}, the implicational clause contains \textit{Y is solid in its natural state}. If the interpretation that the wine was frozen is accepted, however, then it is possible that the implicational clause of (6-77a) will be updated to, say, \textit{Y is solid or frozen}, so that the next time the sentence may be interpreted more directly. In this sense, the modification of the knowledge base, although trivial, may be considered meaning extension.

Assume now that the knowledge base, instead of containing (6-77), contains the entries in (6-78).

(6-78) a. \text{ate}(x, y); Y is solid in its natural state.
b. \text{is}(x, \text{liquid}); X may be frozen.
c. \text{is}(x, \text{frozen}); X is solid.
d. the (wine); Wine is liquid.
In this case, no valid interpretation may take place because of the solid/liquid clash. Assume, however, that the hearer somehow finds out that the sentence (6-76a) means that the wine was frozen when the man consumed it. Now, in order to permit the sentence to have this interpretation, the knowledge base must be modified so that the clash is eliminated. This would have to be done in the implicational clause of (6-78a). — The new implicational clause then must be \( Y \) is solid, \( Y \) is solid in its natural state or frozen, or \( Y \) is solid or frozen. (Whether this modification is temporary or permanent is of no consequence since the processes followed and the changes in the knowledge base made would be the same. The modification would be temporary if the hearer made it just for the interpretation of the particular sentence, trying to understand the speaker in accordance with the Cooperative Principle. In this case, it would be establishing what the speaker's knowledge base is like. The modification would be permanent if the hearer used the modified entry for interpreting all future sentences containing ate. An explanation when such a modifications is temporary and when permanent should not be provided by a linguistic semantic theory but by a theory of performance. It should be observed here that the sentence (6-76a) might receive the interpretation that the man consumed the wine using a spoon, if the knowledge base warrants this.)
Consider now the other example of anomaly mentioned earlier, namely (5-12a) and its trace of the mapping (5-12b), repeated below as (6-79a) and (6-79b).

(6-79)  a. The wine drank the man.
    b. *drank(the(*wine),the (*man))

In this case, both of the arguments are marked as not occurring together with the predicate in the knowledge base. Assume that the knowledge base contains the entries in (6-80).

(6-80)  a. drank(x,y); X has a mouth. T is liquid. Y no longer exists.
    b. the (man); Man is not liquid.
    c. the (wine); Wine has no mouth.
    d. destroyed (x,y); Y no longer exists.

Assume also that the hearer imposes on (6-79a) the interpretation that the man destroyed himself by drinking (wine) or, rephrased, that wine (drinking) destroyed the man. The straightforward interpretation that wine consumed the man is not possible because of the clash between the implicational clauses of (6-80a), on the one hand, and (6-80b) and (6-80c) on the other. This is reflected in the words being marked with asterisks. If the interpretation is to be imposed, however, the clash must be disregarded. For the interpretation to take place, the logical component must go through the following steps:
1. Identify the similarity between the implicational clauses of (6-80a) and (6-80d), namely Y no longer exists.

2. Modify the implicational clause of (6-80a) by indicating in it, in a manner to be specified, that, if a clash occurs, then the implication is X destroyed Y.

This constitutes meaning extension amounting to metaphorical interpretation.

So, here again we see an instance of establishing identity between parts of implicational clauses as a way out of a clash between the input semantic marker and the knowledge base.

Let us look now at the examples (6-81) and (6-82).

(6-81)  
  a. The diamond sparkled.  
  b. sparkled(the(diamond))

(6-82)  
  a. The conversation sparkled.  
  b. sparkled(the(conversation))

Assume that (6-82a) is interpreted in a normal (nonmetaphorical) fashion. Some of the entries underlying the interpretation of the two sentences then must be as in (6-83).

(6-83)  
  a. the(diamond); A diamond is an object.  
  b. the (conversation); A conversation is not an object.
c. sparkled (x); 1. X is an object. X reflected light. X stood out. X was admirable.
2. X is not an object. X was witty.
d. was (x, witty); X is not an object. X stood out. X was admirable.

The meanings of the two sentences (that is, the meanings of sparkle in them) are quite different, but the sentences are interpreted with the same entry (6-83c) for sparkle. – In order to avoid a clash, for (6-81a), the logical component will select the implicational clause (6-82c1) and for (6-82a) the implicational clause (6-83c2). In this second case, the implicational clause (6-83d), for was (x, witty), will be added to that of (6-83c2). Now, (6-82a) is an example of a dead metaphor. – The word sparkle had originally only the physical meaning (< ME sparken ‘to spark’; see The American Heritage Dictionary of the English Language, Morris (1969)) and before the metaphor became accepted in English the implicational clause in the entry for the word must have been (6-83c1). So, the extension of meaning that took place with the acceptance of the metaphor must have been adding the second implicational clause to the entry. – How did this happen? – If we look at the entry (6-83d), for was (x, witty), we see that it contains some similarity with (6-83c1), the original entry for sparkle, namely X stood out and X was admirable. Now, since at that time the metaphor was new, the sentence (6-82a) had to be interpreted by the two-step process outlined above. So, the first step must have been establishing the
similarity between the two entries. The second step, then, consisting of implicational clause modification in order to eliminate the clash, must have been adding the second implicational clause to the entry for sparkle. We can restate, then, the process followed in metaphorical interpretation as in (6-84). I will call it the meaning-extension process.

(6-84) Meaning-Extension Process

For a trace of the mapping containing two asterisks, do the following:
1. Identify the clashing implications in the entries a and b, which gave rise to the two asterisks.
2. Find another entry, c, which has at least one implication in common with a and at least one in common with b. One of these implications must be the clashing implication.
3. Add a second implicational clause to a or b, or both, consisting of implications in c common with b or a, or both, followed by a pointer to c. One of the added implications for each implicational clause must be the clashing implication. It is this implicational clause that constitutes the interpretation.

The interpretation process for (6-81a), whose original trace of the mapping must have been *sparked(the(*conversation)), is as follows.

1. The clashing implications are A conversation is not an object in entry (6-83b) (=a) and X is an object in entry (6-83c1) (=b).
2. The entry (6-83d) (=c) has X is not an object in common with entry (6-83b), which includes A conversation is not an object. (I am assuming that the logical component is
capable of establishing the similarity between these two sentences.) The entry also has X stood out and X is admirable in common with entry (6-83c1).

3. The second implicational clause added to (6-83c) is the one in (6-83d) common with (6-83b) and which corresponds to the clashing implication, or X is not an object. The rest of the implicational clause is a pointer to entry (6-83d), or the proposition in the entry. (In the example, it is the sentence which the proposition represents).

The situation with sparkle is the same as with lead in Jackendoff's example discussed in 4.2 and 6.2. Thus, the knowledge-base approach permits one not only to derive the correct implicational clauses for sentences containing dead metaphors but shows how a word may acquire a second meaning. The theory, thus, provides a tool for historical linguistics to study the process of meaning extension. (It is not to say that historical linguistics does not have a tool to study the phenomenon at this time. But, when the process is more clarified, it might serve as a better tool for historical linguistics.)

For the example (6-79a), the process is similar, except that it has to be carried out twice — first for the wine drank and then for drank the man. Here, (6-80d) is selected because the implicational clause of destroyed includes the additional sentences shown in (6-80d'). (They were merely not listed earlier.) The temporary entry for drank, of
which the second implicational clause constitutes the interpretation, is as in (6-80a').

(6-80) a'. drank (x,y); 1. X has a mouth. Y is liquid.
   Y no longer exists.
   2. X does not necessarily have a mouth.
      Y is not necessarily liquid. X destroyed y.

d'. destroyed (x,y); X does not necessarily have a mouth. Y is not necessarily liquid. Y no longer exists.

Although (6-84) does elucidate some issues in meaning extension, there are other that remain unclear. For instance, the definition of the process does not specify whether to select the entry a or b, or both, in step 3. In (6-82a), there was no difficulty in making a choice because, since conversation had a reference, only sparkle could have been changed. In (6-80a), the situation with the wine drank is no longer so clear. — It may be that actually both of the words have their meanings extended in the interpretation, the wine to drinking and drank to destroyed. But consider John is a pig. The sentence ostensibly has one meaning, which may be expressed as John is a slob. (I am disregarding the fact that the sentence may also mean that the name ‘John’ refers to a pig, since this would not involve meaning extension.) So, it appears that the extension of meaning is in the word pig. But there is another way of stating the interpretation, which may or may not be
synonymous with the first one, namely *John behaves like a pig*. Here, apparently, it is the verb that has undergone meaning extension. That is, under this interpretation, the word *is means behaves like*. This suggests that metaphorical interpretation of a sentence may have more than one analysis. The issue needs further clarification.

Another unclear issue is why a certain entry in the knowledge base is selected as the c entry in step 2 in (6-84) over other entries which presumably may satisfy the criteria. The answer that first comes to mind is that it is the one with the greatest number of implications in common with the two clashing entries. This sounds reasonable except that there may be other factors at play as well. For instance, it is possible that the abundance of moralizing maxims in our society, in particular regarding alcoholism, may be the reason why the sentence (6-79a) will be commonly interpreted as said above. This explanation, however, again should no longer be expected of a linguistic semantic theory but, rather, of a theory of linguistic performance. This suspicion receives support from the fact that the identification of a c entry is obviously a function of the intelligence of the hearer. But intelligence (the effective intelligence, which is what comes into play here) is a function of concentration, memory, and so forth, factors which are commonly considered parameters of linguistic performance.
But there is no room here to go into issues such as these and they must wait for future research.

In chapter four, I qualified the clause (4-2c) of the definition of the scope of a linguistic semantic theory, which says that such a theory must explain meaning acquisition and extension through the means of language. – I said that what a semantic theory first ought to do is to investigate the processes of meaning acquisition and extension so as to determine whether this goal should, in fact, be part of the scope, on the basis of whether or not the processes fitted in naturally with the other clearly linguistic processes forming part of the semantic component.

I am not sure whether an unqualified affirmative answer can be given to the question on the basis of the examples studied in this section. But, I feel that an unqualified negative answer can certainly not be given. – Both meaning acquisition and meaning extension involve the processes of copying of implicational clauses, which is part of the implicational-clause generation process. For meaning acquisition, the added process is creating a new entry into which the generated implicational clause is copied. Essentially, this consists of dropping ? from the unknown word already in the knowledge base (as part of the trace of the mapping) and transferring the generated implication to it. There does not appear to be anything about this process that makes it require to belong to another cognitive
process, and, certainly, not to a performance model. For meaning extension, the added processes are establishing similarity in implicational clauses and modifying (adding implications to or deleting from) implicational clauses. These, again, do not clash in any outrageous way with the obviously linguistic processes. — Establishing similarity, for instance, must be part of the process of mapping of the input semantic marker onto the knowledge base, except that the comparison is on the lexical part of the entry (the argument, in set-theoretic terminology), rather than on the implicational clause (the value, in set-theoretic terminology). And implicational-clause modification is very similar to the process of new-entry creation (identical to it in the case of implicational-clause addition; this shows that the processes of meaning acquisition and extension do belong together) and, by the same token, to implicational-clause generation. Moreover, as was said above, merged with the processes necessary for meaning acquisition and extension, there are processes which obviously belong in a performance model and which bear no resemblance to the processes in question. This suggests that the processes of meaning acquisition and extension are part of language competence and should be considered part of grammar.

Thus, my feeling continues to be that the processes of meaning acquisition and extension through the means of
language should be part of a linguistic semantic theory. And it appears that the knowledge-based theory provides good tools for investigating these processes.
CHAPTER SEVEN:  
CONCLUSIONS AND DISCUSSION

7.1 CONCLUSIONS

The semantic theory developed in this book is based on the premise that the goals of a linguistic semantic theory (see (4-1)) are to define its own scope and to specify the mechanisms and rules underlying semantic interpretation without attempting to define meaning or, in other words, that a semantic theory may be constructed without a level of semantic representation on which the meanings of sentences are defined.

The scope of a linguistic semantic theory (see (4-2)) is advanced to consist of three points: specifying the role of syntactic structure in semantic interpretation; specifying the role of the components of a sentence in producing the meaning of the sentence; and specifying the mechanisms at play during the processes of meaning acquisition and extension through the means of language. The first stage of the last point is to determine whether this topic should be part of a linguistic semantic theory on the basis of how well the mechanisms fit in with the other obviously linguistic processes.

The semantic theory developed in this book along the above lines is called the knowledge-based theory or knowledge semantics. The embodiment of the theory is the
knowledge component, which is part of the semantic component. The framework in which the component is developed is the revised extended standard theory. Under the knowledge-based theory, the semantic component (see chapter five, Fig. 9) consists of the indexing component and the knowledge component. The indexing component consists of rules of construal and conditions on binding, forming part of the semantic component under the revised extended standard theory (see (2-1)).

The input to the knowledge component is the output of the indexing component, or indexed surface structure enriched by traces. By ‘indexed’ is meant that all anaphoric elements in the surface structure are coindexed with their antecedents. The knowledge component consists of three subcomponents: the semantic-marker structuring component, the semantic-marker mapping component, and the logical component.

The semantic-marker structuring component converts the indexed surface structure enriched by traces into a semantic marker, called the input semantic marker, which represents the semantic structure of the input sentence. A semantic marker may be expressed in the (higher-order) predicate-logic notation, the phrase-marker tree notation, or the labeled-bracketing notation. In all three representations, the basic units are propositions, consisting of predicates and arguments. The semantic-marker structuring component
satisfies the first requirement of the scope of a linguistic semantic theory — it specifies the role of syntactic structure in semantic interpretation.

The semantic-marker mapping component has two inputs: the input semantic marker and the part of the knowledge base pertinent to the utterance. This knowledge base is derived from the full knowledge base by the nonlinguistic part of the logical component, which is not part of the knowledge component. The knowledge base consists of entries expressed in the same language as the semantic marker, that is, it consists of propositions. With each proposition in the knowledge base (that is, with each entry) there are associated one or more implications, which are pointers to other propositions, or entries, in the knowledge base, implied by the proposition in the entry (see (5-6)). This list of pointers constitutes the implicational clause of the proposition in the entry. The semantic-marker mapping component breaks down the input semantic marker into propositions which can be mapped onto the knowledge base, producing the trace of the mapping. The trace of the mapping, then, is the pertinent knowledge base with the input semantic marker superimposed on it. Unknown elements (morphemes) in the input semantic marker are entered in the trace with an indication that they are unknown. Anomalous propositions, that is those not occurring in the knowledge base, are marked anomalous. The semantic-marker mapping component satisfies part of the second goal of a linguistic semantic theory — it identifies the semantic components of
a sentence. The research underlying this book indicates that the components range from bound morphemes to complex syntactic structures.

The logical component transfers the trace of the mapping onto the full knowledge case. For traces with no unknown elements or anomalous prepositions, it combines the implicational clauses of all prepositions in the trace to form a combined implicational clause for the input sentence. This implicational clause is called the output implicational clause. Because implications imply other propositions which in turn imply other, the output-implicational-clause generation process is lengthy and, potentially, for cases when implications are recursive, infinitely long. An output implicational clause is a function of the knowledge base and the capability of the logical component, which (capability) represents the linguistic intelligence of the hearer. Part of the intelligence is memory (remembering implications). Since memory is a function of such factors as interest and concentration, the output implicational clause is also a function of such factors. Accounting for this no longer constitutes part of the theory, however, but belongs in a theory of performance. When the trace of the mapping contains unknown elements or anomalous propositions, the logical component makes changes in the knowledge base so as to produce an implicational clause. For unknown elements, the changes constitute creating an entry with the unknown
element in the proposition and with portions of other implicational clauses, which belong to the entries in the trace of the mapping, in the implicational clause of the created proposition (for instance, Kutya is probably food if the input sentence is The man ate the kutya). For anomalous propositions, typically, a second implicational clause is generated according to the meaning-extension process defined in (6-84). If the input semantic marker carries information not present in the knowledge base, the information, in the form of an implication, is added to the implicational clause of a knowledge-base entry. For traces containing entries with two implicational clauses, the logical component selects the one which avoids a clash in implications. For instance, in The diamond sparkled, the word sparkle will receive the interpretation reflected light rather than was witty because diamond implies material and was witty presupposes a nonmaterial subject. If the trace of the mapping contains two parallel words (for instance, bank (f) and bank (t) for ‘financial’ and ‘river’), or if one of the entries has two implicational clauses, neither of which the logical component is able to eliminate, (for instance, as for the word sparkle), two output implicational clauses are generated, indicating that the input sentence is ambiguous. If the logical component is incapable of eliminating the unknown or anomalous indications, it cannot generate a full output implicational clause for the input sentence and the sentence remains uninterpreted as a whole, although parts of it will have been interpreted.
The pairing of the knowledge base containing the trace of the mapping and the changes, if any, with the (full or partial) output implicational clause, or clauses, is the output of the logical component as well as of the knowledge component. This represents the interpretation of the sentence. This may also be considered the meaning of the sentence. In accordance with the second of the two requirements of the goal of a semantic theory, the meaning cannot be said to have been defined, however, but merely represented. It is defined only in terms of the knowledge base and will be ‘understood’ only by a mechanism having the same knowledge base as the one used for the interpretation. The theory, thus, states that meaning is not invariant but is a function of the knowledge base and intelligence of the hearer. Furthermore, the theory suggest that meaning might be infinitely long.

The logical component satisfies the rest of the second requirement of the scope of a linguistic semantic theory — it identifies the contributions of the semantic components of the sentence to its meaning. The logical component also satisfies the third requirement of the scope of a linguistic semantic theory — it defines the processes at play in meaning acquisition and extension through the means of language.

The main goal of the research underlying this book was to determine whether it is possible to
construct a viable semantic theory which does not require a level of definitional semantic representation, that is, a level on which the meanings of sentences are defined. On the basis of this research, it may be concluded that it is indeed possible to construct such a theory. In other words, it may be concluded that it is feasible to develop a semantic theory which attempts to specify the mechanisms and rules underlying semantic interpretation without defining meaning. Such a theory not only is capable of satisfying the requirements posed by the definition of the scope of a linguistic semantic theory — that is, specifying the role of syntactic structure in semantic interpretation; specifying the role of the components of a sentence in producing the meaning of the sentence; and specifying the mechanisms at play during the processes of meaning acquisition and extension through the means of language — but also, in the process of doing this, raises many interesting empirical issues which do not arise in any of the established theories, such as: how does the hearer’s knowledge influence the interpretation of a sentence; should a word be represented as a predicate or an argument in a proposition; what are the semantic components of a sentence; how is the numbering reading of a quantifier affected by the other words in the sentence; and others. In addition, there are a number of specific conclusions that may be reached on the basis of the research underlying this, of which the more interesting ones are the following.
It appears that the semantic phrase marker should contain all the lexical matter present in the syntactic phrase marker. If a lexical item carries no meaning, this should be indicated by the knowledge-base entry onto which the item will be mapped. PRO’s which have no surface realization are sometimes not represented by any lexical matter in the semantic phrase marker. Such syntactic-phrase-marker constituents as number, case, tense, and so forth, act as predicates in the semantic phrase marker.

The translation rules that map the syntactic phrase markers onto the semantic (see 6.6) are similar to rewrite rules in syntax. They may be subdivided into argument-formation rules, predicate-formation rules, and proposition-formation rules. Conventions, similar to the pruning conventions in syntax, apply to the output of the translation rules. These rules are obligatory, with only one exception—a rule permitting the interpretation of isolated noun phrases. The translation rules are extrinsically unordered, but apply cyclically, as do rules of syntax, starting at the most deeply embedded constituents and moving up the syntactic phrase marker.

The knowledge-based theory sheds some interesting light on the interpretation of quantifiers (see 6.3). It appears that quantifiers may be classified, on the basis of how they affect the numbering readings of sentences, into individual (for instance, a, the, one, every), collective (for
instance, a pair (of), a threesome (of)), and ambiguous (for instance, many, a few, some, two, three). The individual and the collective quantifiers have one implicational clause. The ambiguous quantifiers have two implicational clauses – one for the individual reading and one for the collective. Thus, unless other words in the sentence permit the logical component to resolve the ambiguity, a sentence containing one of these quantifiers will have two readings, one with two will have four, one with three will have eight, and so forth. This analysis shows the analyses based on the scope of quantifiers to be incorrect.

Chomsky (1973), pp. 95-6, observes that the sentence *I didn't see many of the pictures* has two readings – *I saw few of the pictures* and *Many of the pictures are such that I didn't see them*, of which the first appears to be the preferred one. The knowledge-based theory may offer an explanation for this phenomenon – it may be that this is so because the first reading is achieved with the aid of a knowledge-base entry containing more lexical matter than for the second reading.

The analysis of conjunctions and nondeclaratives under the knowledge-based theory suggests a mechanism for identifying semantic primitives. – If it is impossible to express the implicational clause of a proposition without referring to the proposition itself, the proposition, or an element (predicate or argument) in the proposition, is a potential semantic primitive. Candidates for such semantic
primitives are some conjunctions, for instance, and and if.
and the concepts of statement, question, and command.

The research shows that nondeclaratives, such as
questions and commands, may be expressed as propositions in
which the argument is the proposition underlying statements
(for instance, love (John, Mary)), and the predicate the
operators ? for questions, and ! for commands. This is
borne out by the analysis of embedded questions and
commands. Modals, employing such words as may, possible,
must, and so forth, may be represented in a similar fashion.

Although the research shows no reason why the processes
of meaning acquisition and extension should not be part of a
linguistic semantic theory, it shows no convincing proof
that they should. The mechanisms underlying the two
processes do, however, have much in common with the
obviously linguistic ones — namely copying of implicational
clauses and establishing identity. The two processes appear
to belong together. The meaning-extension process, which is
defined in (6-84), suggests that the selection of the entry
whose implication is to be changed, out of the many
possibilities, is a nonlinguistic process, but that the
actual process of meaning extension probably belongs in a
linguistic semantic theory. One argument in favor of
including the meaning-extension process in grammar is that
it provides a tool for historical linguistics to study
meaning extension.
7.2 DISCUSSION

Although the definition of the goal of a linguistic semantic theory \( (4-2) \) does not contain the requirement to explain the various semantic properties and relations because there are indications that underlying these are broader cognitive processes, I said in chapter four that I was going to show how these properties and relations could be accounted for by the knowledge-based theory. This is done below. (For a definition of the fifteen phenomena, see Katz (1972), pp. 5-6.)

1. Synonymy and Paraphrase. Two sentences are synonymous or paraphrases of each other if their implicational clauses are identical, as for John is a person and John is a human being, assuming that the implicational clauses of a person and a human being are the same.

2. Semantic Similarity and Semantic Difference. Two sentences are similar to the extent that their implicational clauses are similar, and different to the extent that their implicational clauses are different. For instance. This is a man and This is a woman are similar to the extent that they both imply This is a person, and different, to the extent that the first implies This is a male person and the second This is a female person.

3. Antonymy. Two words, \( w_1 \) and \( w_2 \), are antonymous if the implicational clause of a sentence containing \( w_1 \) has the
implication $W_1$ is the opposite of $w_2$, or its equivalent. For instance, to open and to close are antonymous because a sentence containing to open will have To open is the opposite of to close in its implicational clause.

4. Superordination. A word $w_1$ is superordinate to the word $w_2$ if the implicational clause of a sentence containing $w_1$ contains the implication $W_2$ is $w_1$, or its equivalent, but not $W_1$ is $w_2$, or its equivalent. This is true, for instance, of finger and thumb.

5. Meaningfulness and Anomaly. A sentence is partly meaningless if the output knowledge base, after the interpretation of the sentence, contains an unknown or anomalous indication. Otherwise, the sentence is meaningful. A sentence is anomalous if it is interpreted with the aid of the meaning-extension process (6-84). This happens when one of the propositions underlying the sentence does not occur in the knowledge base, without there being any unknown morphemes in the sentence.

6. Semantic Ambiguity. A sentence is ambiguous if the output of the semantic component contains more than one implicational clause as a result of the interpretation of the sentence.

7. Semantic Redundancy. A phrase is semantically redundant if the implicational clause of the sentence it occurs in contains an implication that appears more than once. For instance, for the semantic marker underlying John is a male man one of the implications is John is male and
another one John is a man. Since John is a man implies John is male, the implicational clause will contain a repetition of the implication John is male.

8. Analytic Truth. A sentence is analytically true if the implicational clause of part of the sentence is the sentence itself, for instance, as for A king is a monarch, where a king implies A king is a monarch.

9. Contradictoriness. A sentence is contradictory if its implicational clause contains two contradictory implications, as is for A king is a woman. This appears to be another version of antonymy.

10. Syntheticity. A sentence is synthetic if it is not analytic.

11. Inconsistency. A phrase is inconsistent if the implicational clause of a sentence it occurs in contains two contradictory or antonymous implications, as for instance, a living corpse, where corpse implies not living.

12. Entailment. Sentence s1 entails sentence s2 if the implicational clause of the sentence s1 contains the sentence s2 but the implicational clause of the negated version of the sentence s1 does not contain the sentence s2. For instance, The person is a bachelor implies The person is male but The person is not a bachelor does not imply The person is male. The person is a bachelor, therefore, entails The person is male.

13. Presupposition. Sentence s1 presupposes sentence
s2 if the implicational clause of the sentence s1 contains the sentence s2 and the implicational clause of the negated version of the sentence s1 also contains the sentence s2. For instance, The person is a bachelor implies The person exists and The person is not a bachelor also implies The person exists. The person is a bachelor, therefore, presupposes The person exists.

14. Possible Answer. Sentence s1 is a possible answer to question s2 if one of the implications of the element in the sentence s1 corresponding to the unknown element in the question s2 is one of the implications of the unknown element of the question s2. For instance, John came at noon is a possible answer to the question When did John come? because when, the unknown element, implies time, the same as at noon, which is the element in the sentence corresponding to the unknown element in the question. But, John came home is not a possible answer to the question because home does not imply time.

15. Self-Answered Question. This appears to be the interrogative equivalent of redundancy. Katz's example is Is a spinster a female? It is female spinster that makes the question self-answered because spinster implies female.

Each of the above phenomena are defined in terms of implicational clauses. But, since implicational clauses reflect the structure of the knowledge base, they can be viewed as results of analyses of the knowledge base. That is, they can be viewed as patterns existing in the knowledge
base which the human mind identifies. But, if this is so, then it is extremely unlikely that the phenomena are exclusively linguistic. In chapter four, it was said that at least some of the phenomena, for instance ambiguity, synonymy, and hyponymy are applicable to visual information. It is possible that this is true of all of the fifteen phenomena. The reason for this is because it appears that the structure of the knowledge base proposed under the knowledge based theory, at least its implicational part, underlies all types of knowledge. For instance, a circle implies that its perimeter is 3.14 times its diameter and its area 3.14 times the square of one half of its diameter, and so forth. Similarly, a hissing noise has certain implications, as does a bitter taste and a sweet smell. So, accounting for the various phenomena, although perhaps interesting, should very likely not be part of a linguistic semantic theory.

Another argument against including the fifteen phenomena within the area of interest of a linguistic semantic theory is the fact that, almost certainly, there is nothing magical about the number fifteen. First, a few of the fifteen phenomena seem versions of others. Second, more similar phenomena (in fact, an infinite number of them) can be thought of. — If we call antonymy between two words or sentences double antonymy, then we can have triple antonymy for three-way antonymous relationships, quadruple antonymy for four-way antonymous relationships, and so
forth, to infinity. It might be true that after some point none will be found in reality, but we could define them and they could be conceived of by our mind. So, if a theory requires the fifteen phenomena to be explicated, it should say why all the other possible ones should not. This fact militates against placing the requirement in terms of such phenomena as the above, on any cognitive mechanism, for, quite clearly, the requirement should be expressed in some more basic terms. I conclude, therefore, that a linguistic semantic theory should not be concerned with the above fifteen semantic properties and relations.

But, one could counter, if the above phenomena are not to be included in a linguistic semantic theory because they manifest themselves as well in nonlinguistic information, then the same argument can be used against some of the processes forming part of the knowledge-based theory, for instance establishing identity and generating implicational clauses. Clearly, they are also at play during nonlinguistic information processing. The two situations, however, are not the same. In the case of the fifteen phenomena, the processes consist of establishing patterns in the knowledge base, which is not part of sentence interpretation and not part of generative grammar. In the case of the processes forming part of the knowledge component, the processes are part of sentence interpretation and, thus, part of generative grammar. The knowledge-base
theory, therefore, shows how purely linguistic processes in the semantic component, namely the mapping of the semantic phrase marker onto the syntactic one, interact with broader cognitive mechanisms during the process of semantic interpretation. Now, although these processes are not exclusively linguistic, since they play a role in generative grammar, they should form part of a generative linguistic theory. The theory, thus, answers the question raised in Chomsky (1980b), quoted earlier:

‘Do the "semantic rules" of natural language that are called to give meaning of words belong to the language faculty, strictly speaking, or should they be regarded perhaps as centrally embedded parts of a conceptual belief system, or do they subdivide in some way?’ (p. 62)

Among the strongest criticisms of the decompositional theory, quoted in chapter three, is that of J. D. Fodor et al. (1975). To recapitulate that work, the authors argue that there is strong evidence, intuitive and experimental, against a level of semantic representation based on decomposition. They say: ‘the semantic level as linguists have generally conceived it does not exist.’ (p. 516) As an alternative, the authors propose using rules of inference, or meaning postulates. The arguments the authors adduce for rules of inference are: that people's comprehension of sentences is extremely fast, suggesting that the semantic
representation is very close to surface structure; that rules of inference are needed to handle the ‘residue’ of decomposition; and that they are needed to handle unsymmetrical relationships, such as red-colored. J. D. Fodor (1977) expresses similar criticisms of the decompositional theories, as was quoted in chapter three, and likewise suggests rules of inference as an alternative to decomposition, to generate the entailments of a sentence. She concludes:

‘A grammar without semantic representations, but with a suitable body of inference rules, could apparently do everything that has traditionally been demanded.’ (pp. 193-4)

But, she observes that

‘it does remain to be shown that meaning relations other than entailment, such as ambiguity, redundancy, anomaly, and so on, can be adequately treated in a semantic system without lexical decomposition.’ (p. 154)

She also says;

‘Once it is recognized that meaning postulates are needed in linguistic decomposition, their proper domain must be precisely determined. It may well turn out to be considerable.’ (p. 155)

The knowledge-based theory proves the above views to be correct. The relationship between a knowledge-base entry and its implicational clause is an inference rule. The
theory is thus able to dispense with a level of definitional semantic representation and relies on the mechanism of inference rules to generate implications (including entailments) of sentences. As to Fodor's reservation whether a semantic theory not relying on decomposition could account for the various semantic properties and relations, it was shown above that the knowledge-based theory is capable of doing it. The knowledge-based theory, therefore, shows how the suggestions proposed in J. D. Fodor et al. (1975) and J. D. Fodor (1977) can be realized.

Aronoff (1981) observes that recent work in semantics has shied away from what he calls ‘opposition-based theories,’ such as Katz and Fodor (1963), that is, decompositional theories,

‘because they seem to presuppose that the meanings of words are clear things. By contrast, linguistic research is concerned now with accounting for the observation that people do not really know exactly what a word means.’ (pp. 329-30)

Aronoff says that, on the one hand, his article will demonstrate

‘the validity of the theory of semantic oppositions by showing that the senses of a number of words in one particular domain can be understood only in relation to one another. On the other hand, it will show that these senses are elusive; they change so rapidly and
imperceptibly that one person's idea of what a given word signifies may be markedly different from another person's.' (p. 330)

Aronoff's work, thus, lends support to the knowledge-based theory by showing that interpretation is a function of the knowledge base.

Referring to the meaning changes, Aronoff observes: 'These changes, though, no matter how rapid, are very regular and operate totally within the predetermined system of oppositions.' (p. 330) The implication here is that the changes are linguistic in nature because of being 'regular' and operating within the 'linguistic' domain of 'the system of oppositions.' The observation, therefore, likewise gives support to the contention advanced in this book that meaning extension is the proper subject for a linguistic semantic theory. Now, Aronoff's data stems from the area of automobile names. But the meanings of these, by their nature, as Aronoff shows, are based on a 'system of oppositions.' Aronoff's claim, therefore, that meaning change must operate within the predetermined system of oppositions is too broad. What the theory shows is that meaning changes take place within the implications of the words, that is, that it is the implications of words that undergo changes. This is exactly what the meaning extension process defined within the knowledge-based theory shows. The fact that the implications of automobile names are based on
a system of oppositions has nothing to do with the actual meaning-extension process.

Bresnan (1978) is an attempt to sketch out an alternative to the standard theory, in which semantic interpretation is derived from deep structures only. Bresnan calls this the lexicalist-interpretive theory. This theory is similar to the extended standard theory as, under it, the semantic component acts both on the deep and surface structures to produce interpretations of sentences. But the lexicalist-interpretive theory differs from the extended standard theory in that, among other things, it contains a lexicon that is unlike that of the extended standard theory.

- Bresnan's lexicon contains information which includes the syntactic context in which a word (verb) occurs — called syntactic context — as well as information about the semantic properties of the word — called functional structure. For the transitive verb *eat*, the partial lexical representation would be as in (7-1a); that for the intransitive verb *eat* — as in (7-1t) (=35)).

\[(7-1)\]

\begin{align*}
\text{a. eat: } V, & \ [\underline{\_\_}\text{NP}], & \text{NP}^1 \text{eat NP}^2 \\
\text{b. eat: } & \ [\underline{\_\_}], & (\exists y) \text{NP}^1 \text{eat } y
\end{align*}

Where \( \exists \) is the existential quantifier. The items in the brackets represent the syntactic context and the formulae on the right the functional structure.
The functional structures ‘combine the grammatical functions with the lexical argument structures.’ (p. 17) In other words, the functional structure in (7-1a) states that, for the transitive verb eat, the grammatical functions ‘subject’ (=NP1) and ‘object’ (=NP2) act as the first and second argument of the predicate eat. In (7-1b), the functional structure states that, for the intransitive verb eat, the subject acts as the only argument of the predicate eat. The use of a variable and the existential quantifier, as in (7–1b), to represent an intransitive verb that can also act as transitive, is Bresnan's attempt to show the difference between such verbs as eat and sleep, which can only be intransitive.

Bresnan's chief aim in proposing the lexicalist-interpretive theory is to eliminate from the syntactic component those transformations that are function-dependent, that is, those in which the moved elements have an assigned grammatical function, for instance the passive. For structures that have traditionally been derived by such transformations, the logical subject and object (that is, the arguments of the predicate corresponding to the verb) will be derived directly from surface structures by virtue of the necessary information being present in the lexicon, as shown in (7-1). Such structures will have been generated by base rules and will have deep structures identical to surface structures.
It is apparent that the lexicalist-interpretive theory bears some resemblance to the knowledge-based theory. The functional structures in the lexicon are similar to the proposition part of knowledge-base entries (to generic propositions), as was observed in 6.2, which identify the arguments of predicates. The difference between the lexicalist-interpretive theory and the knowledge-based theory is that the latter, in addition, makes a distinction between the semantic structure of the input sentence — the input semantic marker — and the knowledge base, onto which the input semantic marker is mapped. This permits the theory to account for meaning extension, which the lexicalist-interpretive theory, when extended to words other than just verbs, appears incapable of handling. Connected with this problem is the technique of handling quantifiers under the lexicalist-interpretive theory, as in (7-1b). As was said in chapter two, Fodor and Fodor (1980) analyze Bresnan's proposal and conclude that it is inadequate because of treating quantificational semantics as part of lexical semantics. They show that quantificational structure must be assigned after functional structure precisely because 'quantificational structure is inextricably entwined with logical inference and is hence most naturally viewed as a property of truth-valuable objects: sentences, not lexical entries.' (p. 769)

Bresnan's main argument for the lexicalist-interpretive theory is built around the sentences in (7-2a) and (7-3a).
(7-2)  a. John tends to annoy Mary.
      b. tends (to (annoy) (John, Mary))

(7-3)  a. Mary tends to be annoyed by John.
      b. tends (to (be) (annoyed (Mary), by (John)))

She shows that, relying on the surface structure and functional structure in the lexicon alone the active/passive relationship may be established. Under the knowledge-based theory, if, as Bresnan assumes, the deep structure of these sentences were the same as the surface structures, then their input semantic markers would be as in the b parts of the examples. Now, to reflect the active/passive relationship, only the entry in (7-4) is needed in the knowledge base.

(7-4) to (be) (annoyed (x), by (y)); ... to (annoy) (y,x) ...

Where the proposition following the semicolon is the implication of the entry, or the proposition underlying the active form of the sentence.

So, the knowledge-based theory is capable of accounting for the active/passive relationship without the need of a passive transformation. But it is immune to the criticisms directed by Fodor and Fodor at the lexicalist-interpretive theory since, under the knowledge-based theory, the quantificational structure is derived from the surface structure of the sentence.
Returning to the topic of the decompositional approach, one has to admit that, in spite of all the arguments that have been cited and brought forth against it, it would be a legitimate question to ask why does it seem so appealing and obvious. Also, why is it that, if one asks oneself what does a word mean, one does not answer in terms of implications but, rather, with single words? I am not sure if this is the right answer to the question, but it is possible that the above responses are ‘surface’ phenomena of the knowledge base. Notice that, if we say that it is true that man can be broken down into animate, human, male, and so forth, it is also true that the implicational clause of man must contain the propositions equivalent to Man is animate, Man is human, Man is male, and so forth. It should not be surprising, therefore, that we respond to the question the way we do. — We respond with a shortened from of implication, omitting the words understood the way we usually do in conversation.\(^1\) The difference, in this respect, between the decompositional approach and the knowledge-base one is that the former claims that the concepts underlying the entailed words are innate and universal and the latter makes no such claim. The implication Man is human bears no more theoretical

\(^1\)Another reason might be because the actual implications of man might be generic propositions, in which the only constants are words such as animate, as for instance in animate(x), which indicates that animate may be the predicate of x.
significance than, say, Man can eat an apple. I believe that similar reply can be made to the question why is the semantic-fields approach (see A. Lehrer (1974)) so appealing or why is it possible to reach generalizations such as thematic relations.

For instance, the fact that to sauté and to deep fry mean (are hyponymous to) to fry, which means to cook; and that to broil, to fry, and to boil all mean to cook, falls out of the knowledge-based approach since this interrelationship is reflected in the structure of the knowledge base—it is our mind analyzing the knowledge base that identifies this pattern.

The same, I think, is true of thematic relations. In John bought an apple from Fred and Fred sold John an apple, apple is the Theme, Fred is the Source, and John is the Goal, in spite of the word-order differences between the two sentences. When interpreted against a knowledge base, both sentences will imply that John is in the possession of something (Goal), Fred no longer possesses something (Source), and that the something is an apple (Theme).

Returning once more to the decompositional approach, I think we are now in a position to say what it does. — When a word, under the approach, is decomposed into the ‘primitives,’ what is achieved is to specify part of the knowledge base which underlies the interpretation of the
word. Now, this might be of some value when done properly, but of little when done in an anecdotal fashion as in the published works of the proponents of the approach. For a specification of the knowledge base to be done properly, it must be achieved through an exhaustive, systematic analysis of the vocabulary of the language, I suspect, in a fashion similar to the segmentation and classification techniques used in morphemic and phonemic analysis. So, it is developing this type of technique that the proponents of the decompositional approach ought to do in order to make their work have some value. Of course, there is a problem with specifying a knowledge base under the decompositional approach. — Doing this, a tacit assumption is made that the knowledge base is the same for all speakers, which is obviously not true. But, since the decompositional approach cannot be considered part of generative grammar, this shortcoming might be overlooked. The knowledge base constructed under the approach might be looked at as a ‘general’ repository of knowledge, not unlike a common definitional-type dictionary, containing the ‘standard’ meanings of words used by persons who speak the language ‘correctly.’

In 5.5.1, it was said that the implications generated under the knowledge-based theory are ‘useless’ since the theory has no way of specifying the contents of the
knowledge base. This is true as far as the theory viewed as part of a theory of linguistic competence is concerned. But, the implicational-clause generating mechanisms developed under the theory might have some practical value. For instance, if a way of reliably specifying a knowledge base were developed outside the knowledge-based theory, then the implicational clauses produced by the mechanisms of the semantic component would constitute the full and correct implications. It is quite likely that such a knowledge base could be constructed for limited areas of discourse, for instance, a technical discipline. Thus, the knowledge-based theory might have practical applications in semantic discourse analysis, namely information retrieval.

At this point, it seems advisable to address the topic of the composition of the knowledge base. In chapter five, it was concluded that the knowledge base should contain the information for all possible types of inferences, that is, logical and factual entailments and presuppositions. The reason given for this was because there does not seem to be a clear-cut distinction between logical and factual knowledge and because what is normally considered meaning includes both entailments and presuppositions. Now, the composition of the knowledge base is not part of the knowledge-based theory. If, however, another theory, not part of knowledge semantics, were developed which could distinguish between logical and factual knowledge, then this fact could be reflected in the
knowledge-based theory by there existing, for each knowledge-base entry, two separate implicational clauses, one for logical implications and one for factual, upon which the rules of the logical component would act to produce two output implicational clauses, again one logical and one factual. Another way of looking at this would be that now the knowledge base would consist of two parts — one logical and one factual — and that the implications of the entries in either could be propositions in either one or the other, or both. (I am not sure if a ‘logical’ proposition can imply a ‘factual’ one, but the reverse should be possible.)

Entailment and presupposition could be distinguished in the knowledge base in a similar way, that is, by occurring in separate implicational clauses — one for entailments and one for presuppositions. In fact, this seems an advisable thing to do because, by this dichotomy, the correct implicational clause could be derived for a negated sentence from its asserted form by a simple rule which would state that, for \( \text{not}(p) \), all members of the entailment implicational clause of \( p \) are to be prefixed by \( \text{not} \), but the members of the presupposition implicational clause are to be left unchanged. With this approach, the implicational clauses of the entries in the knowledge base could consist of four parts — logical entailment, logical presupposition, factual entailment, and factual presupposition; but for some entries one or more of these could be null. Output implicational clauses, then, would likewise consist of these
four parts, thus permitting a distinction between the four
types of knowledge in the interpretation of sentences.

In connection with this, let us look at how the so-
called factive and implicative verbs might be interpreted
under the knowledge-based theory. (For a discussion of these
see Karttunen (1971). See also Kiparsky and Kiparsky (1970)
for a discussion of the notion ‘factive.’)

Consider the sentences (7-5) and (7-6).

(7-5)  a. John knows that Mary loves Peter.
       b. John doesn't know that Mary loves Peter.

(7-6)  a. John managed to kiss Mary.
       b. John didn't manage to kiss Mary.

The sentence (7-5) contains the factive verb know (others
are realize, regret, and so forth); the sentence (7-6)
contains the implicative verb manage (others are remember,
bother, get, and so forth; see Karttunen (1971), pp. 341-2).
For both types of verbs, the implication is that the
propositions underlying the embedded clauses of the asserted
form of the sentences (sentences a) are true. For the
negated version of the sentences (sentences b), however, the
proposition underlying the embedded clause of the
factive-verb sentence ((7-5b)) remains true; in other words,
it is a presupposition. But for that of the
implicative-verb sentence ((7-6b)), it is false; that is, it
is an entailment. — Both (7-5a) and (7-5b) imply that John
loves Mary. But only (7-6a) implies that John kissed Mary: (7-6b) implies that John did not kiss her. This type of behavior is true for all factive and implicative verbs, which means that, for factive verbs, the proposition underlying the embedded clause constitutes a presupposition (and therefore everything implied by the proposition does), but for implicative verbs, the proposition underlying the embedded clause constitutes an entailment. This fact can be accounted for by the knowledge-based theory with the help of such entries as (7-7) and (7-8), where IC stands for ‘implicational clause.’

(7-7) knows(w,that (x (y,z))) ; Entailment IC: ... Presupposition IC: ...Y x-ed z. ...

(7-8) managed (to (x) (y,z)); Entailment IC: ...Y x-ed z. ... Presupposition IC: ...

Whether the entailed and presupposed propositions are considered logical or factual will depend on what part of the knowledge base – logical or factual – the entry in which they occur as the argument appears, as was suggested above.

The technique of using separate implicational clauses for factual and nonfactual information and for entailments and presuppositions may also be used for distinguishing between denotational and connotational implications.
Let us look now at Jackendoff’s multi-level semantic representation. Under his theory (see 3.4), semantic representation consists of four separate levels: functional structure (expressing thematic relations), modal structure (expressing the scope of logical elements, and so forth), table of coreference (expressing coreferentiality of noun phrases), and focus and presupposition (expressing entailed and presupposed information). The knowledge-based theory, on the other hand, proposes a single-level representation. The reason for the difference is because, in Jackendoff’s theory, representation is equivalent to interpretation, whereas in the knowledge-based theory, the representation has the form of a phrase marker and the interpretation is the pairing of the phrase marker, mapped onto the knowledge base, with the implicational clauses produced as a result of the mapping. So, for instance, identifying that, in the sentence Fred sold John an apple, apple is the Theme, on Jackendoff’s theory, says all there is to be said about the semantic function the word apple plays in the sentence. In the modal structure, it is the bracketing of the logical elements which indicates how the sentence is to be interpreted (what is the scope of the logical elements), for instance, (not{many (hit)}) for sentence negation, and

\footnote{In Chomsky’s logical form, the factoring out of quantifiers and wh words serves the same purpose of scope representation. For Chomsky, therefore, representation also is equivalent to interpretation.}
(many(not(hit))) for verb-phrase negation. Similarly, the representation of focus and presupposition constitute the interpretation of this type of information. In the knowledge-base theory, however, it is the position of the word apple in the semantic marker — the fact that it is the second argument — and that its predicate is sold which is used to produce the implicational clause; part of it should constitute the implications of Theme. Likewise, it is the position of not in the semantic marker that indicates the effect of negation (see 6.3). The subject of interpreting focus has not been discussed under the knowledge-based theory but there does not appear to be any reason why its mechanisms would not be able to handle such constructions. As to the table of coreference, it is equivalent to the indices in the indexed surface structure serving as the input to the knowledge component. The knowledge-based theory, therefore, is capable of accounting for all the information contained in the four-level representation proposed under Jackendoff's theory. The knowledge-based theory, however, has the advantage that it shows what it means to be a Theme, a Source, a Goal, and so forth, whereas in Jackendoff's scheme, the concepts have to be assumed to be semantic universals. Likewise, in the case of logical elements, the knowledge component actually produces all the readings of the sentence, with all their implications, whereas, in Jackendoff's scheme the implications remain unspecified. (I am assuming that the representations for
quantifiers are the correct ones, not the ones Jackendoff (1972) proposes; see 6.3.)

Because of not being based on untestable precepts, as the decompositional theories are, the knowledge-based theory is empirical. All of the solutions proposed under it are based on analyses of data and, thus, may be revised. In addition to this, the knowledge-based theory answers some questions it is legitimate to ask of a semantic theory but which other theories either do not address themselves to or dismiss as lying outside their scope. — The knowledge-based theory is capable of accounting for all implications of a sentence, what is generally known as logical and factual presupposition and entailment. But, if need be, the theory is capable of distinguishing between these types of implications, to the degree that it is possible, as was shown above. The theory also shows how a sentence with an unknown element is interpreted, as well as one with an anomalous phrase. The theory, finally, shows what happens when a sentence is not interpreted as a whole. One cannot deny that all of these questions are legitimate and there are no a priori grounds for dismissing them as inappropriate.— A theory cannot be considered scientific if it dismisses a question pertaining to the theory's area of interest off hand. As was said earlier, this can be done only after the issue has been studied and the mechanisms or
processes underlying it are shown to clash in some predefined way with the mechanisms belonging in the theory. One of the most interesting consequences of the knowledge-based theory is that it suggests that there are two processes by which a sentence may be interpreted — by an existing implicational clause in the knowledge base being used in the output implicational clause or by a newly created implicational clause being used. In defining the meaning-extension process (6-84), it was said that it is used only for propositions marked with asterisks, that is, anomalous expressions. It appears that, in practice, this does not have to be true. Bear in mind that a sentence is normally spoken in some context. Now, the context will frequently suggest what the sentence means. So, interpretation may be looked at as a fitting of a sentence onto a meaning. In such a case, then, even though the propositions underlying the sentence are not anomalous, their implicational clauses might have to be modified to fit the context (meaning). For instance, imagine the sentence *The gentleman is taking out the lady* being uttered, referring to a male and a female dog busily trotting down the street. Here, the sentence appears to be semantically perfectly well-formed but it does not mean what it appears to say. Yet, the sentence also is not merely saying *There go a male and a female dog busily trotting down the street*. Apparently, the sentence speaks of some formal, polite relationship between the two dogs, of both of them looking
very prim and proper, and so forth. So, the sentence is appropriate. What must take place in the interpretation, then, is that the meanings of some of the words in the sentence – namely *gentleman*, *take out*, and *lady* – have been modified; and they must have been modified according to the process (6-84). The above example might be an extreme case but I suspect that similar, less drastic processes of meaning extension take place very frequently during sentence interpretation. In chapter three, J. D. Fodor (1977) was quoted as observing that ‘the meaning of a word is something pretty threadbare, [...] (contrary to commonly received views) it does not even in principle determine the extension of the word.’ (p. 149) I think, we now have an answer why this is so. – Because the implicational clause of the entry underlying a word may frequently not be used but may be modified to fit the physical and linguistic context. The meaning (implications) of a sentence may be viewed, then, as not something invariable, even for a given knowledge base, but as, again, potentially infinitely variable, generated by the mechanisms of the semantic component not unlike a syntactic phrase marker is generated by the mechanisms of the syntactic component. I think, then, that it is reasonable to assume that the meaning-extension process (6-84) is the basic process in sentence interpretation, which must be part of generative grammar and that what appears to be the ‘normal’ interpretation process of using
existing implicational clauses is a simpler, 'special-case' variant of the other one.

As a final observation on the meaning-extension process, consider the following. Assume that we know that a person named John is five feet nine inches tall and someone says, referring to John, John is ten feet tall. Since, in the knowledge base, John implies John is five feet nine inches tall and since the input sentence (every sentence implies itself) implies John is ten feet tall, a clash will occur during the process of mapping the input semantic marker onto the knowledge base. The sentence will thus not be able to receive an interpretation through the straightforward process of compounding of implicational clauses. At this point, there are three ways, semantically speaking, that the sentence may be treated. — It may be considered a metaphor, receiving an interpretation according to the meaning-extension process; it may be considered a statement of factual error; or it may be considered a lie (or an exaggeration). In the case of the given sentence, the first choice is likely to be made. This decision must be reached because the sentence is not likely to be a statement of factual error or a lie since people never grow to be ten feet tall. That is, the decision must be reached on some nonlinguistic grounds (on the grounds of probability). And this must be true in making any of the three choices. Consider, for instance, what would happen if
the input sentence were *John is five feet ten inches tall*. If the speaker is known to be a habitual liar or if he or she stands to gain something by lying, the statement may be considered a lie. If, however, the speaker is not deemed to be in a position to know John's true height, the sentence may be considered a statement of factual error. This sentence is not likely to be considered a metaphor because nothing particularly interesting can be attributed to a person five feet ten inches tall (but *ten feet tall* implies *outstanding*). So, we see that for any situation involving a clash between the input semantic marker and the knowledge base, nonlinguistic processes such as the above must come into play. But, on the other hand, when a sentence is considered to be a statement of factual error or a lie, the hearer, obviously, must first go through the meaning-extension process, so as to conclude, on nonlinguistic grounds, which of the three possibilities is the most likely. The meaning-extension process (6-84), therefore, must truly be very frequently used during the process of interpretation, not only in cases of metaphorical interpretations but in those involving statements of factual error as well as lying. He may conclude, then, that whether or not a sentence is considered to involve the meaning-extension process is considered a matter of performance, but that in all instances of a clash between the input sentence and the knowledge base, the meaning-extension process comes into play.
Concluding, I would like to make the following observation. Kempson (1977) argues for truth-based semantics\(^3\) as the theory of the semantics of natural language. Under this approach, she says,

‘to give the meaning of a sentence in terms of the necessary and sufficient conditions for the truth of that sentence is to provide a specification from which entailments of a sentence can be derived by an automatic procedure.’ (p. 39)

This sounds appealing except that neither Kempson nor, to my knowledge, anyone else (with a possible exception of Montague) has shown how this can be accomplished. It is this fact that has led Chomsky (1980b), p. 116, to argue against this approach, as was said earlier. Again, I am not sure if this is true but it appears that the implicational clause connected with each proposition in the knowledge base, by specifying the implications of the proposition, specifies the conditions under which the proposition is true. So, the knowledge-based approach seems, at least to some extent, to be an implementation of truth-based semantics. Davidson (1970) seems to support this when he says: ‘there is no giving the truth conditions of all sentences without showing that some sentences are logical consequences of others.’ (p. 248) It is interesting to note

\(^3\)See Davidson (1970) for an elaboration of the approach, which is based on Tarski (1947).
that Davidson also suggests that pursuing the objectives of truth-based semantics will lead to a situation where

'some problems that have dominated recent work on semantics will fade in importance: the attempt to give "the meaning" of sentences, and to account for synonymy, analyticity and ambiguity. For the first of these, the theory of truth provides a kind of substitute; the second and third become unnecessary appendages; the fourth reappears in a special form.' (p. 250)

This coincides with the attitudes voiced under the knowledge-based theory.


'Semantics,' Lyons (1963), pp. 166-84.


pp. 62-119.


Fillmore, C. J. (1968). ‘The Case for Case,’ Bach and Harms (1968), pp. 1-90-


--------- (1972a). 'Logical Form,' Foundations of


-----------. (1968). Introduction to Theoretical


Boston.


---------- . (1965). ‘How Not to Talk About Meaning,’ Cohen,


