Because of the way certain combinations of positions on these questions and reasons have been associated with various schools of linguistics, it is important to point out that they have a degree of independence which may not always have been recognized. If decomposition is desirable because of reasons (1) and/or (2), question (II) is not thereby answered automatically; we must still look at reason (3) and other considerations to decide it. But conversely, if reason (3) is rejected, some "semantic" decomposition analyses may still be useful because of (1) or (2).

NOTES

[1] This is easy to demonstrate, once one observes that because of the lambda-operators, there is for any λ-deep structure an equivalent λ-deep structure with any word transposed to the beginning or end (and therefore, another equivalent λ-deep structure with another word transposed, etc.); cf. Ruttenberg (1976) for discussion.

[2] See Goodman (1976) for a formulation of these principles as a transformational syntax for deriving surface structures from λ-deep structures.

[3] Actually, Cooper and Parsons use this same transformation to effect "quantifier lowering" for quantifications over CN and IV phrases, as well as over sentences. Thus the label "S" in the structural description should really be replaced by the disjunctive label "S or CN or VP". The phrase structure rules that initially produce these other input quantifier structures are thus different from (10) though similar to it.

[4] As mentioned later in the text, this "translation algebra" is not really the same thing as the syntactic algebra of the intensional logic itself, but rather consists of the later algebra "expanded" to include derived syntactical rules formed by combining two or more operations. For example, the translation rule that gives $\alpha'(\hat{}\beta')$ is really the composition of the operation producing $\delta(\gamma)$ from δ and γ with the operation producing $\hat{}\zeta$ from ζ.

CHAPTER 2

THE SEMANTICS OF ASPECTUAL CLASSES OF VERBS IN ENGLISH

In this chapter I will present a set of lexical decomposition analyses of classes of verbs in English. Their place in the present work is to provide a "case study" from a natural language with which to illustrate the theoretical issues presented at the end of the last chapter. These analyses are based in part on my own previous work in this area (Dowty, 1972), but aside from my own familiarity with this area, there are good reasons for choosing this topic here. The problems connected with these verb classes touch on the best-known kinds of analyses of word meaning in generative semantics (with the possible exception of those in Postal's 'Remind' (Postal, 1970)) and the strongest independent syntactic arguments for this kind of analysis. Whether or not the problems that arise here are really typical of those that would arise with many other kinds of word meanings, they are in any case central as far as existing research goes. Also, this case study provides a good example of how the analysis of "logical words" (here tenses and time adverbials) can depend on the semantic analysis of "non-logical" words. Finally, these classes of verbs have a tradition of study in philosophy that goes back to Aristotle.

The plan of the chapter is to begin with a brief introduction to the generative semantics theory of lexical decomposition, then to present the analyses from the implicit point of view of the "classical GS" theory along with an explanation of the "structural motivation" that linguists might recognize as supporting such analyses – that is, citation of syntactic, morphological and semantic patterns and regularities that these analyses can be said to explain in some sense. At the same time, these decomposition analyses are treated as forming a fragment of a "Natural Logic" for which explicit model-theoretic interpretation is given. In later chapters we will modify these analyses, examine the independent syntactic motivation for treating them as underlying syntactic structures of English, and consider the alternative of capturing the same semantic effect of these decomposition analyses by using the translation function and other constraints on model-theoretic interpretation, rather than by appealing to abstract deep structures.

CHAPTER 2

2.1. THE DEVELOPMENT OF DECOMPOSITION ANALYSIS IN GS

2.1.1. *Pre-GS decomposition analyses*

As mentioned in the introduction, decomposition analysis of word meaning in modern linguistics originates with the early structuralist writings of Hjelmslev (1953) and Jakobson (1936), if not earlier. The standard Hjelmslev example, the data for which is repeated below, is motivated by purely *paradigmatic* considerations at the semantic level.

(1)

woman	man	child
cow	bull	calf
mare	stallion	foal
hen	rooster	chick

That is, when attention is paid to the way members of the same paradigm (the same distributional class, which is in this case common nouns) contrast with each other semantically, certain contrasts appear repeatedly. In this set of words, all the words in the first column contrast with the third in the same way, and all the words in a row contrast with corresponding words in some other row in the same way. This systematic relationship is described by assigning the semantic component (or *semantic feature* or *semantic marker*) *female* to all the words in the first column, the component *male* to those words in the second column, the component *adult* to the words in both the first two columns, the component *non-adult* to the third column, and components such as *human, bovine, equine*, etc. to various rows. When one has gone through the entire vocabulary of the language postulating and assigning semantic markers in this way, one should in theory be able to distinguish the meaning of any word from that of any other by inspecting the semantic markers assigned to each of them, in exactly the same way as one distinguishes in phonological theory any phoneme of the language from any other by inspecting the phonological features assigned to them. If this feature system is adequate to represent all the semantic *contrasts* evidenced in the language and is the "optimal" feature system for doing so, then according to structuralist semantic theories, the task of semantics is done. We need not inquire further what sort of entities these features *adult, female, human*, etc. are, but may safely take them as primitives of the semantic theory. Though more recent versions of structural theories such as Katz' have been enlarged and modified in various ways, this basic view of the componential analysis of

word meaning seems to have survived intact. If one looks at Katz' recent analysis of the meaning of *chair*, exactly the same motivation seems to be present (Katz, 1972, p. 40):

(2) (Object) (Physical) (Non-living) (Artifact) (Furniture) (Portable) (Something with legs) (something with a back) (something with a seat) (seat for one)

Here, (Object) distinguishes the meaning of *chair* from that of abstract words like *number*, (Physical) distinguishes it from *deity*, (Non-living) from *tree*, (Artifact) from *mountain*, (Furniture) from *house*, (Portable) from *bed*, (Something with legs) from *wastebasket*, (Something with a back) from *stool*, (Something with a seat) from *table*, (Seat for one) from *bench*. Katz is of course not the only modern proponent of this approach. A recent textbook in "linguistic semantics" (Dillon, 1977) is concerned largely with analysis into primitive components of just this sort.

My point here is not to argue the usefulness of this sort of decomposition, (though I am inclined to doubt that it has great value). Rather, I want to point out that if we ask what consequences such analysis will have in a theory of reference, there seems to be only one possible answer: what is going on here is simply that the denotations of extensional predicates are being defined in terms of the intersections of the denotations of other, supposedly more basic extensional predicates. As Cresswell points out (Cresswell, 1975, p. 14), Katz' analysis of *chair* is, from a referential point of view, tantamount to saying that *x is a chair* is analyzed as a conjunction (3),

(3) $object'(x)$ & $physical'(x)$ & . . . & $seat\text{-}for\text{-}one'(x)$

where *object'*, *physical'*, . . . *seat-for-one'* are all extensional first-order predicates of an artificial language of linguistic theory, since clearly chairs are just those things which are objects, physical, . . . and seats for one. If we add binary semantic features to our repertory (i.e., a feature of the form $-\alpha$ for each feature α, such as $-$*human*, as well as $+$*human*), then we have in effect added negation as well as conjunction to our "markerese" language.[1] We must regard these predicates as essentially *non-logical constants*, in the sense that nothing whatsoever is said in Katz' theory that would determine *which* individuals are to be in the extension of each of these predicates.

One thing that this "conjunctive" decomposition of course buys us is the ability to reduce certain entailments in natural language among apparently "non-logical" words to logical entailments that are definable in terms of the sentential operators &, ∨, ¬, and →. Thus for example, if we do not

decompose *bachelor* and *unmarried man*, example (4) will at best have the logical form (5), and this formula will not (in the absence of meaning postulates or other restrictions on possible interpretations) count as a valid (or analytic) formula.

(4) Every bachelor is an unmarried man.

(5) $\Lambda x\,[bachelor(x) \rightarrow [\neg married(x)\ \&\ man(x)]\,]$

If however we decompose *bachelor* into the markers (*— married*), (*adult*), and (*male*) and decompose *man* as (*adult*) and (*male*), then the resulting logical form of (4) will be a valid formula of standard first-order logic:

(6) $\Lambda x\,[[\neg married(x)\ \&\ adult(x)\ \&\ male(x)] \rightarrow [\neg married(x)\ \&\ adult(x)\ \&\ male(x)]\,]$

(If "¬*married*" were represented as a single marker (*unmarried*), or if it were further decomposed into a conjunction of predicates, then the formula would be valid just the same.) Given this apparent equivalence between semantic markers of this sort and conjunctions of predicates, it is hard to see how Katz' definition of *entailment* in terms of containment of one reading (group of markers) in another is anything but a degenerate or equivalent version of entailment as defined in first-order logic. Whether *all* entailments in natural language among extensional predicates can be captured economically by this method remains an open question, since no thorough treatment of this sort of a large segment of the vocabuluary of any language exists.

I will have nothing more to say about such conjunctive, purely extensional decompositions. The decomposition analyses to be considered below are supported linguistically by quite a different sort of evidence than the purely paradigmatic considerations illustrated above, and as they involve modal and tense operators and connectives rather than extensional predicates, the semantic problems in constructing a referential basis for them are much more complex.

2.1.2. *Causatives and Inchoatives in Lakoff's Dissertation*

The development of the verb analysis we will be concerned with begins in part with Lakoff (1965).[2] One set of sentence forms that Lakoff was concerned with were triads like (7a-c) and (8a-c).

(7) a. The soup was cool
b. The soup cooled
c. John cooled the soup

(8) a. The metal was hard
b. The metal hardened
c. John hardened the metal

As similar triads can be found with quite a large number of verbs in English, a systematic syntactic relationship is clearly involved from the point of view of the transformational grammarian of 1965. That is, the same "deep grammatical relation" is intuitively evident (or seemed evident then) between subject and predicate in the (a) and (b) sentences of the sets, and a similar relation holds between verb and object in (c). Parallel selectional restrictions also hold for the three kinds of sentence – that is, if we pick an inappropriate subject for the (a) example (**The prime number is cool*), then we can correctly predict that the (b) example (**The prime number cooled*) and the (c) example (**John cooled the prime number*) will be equally inappropriate. As these three sentences could not be derived from the same deep structure under the then universally accepted hypothesis that transformations preserve meaning, Lakoff had to seek distinct though related deep structure sources for the (b) and (c) examples. He noted the following types of sentences:

(9) a. The soup cooled.
b. The soup became cool.
c. The soup came to be cool.
d. It came about that the soup was cool.
e. That the soup was cool came about.

As examples of the form of (9a) and (9b) are virtually synonymous and differ very little in syntactic form, Lakoff noted that it would be plausible that they were derived from the same or almost the same deep structure. Assuming that this was in fact the case, Lakoff made a similar observation about (9b) and (9c). But (9c) can be seen as a transformed version of (9d), the transformation in this case being the well-motivated Raising-to-Subject transformation (at that time known as *It*-replacement). And (9d) is the extraposed form of (9e). (Some treatments of Raising would derive (9c) directly from (9e), without extraposition.) If all the sentences (9a)-(9e) come from the same or nearly the same deep structure source, then this source or sources most closely resemble (9e), where there is a sentential subject *The soup is cool* and an intransitive verb *come about*. As abstract

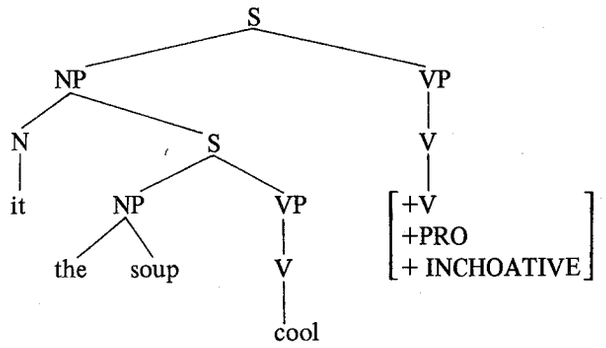
deep structure elements with semantic significance were coming into vogue at that time (cf. Katz and Postal's (1964) *Neg* and *Q*), (9a) was considered by Lakoff to differ from the others in having an abstract verb with the feature +INCHOATIVE where the others had real verbs *become* or *come about* with about the same meaning. As the deep structure of (7a) is contained within that of (7b) under this analysis, the coincidence of grammatical relations and selectional restrictions is thereby predicted.

The situation with (7c) is quite parallel. One can find paraphrases of (7c) which are plausibly transformational variants of it but have one more clause than (7b), just as (7b) has one more clause than (7a):

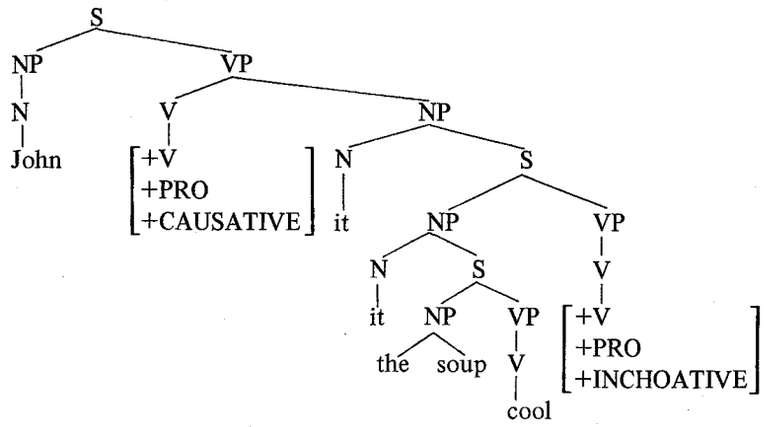
(10) a. John cooled the soup.
b. John caused the soup to cool.
c. John made the soup cool.
d. John caused the soup to become cool.
e. John brought it about that the soup was cool.
f. John caused it to come about that the soup was cool.

If all of (10a)-(10f) come from the same or at least structurally identical deep structures, then those structures will contain the deep structure of (7b) embedded in a higher sentence which has the main verb *cause, make*, or the semantically similar abstract verb with the feature +CAUSATIVE. Here again, the parallel grammatical relations, selectional restrictions and meaning between (7b) and (7c) are accounted for. Lakoff's deep structures for (7b) and (7c) are (7b′) and (7c′) respectively. The feature +PRO indicates that the verbs are abstract.

(7b′)



(7c′)



For these deep structures, obligatory transformations will replace the abstract verbs with the real lexical verb from the lower clause, thus reducing the two or three clauses of the deep structure to a single clause in each case. The causative transformation is not limited to cases where the verb has previously undergone the inchoative transformation, however:

(11) a. The window broke.
b. John broke the window.

(12) a. The horse galloped.
b. John galloped the horse.

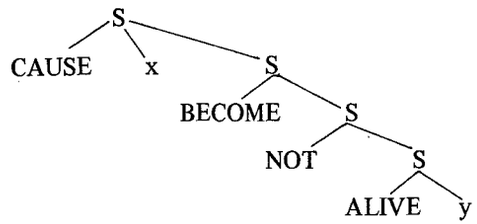
The (b) example was derived from the (a) example in these cases according to Lakoff's analysis, though *break* and *gallop* have no adjectival, non-inchoative counterparts.

2.1.3. *McCawley's Post-Transformational Lexical Insertion*

As abstract lexical items with semantical significance began to proliferate in deep structures in the later 1960's, Lakoff, James McCawley, J. R. Ross and others began to suggest that the "deepest" level of underlying syntactic structure would turn out to have all the properties formerly attributed to semantic representation – i.e. a "level" of linguistic structure fully representing the meaning of a sentence but not containing words specific to a single

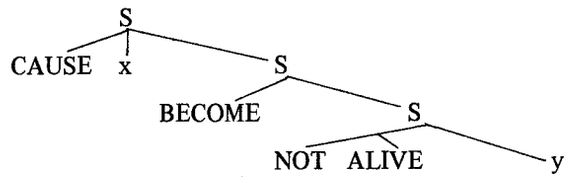
natural language. As it was assumed that most "surface" English words would be represented at this deepest level by complex expressions rather than by single elements (indeed, this view was no doubt taken over without question from the decomposition approach of earlier linguists), attention turned to the question of just how individual lexical items of a language came to replace multiple parts of an underlying tree in the course of a derivation. McCawley's (1968) proposal for this problem came to be the most influential one. He used as an example the verb *kill*, and suggested that it be analyzed into components CAUSE, BECOME, NOT and ALIVE in the following way, where the tree represents the underlying structure of *x kills y*:

(13)

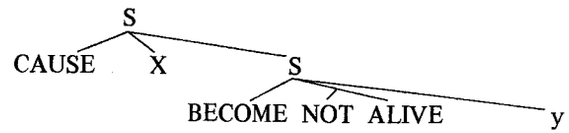


Note that the parts of the treee corresponding to *kill* do not form a constituent (are not dominated by a single node that dominates nothing else). McCawley suggested that transformations would have to rearrange these parts of the tree to form a single constituent before lexical transformation could insert the single word *kill*. This followed the independently motivated principle in transformational grammar that a transformation typically replaces or moves a single constituent rather than parts of different constituents. (Gruber (1965; 1967) proposed a similar theory which did not assume that such elements underlying words had to first be grouped together in this way – the so-called *polycategorial lexical attachment* theory.) McCawley thus postulated a transformation of *Predicate Lifting* (later, *Predicate Raising*) which attaches a predicate (element such as CAUSE, BECOME, NOT, and ALIVE in this tree, though they are not so labeled by McCawley) to the predicate of the next higher sentence. Thus successive stages of the derivation of a surface structure from (13) would be the following:

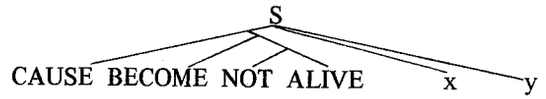
(14)



(15)



(16)



At this last stage, (16), the elements corresponding to *kill* form a single constituent, and a lexical insertion transformation will replace a sub-tree consisting of just this collection of elements with the word *kill*.

The predicate-raising transformation was to be an optional one at each stage. If it did not apply at all these stages in a derivation from (13), different lexical items would be inserted to replace the different abstract elements or groups of elements that ended up as single constituents. Thus from the same deep structure, other English sentences could also be derived such as *x causes y to become not alive, x causes y to become dead, x causes y to die,* and *x bring it about that y is dead* (assuming later substitution of noun phrases for the variables).

Also, perfectly well-formed underlying structures might be converted by this transformation into structures for which no existing English words would be appropriate. Suppose the lowest predicate ALIVE in (13) were replaced with a predicate OBNOXIOUS (again, this is an abstract semantic unit, possibly complex itself, not the English word *obnoxious*). If all the same applications of predicate raising took place as in the above derivation, a constituent containing CAUSE-BECOME-NOT-OBNOXIOUS would arise, but there is no English word answering to this meaning. In such cases the derivation "blocks" since not all abstract elements can be replaced with words. This is not a new situation in transformational grammar, since transformations have been used to "filter out" undesired derivations since Chomsky (1965).

2.1.4. *Paradigmatic and Syntagmatic Evidence for Decomposition*

We might now consider the question why this particular analysis of *kill*, as opposed to any other conceivable analysis, should be considered the correct one. Of course, McCawley was only interested here in illustrating the method of lexical insertion, and perhaps did not intend this to be taken too seriously as an analysis of *kill*. Nevertheless, the analysis became a standard

one, and there are fairly clear reasons why it would seem motivated, given the traditional linguistic structuralist approach to meaning. Note the similarity of McCawley's analysis to Lakoff's analysis of derived causatives and inchoatives. (Certain differences in the ways the trees are drawn should not be taken too seriously – such as the fact that verbs precede sentential subjects in McCawley's tree but follow them in Lakoff's, or the absence of node labels and feature notation in McCawley's tree.) McCawley's analysis would assign the same relationship among (17a)-(17c) as among (7a)-(7c) (repeated below):

(7) a. The soup is cool.
b. The soup cooled.
c. John cooled the soup.

(17) a. Harry is dead (not alive).
b. Harry died.
c. John killed Harry.

Clearly, the semantic relationship among the three sentences is the same or approximately the same in (7) and (17). Here McCawley has made the analytic leap of going from one case, (7), where certain "units of meaning" are supposedly needed to describe a morphologically-motivated relationship among sentences, to a set of morphologically unrelated cases in (17), where the same semantic relationship seems to obtain, giving it the same analysis as the first case. Why would this be justified? Regardless of what McCawley may have intended, I think subsequent generative semanticists have seen this as a justified (or at least initially plausible) inference because of the assumption that all word meanings are built up out of a single set of fundamental units, and wherever one recognizes the same aspect of meaning, the same unit must be present. If an abstract causative and inchoative predicate are involved in (7), they must be involved in (17) as well. But there is a more basic question now: why, if at all, should the units of meaning contrasting (7a) with (7b) and (7b) with (7c) be basic, rather than some arbitrary combination of more basic units? Of course McCawley and other generative semanticists were careful to point out that these "predicates" might turn out not to be basic, but again they in fact have tended to be taken as basic, and for a methodological reason which became increasingly important in GS, if never explicitly stated. In the causative and inchoative cases we have different syntactic constructions based on the same basic lexical items but with a "unit of meaning" present in one that is not present in the other. As we shall see illustrated later in this chapter, the same "units of meaning" tend to appear

over and over as distinguishing other pairs of syntactically related constructions containing the same basic words. The idea seems to have arisen in GS that where this happens, the "unit of meaning" is a primitive element, an "atomic predicate." This is but another way of extending structuralist methodology to semantics – the theory of language is to be justified entirely on the contrasts and patterns evidenced in the language itself. In generative semantics of course, a particular *syntactic* explanation is given to this phenomenon: the meaningful element is present in underlying syntactic structure, and this explains how transformations can be sensitive to it. (I will suggest later, however, that we need not adopt this generative semantics syntactic explanation of such phenomena even though we take them as clues as to how to structure a semantic analysis.)

What is of interest here is that such cases present quite a different kind of evidence for basic semantic units than the paradigmatic considerations illustrated earlier with Hjelmslev's example. There the basic units were thought to be revealed by contrasts in different words of the same distribution, here they are revealed by syntagmatic considerations, differences in meaning that somehow attach to specific syntactic constructions, regardless of the words occurring in them. Such syntagmatic contrasts are far fewer in number than the multitude of possible contrasts among words of an entire vocabulary and are thus easier to investigate thoroughly. A further reason why these syntagmatic contrasts are of greater theoretical interest than the paradigmatic ones is that compositional semantics naturally plays a more basic role in developing a semantic theory than does word semantics (at least in theories such as Montague's, though not of course in traditional linguistic semantics). If such "semantic units" as CAUSE and BECOME are involved in the semantics of syntactic rules in the kinds of sentences discussed by Lakoff, but in a way that cannot be attributed to the basic words occurring in them, then these units are necessarily the concern of compositional semantics as well as word semantics. Most of the evidence to be presented later for postulating certain decomposition analyses is in fact of this syntagmatic variety, though the question of whether the rules involved are syntactic rules proper or a different kind of formation rule will also have to be considered.

2.1.5. *The Place of Lexical Insertion Transformations in a GS Derivation*

Having pointed out that general theoretical considerations led him to hypothesize that at least one transformation – predicate raising – must apply in a derivation before certain lexical items could be transformationally

inserted, McCawley raised the question of at just what stages of a derivation lexical insertion might apply. As the matter developed in subsequent research, there are two main ways that this might happen. First, the lexicalization of words with multiple parts to their underlying representations might happen essentially as McCawley illustrated for *kill* – that there is one and only one lexicalization rule involved in deriving this word, a transformation replacing the subtree consisting of the four abstract predicates CAUSE, BECOME, NOT and ALIVE with *kill*. The second possibility is that this lexicalization happens in stages – that after each step of predicate raising, a transformation replaces the newly derived complex predicate of that step by a word of English (if there is a word for that stage). In this second method (though not necessarily in the first method), the lexicalization transformations are cyclical; they apply first to the most deeply embedded clause, then to the next higher clause, and so on. In the case of the derivation of *kill*, the predicate ALIVE is lexicalized as *alive* on the first cycle (most deeply embedded clause). When transformations are then applied to the next higher clause, *alive* is predicate-raised and attached to NOT, yielding the "hybrid" verb [NOT *alive*]$_V$. Then another lexicalization transformation replaces [NOT *alive*]$_V$ with *dead*. At the next higher cycle after this, *dead* is raised and attached to BECOME, yielding [BECOME *dead*]$_V$, and this is then lexicalized as *die*. Finally, on the highest cycle, *die* is raised to give [CAUSE *die*], and this lexicalizes as *kill*. Thus three lexicalization rules are involved in deriving *kill*. (In the first approach on the other hand, the lexicalization rules for *dead, die* and *alive* are quite independent of the rule for *kill* – one such rule replaces [BECOME [NOT ALIVE]] with *die*, another replaces [NOT ALIVE] with *dead*, etc.)

What significant differences are there, if any, between the two approaches? It seems that McCawley's approach, the first approach here, treats the relationship of *kill-die-dead* as the normal relationship to expect among adjectives and the semantically related inchoative and causative verbs. That is, the fact that the three words bear no predictable morphological relationship to each other presents no complication at all, since the rules inserting the three words depend only on their respective "meanings." Under the first approach, the grammar of English would be no more complicated if there were no instances of semantically "nested" groups of words with morphologically related forms (or identical forms, such as *cool* (Adjective) *cool* (intransitive verb) and *cool* (transitive verb)). But in fact, English has literally hundreds of such related words, plus even more cases where two out of the three forms exist but not the third. This first approach leaves such

cases of related words as apparent accidents, and thus linguists who adopted it would no doubt feel compelled to postulate some new theoretical device to describe these morphological regularities, something on the order of the *lexical redundancy rules* proposed by Jackendoff (1975).

The second method can obviously accommodate morphologically unrelated words like *dead-die-kill*, but can take into account the morphological form of words as well and thereby capitalize on systematic patterns. Thus instead of a long list of unrelated lexical causative transformations, replacing [CAUSE *cool*] with *cool*, [CAUSE *harden*] with *harden*, [CAUSE *break*] with *break*, etc., we can have a general rule replacing [CAUSE α] with α, where α is an already lexicalized verb.

One particularly striking kind of evidence for the latter kind of lexicalization rule (or perhaps better, *relexicalization* rule) was noticed by Binnick (1971), and independently by Charles Fillmore and David Perlmutter. An (exceptional) causative is *bring*, which is the causative form of *come*. There are numerous idiomatic expressions in English consisting of *come* plus a verb particle or adverb, such as *come down* "become depressed or less euphoric", *come off* "happen successfully (of parties, events, etc.)" *come to* "become conscious", and many others. What these investigators noticed is that for most of these idioms there is a second idiom with *bring* replacing *come* and paraphrasable by prefacing the paraphrase of the original idiom with "cause to." Thus *bring down* can mean "cause to become depressed or less euphoric", *bring off* can mean "cause to happen successfully", etc. It has been assumed in GS that idioms will have underlying structure not predictably related to their surface form, and thus have individual lexicalization rules replacing their semantic representation with a whole phrase. It would now appear quite accidental that the *come* idioms are paralleled by *bring* idioms without the possibility of lexicalization rules of the second type. With this type of rule, we can merely assume a lexicalization rule that replaces [CAUSE *come* α] with *bring* α, where α is an (already lexicalized) particle or adverb. Such a rule correctly predicts that the meaning of *come* α is irrelevant to the lexicalization of the causative form as *bring* α.

There are problems with this account of the *bring* idioms however. If all lexical replacement of multiply complex logical structures is done by the second (relexicalization) method, then we should expect to find idioms with verbs other than *come* to be regularly paralleled by causative forms of those idioms whenever the basic verb of the idiom has a causative form itself (in its literal meaning). But as Binnick notes (1971, p. 260), this is not the case with idioms in *go* and *send* (assuming *send* to be the causative form

of *go*), and I am not aware of any other verb whose idioms have the striking number of causative parallels that *come* idioms do. Of course a grammar might contain both kinds of rules – a general relexicalization rule for [CAUSE *come* α], but completely separate rules for lexicalizing *go* and *send* and all idioms in which these morphemes appear. Yet there are still problems. As Binnick notes, there are also quite a few idioms with *come* that are not paralleled by *bring* idioms, such as *come clean* "reveal the full truth," *come by* "get, obtain,", etc. Though such cases might be handled by restricting α in the lexicalization of [CAUSE *come* α],[3] other kinds of cases will be more recalcitrant.

As example (8) illustrated (*The metal was hard, The metal hardened, John hardened the metal*), *hard* is an adjective that has phonologically regular inchoative and causative verbal forms, thus presumably these should be accounted for by a general relexicalization rule. But as Lakoff noted (1965), when *hard* has the meaning "difficult" instead of the meaning "physically rigid or impenetrable", the inchoative and causative forms are not possible:

(18) The problems in this textbook are hard.

(19) a. The problems in this textbook get hard (harder) in the later chapters.
b. *The problems in this textbook harden in the later chapters.

(20) a. The author of the textbook made the problems hard (harder) in the later chapters.
b. *The author of the textbook hardened the problems in the later chapters.

This is the opposite of the Binnick cases – here it is the meaning and not the phonological form that determines whether lexicalization of causative and inchoative takes place. Yet for the other meaning of *hard*, we clearly do want to say that it falls under the phonologically-determined general pattern for English regular causatives and inchoatives, and if the phonological form is all that is at stake for that rule, then there would seem to be no way of excluding the relexicalization rule from applying to *hard* meaning "difficult." I don't know how many cases like *hard* there will be in which morphological and semantic criteria for lexicalization are in conflict,[4] but even a few such cases cast doubt on the claim that all lexicalization rules can be successfully formulated either completely in terms of meaning or else via relexicalization rules. (One could of course reply that there are homonyms $hard_1$ and $hard_2$ and that only one of these undergoes the general causative and inchoative relexicalization rules. But if a relexicalization rule is sensitive to the distinction between homonyms, then it is unclear that it really describes a generalization stated entirely in terms of the form but not the meaning of a word.)

Of course, relexicalization rules would have to be provided with a means for handling exceptions quite apart from troublesome cases like *hard*. There are many exceptions in English to the causative and inchoative patterns illustrated for *cool* and *hard* (cf. Lakoff, 1965), as there are to the various nominalization patterns. The point of this discussion is merely to establish that the device of post-transformational lexical insertion does not, as is sometimes supposed, unequivocally eliminate the problem of "exceptions" to lexical transformations.

Generative semanticists were not unaware of these problems (cf. Gruber, 1967). McCawley has pointed out (personal communication) that in writing McCawley (1968a) he had in mind "the sort of complex dictionary entry introduced by Gruber, in which specific morphological realizations were indicated for optional adjuncts to a semantic item," and "in addition, there is nothing to prevent general rules for the morphological realization of some of those items (e.g. BECOME → *-en*), with the general rules being overridden by any specific realizations given in particular dictionary entries." (This suggestion, of course, involves a more complicated theory of grammar than I have been describing, since the application of a general lexical insertion transformation would be constrained by properties of certain other, specific lexical insertion transformations that happened to be in the grammar. However, I believe the details of a solution to this problem were not generally agreed upon, nor have they been worked out explicitly since.)

2.2. THE ARISTOTLE-RYLE-KENNY-VENDLER VERB CLASSIFICATION

In this section I will introduce a classification of verbs (or rather, of verb phrases) that developed in the philosophical literature as a result of a distinction made originally by Aristotle. This is not to deny that the distinctions have been recognized at one time or another by various linguists, but attempts at a comprehensive analysis of these classes have been restricted until recently to philosophers (cf. Comrie (1976) for linguistic references). The relevance of the verb classification at this point in the book is that the differences among the various classes will turn out to be explained, to a remarkable degree, by the hypothesis that one verb class differs from another in which of the abstract operators CAUSE, BECOME or other such operators appear

in the Logical Structure of all verbs of each class; that is, the classes differ systematically in the way exemplified by the logical structures of the three words *cool* in (7a), (7b) and (7c), or the structures underlying the words *dead, die* and *kill* in McCawley's analyses.

I have earlier referred to this classification (Dowty, 1972) by the term *verb aspect*. This is not a wholly appropriate term, since *aspect* in linguistic terminology is usually understood to refer to different inflectional affixes, tenses, or other syntactic "frames" that verbs can acquire (*aspect markers*), thereby distinguishing "different ways of viewing the internal temporal constituency of a situation" (Comrie, 1976, p. 3). The Slavic languages provide the best-known examples of aspectual affixes for verbs. *Aspect* is distinguished from *tense* from the point of view of semantics in that tenses (like the tense operators of standard tense logics) serve to relate the time of a situation described to the time of speaking (as in past, present and future tenses), whereas *aspect* markers serve to distinguish such things as whether the beginning, middle or end of an event is being referred to, whether the event is a single one or a repeated one, and whether the event is completed or possibly left incomplete. By this use of the term *aspect*, the only instances of pure aspect markers in English are the progressive "tense" and the habitual quasi-auxiliary *used to* (phonetically [ˈyustə]), as in *I used to go to the movies on Saturday*. However, it is recognized that in all languages, semantic differences inherent in the meanings of verbs themselves cause them to have differing interpretations when combined with these aspect markers, and that certain of these kinds of verbs are restricted in the aspect markers and time adverbials they may occur with (Comrie, 1976, Chapter 2). It is because of this intricate interaction between classes of verbs and true aspect markers that the term *aspect* is justified in a wider sense to apply to the problem of understanding these classes of verbs as well, and it turns out to be this same classification of verbs which is the subject of the Aristotelian categorization. If it is necessary to distinguish the two uses of *aspect*, we can (following Johnson, 1977) distinguish the *aspectual class* of a verb (the Aristotelian class to which the basic verb belongs) from the *aspectual form* of the verb (the particular aspect marker or markers it occurs with in a given sentence).

2.2.1. *The Development of the Verb Classification*

It is Aristotle who is generally credited with the observation that the meanings of some verbs necessarily involve an "end" or "result" in a way that other verbs do not. In the *Metaphysics* 1048b, he distinguished between *kineseis*

(translated "movements") and *energiai* ("actualities"), a distinction which corresponds roughly to the distinction we shall be making between accomplishments and activities/states. However, Aristotle elsewhere made the distinctions differently and with different terms; couched in metaphysical discussions of the potential and the actual, these contrasts seem barely relevant to natural language semantics and perhaps even contradictory at times. Therefore the reader is referred to Kenny (1963: 173-183) for an exegesis of Aristotle and additional references. (Kenny also claims to have discovered in Aristotle's *De Anima* the distinction between states and activities.)

Despite these problems, several Oxford philosophers of this century have had a go at Aristotle's classes, and in ways that are increasingly relevant for linguistic methodology. The first of these was Gilbert Ryle, who in his book *The Concept of Mind* (Ryle, 1949, p. 149) coined the term *achievements* for the resultative verbs, to be distinguished from the irresultative *activities*. Achievements, such as *win, unearth, find, cure, convince, prove, cheat, unlock*, etc., are properly described as happening at a particular moment, while activites such as *keep (a secret), hold (the enemy at bay), kick, hunt,* and *listen*, may last throughout a long period of time. Ryle also noticed that achievements have a kind of semantic dichotomy that activities do not:

> One big difference between the logical force of a task verb and that of a corresponding achievement verb is that in applying an achievement verb we are asserting that some state of affairs obtains over and above that which consists in the performance, if any, of the subservient task activity. For a runner to win, not only must he run but also his rivals must be at the tape later than he; for a doctor to effect a cure, his patient must both be treated and be well again . . . (Ryle, 1943, p. 150)

However, he also distinguished a sub-class of achievements which lack this dichotomy, "which are prefaced by no task performances." Ryle also supplied a test for these "purely lucky achievements" in the form of a list of adverbs which cannot co-occur with them:

> . . . we can significantly say that someone has aimed in vain or successfully, but not that he has hit the target in vain or successfully; that he has treated his patient assiduously or unassiduously; but not that he has cured him assiduously or unassiduously; that he scanned the hedgerow slowly or rapidly, systematically or haphazardly, but not that he saw the nest slowly or rapidly, systematically or haphazardly. (Ryle, 1949, p. 151)

Additional test adverbs are *attentively, studiously, vigilantly, conscientiously,* and *pertinaciously*.

In *Action, Emotion and Will* (Kenny, 1963, pp. 171-186) Anthony Kenny brought more grammatical and logical criteria to bear on these classifications.

He observed that if ϕ is a *performance verb* (his term for the class that corresponds to Ryle's achievements) "A is (now) ϕing" implies "A has not (yet) ϕed." If a man is building a house, then he has not yet built it. But if ϕ is an activity verb, then "A is (now) ϕing" entails "A has ϕed." If I am living in Rome, then I already have lived in Rome. While Kenny apparently did not appreciate Ryle's distinction between achievements with an associated task and purely lucky achievements,[5] he did on the other hand make precise the distinction between *activities* and *states*. Activities and performances can occur in progressive tenses, states cannot: We say that a man is learning how to swim, but not that he is knowing how to swim. On the other hand, the simple present of activities and performances always has a frequentative or habitual meaning (*John listens to Mary, John builds houses*) in a way that the simple present of states does not; *John knows the answer* is not frequentative. (The rest of Kenny's tests are incorporated below.)

It was Zeno Vendler who first attempted to separate four distinct categories of verbs by their restrictions on time adverbials, tenses, and logical entailments (Vendler, 1967). He distinguished *states, activities, accomplishments* (which are Kenny's performatives, Ryle's "achievements with an associated task"), and *achievements* (which are Ryle's "purely lucky achievements" or "achievements without an associated task"). This terminology will be adopted throughout the present work. Examples of verbs from Vendler's four categories are listed below:

States	*Activities*	*Accomplishments*	*Achievements*
know	run	paint a picture	recognize
believe	walk	make a chair	spot
have	swim	deliver a sermon	find
desire	push a cart	draw a circle	lose
love	drive a car	push a cart	reach
		recover from illness	die

One of the things which seemed to bother Vendler was the question of how the four categories should be grouped together. He considered states and achievements to belong to one "genus" and activities and accomplishments to belong to another, on the basis of the fact that the first two categories lack progressive tenses while the second pair allow them. (We shall see that states and achievements also fail the tests for agency, unlike the other two classes.) Yet he also noticed that achievements and accomplishments share some properties (e.g., they take time adverbials with *in*, such as *in an hour*) which activities and states lack. What we will attempt to do in the analysis that follows is not merely arrive at the most pleasing taxonomy of four or more categories of verbs, but to try to explain by the analysis given just why each of the categories or combinations of categories has the properties it does.

2.2.2. *States and Activities*

The distinction between states and activities (or actually between states on the one hand and activities and accomplishments on the other) is familiar to the linguist as the distinction *stative* vs. *non-stative*[6] drawn by Lakoff in his thesis (Lakoff, 1965) and does not require extensive discussion here. The usual tests are as follows (*know* is a stative, *run* is an activity, and *build* is an accomplishment):

I. Only non-statives occur in the progressive:

(21) a. *John is knowing the answer.
b. John is running.
c. John is building a house.

II. Only non-statives occur as complements of *force* and *persuade*:

(22) a. *John forced Harry to know the answer.
b. John persuaded Harry to run.
c. John forced Harry to build a house.

III. Only non-statives can occur as imperatives:

(23) a. *Know the answer!
b. Run!
c. Build a house!

IV. Only non-statives co-occur with the adverbs *deliberately, carefully*:

(24) a. *John deliberately knew the answer.
b. John ran carefully.
c. John carefully built a house.

V. Only non-statives appear in Pseudo-cleft constructions:

(25) a. *What John did was know the answer.
b. What John did was run.
c. What John did was build a house.

VI. As Kenny noted, when an activity or accomplishment occurs in the

simple present tense (or in any non-progressive tense), it has a frequentative (or habitual) interpretation in normal contexts. If (26b) and (26c) are not used in one of a few specialized contexts (e.g. used by an announcer at a sports event, appear as a stage direction, appear in a narrative in the historical present), then they are understood to involve more than one event of reciting a poem or running respectively. But (26a) does not involve more than one occasion of knowing the answer. (The third example is changed from *build a house* to *recite a poem*, because one cannot build the same house more than once, so the frequentative interpretation would be problematic.)

(26) a. John knows the answer.
b. John runs.
c. John recites a poem.

(The behavior of achievements with respect to the stativity tests is complicated and will be discussed below.)

2.2.3. *Activities and Accomplishments*

Activities and accomplishments are distinguished by restrictions on the form of time adverbials they can take and by the entailments they have when various time adverbial phrases are present.

I. Whereas accomplishment verbs take adverbial prepositional phrases with *in* but only very marginally take adverbials with *for*, activity verbs allow only the *for*-phrases:

(27) a. ?John painted a picture for an hour.
b. John painted a picture in an hour.

(28) a. John walked for an hour.
b. (*)John walked in an hour.

II. Almost parallel semantically to the *for-an-hour* sentences and the *in-an-hour* sentences above are (29) and (30):

(29) a. John spent an hour painting a picture.
b. It took John an hour to paint a picture.

(30) a. John spent an hour walking.
b. (*)It took John an hour to walk.

(Though (30b) and perhaps even (28b) have acceptable readings, *an hour* in these readings does not describe the duration of John's action as it does in (27b) and (29b), but rather seems to give the time that elapsed *before* John actually began to walk. The full explanation of these readings cannot be given until Chapter 7, however.)

III. The entailments of activity verbs with *for*-phrases differ from those of accomplishment verbs under the same conditions. If John walked for an hour, then, at any time during that hour it was true that John walked. But if John painted a picture for an hour, then it is not the case that he painted a picture at any time during that hour. This difference in entailment might be represented as in (31):

(31) If ϕ is an activity verb, then *x ϕed for y time* entails that at any time during *y*, *x ϕed* was true. If ϕ is an accomplishment verb, then *x ϕed for y time* does not entail that *x ϕed* was true during any time within *y* at all.

IV. As Kenny noted, entailments from the progressive to the non-progressive tenses also distinguish activities from accomplishments:

(32) If ϕ is an activity verb, then *x is (now) ϕing* entails that *x has ϕed*. If ϕ is an accomplishment verb, then *x is (now) ϕing* entails that *x has not (yet) ϕed.*

(This last test must be used with caution. It can be true that John is now building a house but also that he has already built a house, namely if he has already built a *different* house from the one he is now building. But the intent of Kenny's test is clear: we must give a "wide scope" reading to any quantifier occurring within ϕ to apply the test appropriately.)

V. A distinction in entailment also shows up if these two kinds of verbs appear as the complement of *stop*:

(33) a. John stopped painting the picture.
b. John stopped walking.

From (33b) we can conclude that John *did walk*, whereas from (33a) we are not entitled to conclude that John *did paint* a picture, but only that he *was painting* a picture (which he may or may not have finished).

VI. Only accomplishment verbs can normally occur as the complement of *finish*:

(34) a. John finished painting a picture.
b. *John finished walking.

VII. The adverb *almost* has different effects on activities and accomplishments:

(35) a. John almost painted a picture.
b. John almost walked.

(35b) entails that John did not, in fact, walk, but (35a) seems to have two readings: (a) John had the intention of painting a picture but changed his mind and did nothing at all, or (b) John did begin work on the picture and he almost but not quite finished it. It is this second reading which is lacking in activity verbs.

Since I have used an intransitive verb *walk* to illustrate the activity class, it might be supposed that the presence or absence of an object accounts for the difference between the two classes. However, there are activity verbs which do take objects. For example, *push a cart* or *drive a car* can be substituted for *walk* in the above examples with the same results.

VIII. Another such difference in possible scope ambiguities between activities and accomplishments has been noticed by generative semanticists, e.g. Binnick (1969). Some accomplishments (specifically, those in which the result brought about is a non-permanent state of affairs) exhibit an ambiguity with *for*-phrases which activities never have:

(36) a. The sheriff of Nottingham jailed Robin Hood for four years.
b. The sheriff of Nottingham rode a white horse for four years.

(36a), an accomplishment, is ambiguous between a repetitive reading (*four years* delimits the time over which the act of jailing repeatedly took place) and a reading in which *four years* delimits the duration of the result-state which the single act of jailing produced. (36b), an activity, has only the repetitive reading.

2.2.4. *Achievements*

Achievement verbs, Vendler's fourth class, can be distinguished by the following tests:

I. Although accomplishments allow both *for*-phrase and *in*-phrase time adverbials with equal success, achievements are generally quite strange with a *for*-phrase.

(37) a. John noticed the painting in a few minutes.
b. ??John noticed the painting for a few minutes.

II. Predictably, the same goes for the *spend-an-hour/take-an-hour* distinction:

(38) a. It took John a few minutes to notice the painting.
b. ??John spent a few minutes noticing the painting.

III. The entailments of achievements also differ from those of accomplishments. If *John painted a picture in an hour* is true, then it is true that John *was painting* a picture during that hour. But from the truth of (37a) it does not follow that John *was noticing* the painting throughout the period of *a few minutes*. Schematically,

(39) If ϕ is an accomplishment verb, then *x* ϕ*ed in y time* entails *x was* ϕ*ing during y time*.
If ϕ is an achievement verb, then *x* ϕ*ed in y time* does not entail *x was* ϕ*ing during y time*.

IV. Unlike accomplishment verbs, achievements are generally unacceptable as complements of *finish*:

(40) *John finished noticing the painting.

V. And unlike both accomplishments and activities, achievements are unacceptable as complements of *stop* (except in a habitual reading):

(41) (*)John stopped noticing the painting.

VI. *Almost* does not produce the ambiguity with achievements that it produces with accomplishments; compare (42) with (35):

(42) John almost noticed the painting.

VII. As Ryle observed, there is a class of adverbs which are semantically anomalous with achievement verbs:

(43) ??John { attentively / studiously / vigilantly / conscientiously / obediently / carefully } { discovered the solution / detected an error / found a penny / reached Boston / noticed the painting }

Since the adverbs *deliberately, carefully* in stativity test IV are a subset of these adverbs, this test distinguishes states as well as achievements from the other categories.

TABLE I

Criterion	States	Activities	Accomplishments	Achievements
1. meets non-stative tests	no	yes	yes	?[7]
2. has habitual interpretation in simple present tense:	no	yes	yes	yes
3. *φ for an hour, spend an hour φing*:	OK	OK	OK	bad
4. *φ in an hour, take an hour to φ*:	bad	bad	OK	OK
5. *φ for an hour* entails *φ at all times in the hour*:	yes	yes	no	d.n.a.
6. *x is φing* entails *x has φed*:	d.n.a.	yes	no	d.n.a.[8]
7. complement of *stop*:	OK	OK	OK	bad
8. complement of *finish*:	bad	bad	OK	bad
9. ambiguity with *almost*:	no	no	yes	no
10. *x φed in an hour* entails *x was φing during that hour*:	d.n.a.	d.n.a.	yes	no
11. occurs with *studiously, attentively, carefully,* etc.	bad	OK	OK	bad

OK = the sentence is grammatical, semantically normal
bad = the sentence is ungrammatical, semantically anomalous
d.n.a. = the test does not apply to verbs of this class.

These criteria, many of which distinguish subsets of the four categories rather than determining a single category, can be perspicuously summarized in the form of a chart (Table I).

2.2.5. *Lexical Ambiguity*

At this point, a qualification must be made concerning this classification. Activities and accomplishments are supposedly distinguished by criteria 4, 5, 6, 8, and 9, but this is not always the case. Notice first that an activity verb describing movement behaves like an accomplishment verb if it occurs with either a locative of destination (Fillmore's *Goal* case) or with an adverb of extent, as in (44):

(44) John walked { a mile. / to the park.

Now (44) meets all the requirements for an accomplishment:

(45) a. John walked to the park in an hour.
b. It took John an hour to walk to the park.

(45a) and (45b) are well-formed and have the proper entailments for accomplishments. (46) is also grammatical:

(46) John finished walking to the park.

(47) does not entail that John walked to the park (except on the habitual reading of course):

(47) John was walking to the park.

Furthermore, it can be objected that even when a locative or extent phrase is not present it is possible to assign an accomplishment reading to an "activity" verb in the proper context. Thus if I know (and the addressee knows) that John is in the habit of swimming a specific distance every day (to prepare himself for a swimming race perhaps), then I can assert that today John swam in an hour, or that he finished swimming early, or that on Tuesday he stopped, but did not finish swimming. (The starred sentences (28b), (30b) and (34b) can likewise be grammatical in special contexts.)

This phenomenon is not limited to activity verbs of motion, of course. *Look at*, for example, is normally an activity, but it has a familiar "special sense" in which it is an accomplishment:

(48) I haven't finished looking at your term paper yet, but I'll try to finish it tonight so we can discuss it tomorrow.

In fact, I have not been able to find a single activity verb which cannot have an accomplishment sense in at least some special context. *Look for* (*listen for*, etc.) would seem to be the most inherently irresultative of the activity verbs, but it is easy to find a context in which they are accomplishments: If a library has an established search procedure for books involving a definite number of prescribed steps, then one librarian can tell another that he finished looking for a certain book but never found it.

Furthermore, it may be supposed that those few examples which sound equally felicitous with *for* and *in* adverbials – e.g. Fillmore's (1971) example *He read a book for/in an hour* or *She combed her hair for/in five minutes*, an example pointed out to me by James McCawley – are all cases where a verb phrase can be read ambiguously as an activity or an accomplishment. In other words, *for* phrases may be restricted to activities exclusively, and

alleged "marginal" occurrences of *for*-phrases with accomplishments such as (27b) are in fact being read as activities.

If this claim is correct, then Vendler's attempt to classify surface verbs once and for all as activities or accomplishments is somewhat misguided. First, we have seen that not just verbs but in fact whole verb phrases must be taken into account to distinguish activities from accomplishments. (In a certain sense, even whole sentences are involved, as will be seen in the next section.) And second, the possibility of giving accomplishment "interpretations" to activity verbs in special contexts blurs the distinction even further. The problem of distinguishing between lexical verbs which *must* be accomplishments, those which *may* be accomplishments with the right time adverbs, and those which can be accomplishments only under special interpretations is an interesting and difficult one, involving as it does the thorny problems of polysemy versus homophony. These problems will not be completely sorted out until Chapters 6 and 7, but the nature of the distinction and its interaction with tenses and time adverbs can be examined in the meantime anyway. The term "activity verb" will be retained for the present to describe instances of particular verbs in particular sentences when those sentences have the appropriate surface syntactic features (according to the criteria in Table I) and an irresultative meaning when understood in their most typical (or otherwise specified) context.

2.2.6. *The Problem of Indefinite Plurals and Mass Nouns*

There is another, more serious problem for Vendler's classification. Accomplishment verbs which take direct objects unexpectedly behave like activities if an indefinite plural direct object or a mass-noun direct object is substituted for the definite (or indefinite singular) one:

(49) a. John ate the bag of popcorn in an hour.
b. *John ate popcorn in an hour.

(50) a. John built that house in a month.
b. *John built houses in a month.

(51) a. It took an hour for John to eat the bag of popcorn.
b. *It took an hour for John to eat popcorn.

(52) a. It took a month for John to build that house.
b. *It took a month for John to build houses.

(53) a. John finished (eating) the bag of popcorn.
b. *John finished (eating) popcorn.

(54) a. John finishing (building) the house.
b. *John finished building houses.

Unfortunately, this difficulty extends to achievement verbs as well. That is, *discover* and *meet*, achievement verbs, disallow the durative adverbials *for six weeks, all summer* in (55a) and (56a), as they should according to our criteria. But (55b) and (56b), with indefinites or mass nouns, are good:

(55) a. *John discovered the buried treasure in his back yard for six weeks.
b. John discovered $\left\{\begin{matrix}\text{fleas on his dog}\\\text{crabgrass in his yard}\end{matrix}\right\}$ for 6 weeks.

(56) a. *John met an interesting person on the beach all summer.
b. John met interesting people on the beach all summer.

Furthermore, if an indefinite plural occurs even as subject of an achievement, the sentence is acceptable with durative adverbials:

(57) a. *John discovered that quaint little village for years.
b. Tourists discovered that quaint little village for years.

(58) a. *A gallon of water leaked through John's ceiling for six months.
b. Water leaked through John's ceiling for six months.

We can informally state a general principle to cover the cases (55)-(58).

(59) If a sentence with an achievement verb contains a plural indefinite NP or mass noun NP (or if a sentence with an accomplishment verb contains such an NP as object), then it has the properties of a sentence with an activity verb.

How should principle (59) be incorporated into the grammar? Around 1967 most generative-transformational grammarians would probably have agreed how to do this. One would postulate syntactic features such as [± durative] and somehow state selectional restrictions, say, between verbs with these features and time adverbials like *for x time* and *in x time*.

In fact, an excellent and very thorough study of the phenomenon of aspect has already been done from this theoretical point of view (Verkuyl 1972) and it will be useful to consider it at this point. Verkuyl was acutely

aware of principle (59) (or at least aware of the data behind it, which is the same in Dutch as in English, and no doubt as in many if not all other languages[9]), and most of his work is devoted to finding a way of generating correctly sentences like (55)-(58). His main thesis is that the notions of durative and perfective aspect are not to be found in any one constituent in surface structure, but arise from the "composition" of certain constituents; hence his title *On the Compositional Nature of the Aspects*. I quote:

> In chapter two the compositional nature of the aspects will be demonstrated with the help of a number of outwardly diverse sentences, all of which allow for the same generalizations regarding the position of durational adverbials. The durative and non-durative aspects in these sentences appear to be composed of a verbal sub-category on the one hand and a configuration of categories of a nominal nature on the other.
>
> (Verkuyl, 1972, p. iv)

This conclusion leads him to propose, for example, that VP nodes should be sub-categorized as *durative* and *non-durative*, the first of which can be expanded as in (60), (61), and (62). Non-durative VPs can be expanded as (63) but not (64); the structure (64), which would correspond to the ungrammatical (49b) or (54), is excluded by the phrase structure rules (Verkuyl, 1972, p. 54):

(60) $[_{VP_{dur.}}\ [_V$ AGENTIVE$]$ + $[_{NP}$ INDEF. PL.$]]$

(61) $[_{VP_{dur.}}\ [_V$ NON-AGENTIVE$]$ + $[_{NP}$ INDEF. PL.$]]$

(62) $[_{VP_{dur.}}\ [_V$ NON-AGENTIVE$]$ + $[_{NP}$ INDEF. SG.$]]$

(63) $[_{VP_{non\text{-}dur.}}\ [_V$ AGENTIVE$]$ + $[_{NP}$ INDEF. SG.$]]$

(64) $^{*}[_{VP_{non\text{-}dur.}}\ [_V$ AGENTIVE$]$ + $[_{NP}$ INDEF. PL.$]]$

Actually Verkuyl later concludes (Verkuyl, 1972, pp. 107ff.) that the sub-categorization with respect to aspect must take place at an even higher node than the VP since information outside the VP, e.g. in (57)-(58), must be taken into account.

Verkuyl's solution seems to produce all the good sentences without producing any of the bad ones; yet I think many linguists today would not be totally satisfied with this kind of solution, and for good reasons. In the first place, Verkuyl's analysis does absolutely nothing toward explaining why the structure (64) is ungrammatical while the others are not. Using his formalism and categories, it would be just as simple to write a grammar in which (60) or (61) or (62) would be blocked while (64) would be generated. Yet I doubt that there is any language in which this would be the case.

In the second place, I believe it would be agreed that the distinction between durative and perfective aspect is a semantic notion at least as much as it is a syntactic notion. What all accomplishments (including activity verbs in the "special interpretation" discussed earlier) have in common (as Ryle and Kenny noted) is the notion of a specific goal or task to be accomplished: in some cases it is a specific distance which is traversed or a specific location which the subject (and/or object) ends up at. In other cases it is the creation or destruction of a specific direct object; in still others it is the new state which the object (or subject) comes to be in as a result of the subject's action. If these verbs occur in a simple past tense, then we understand the goal or task to be reached. If these verbs occur in the progressive, then we are not entitled to assume the same task to be accomplished, though we understand that the action the subject performed was the same kind as before. Surely a semantic analysis of these verbs must account for these meanings in terms of the very same notions of time reference, completion of action and definiteness or indefiniteness of object that Verkuyl has neatly explained away as co-occurrence restrictions. The effect of these restrictions would surely have to be reflected in the semantic component, hence duplicated in the grammar.

2.2.7. *Examples of the Four Vendler Categories in Syntactic and Semantic Subcategories*

I believe that a defect of previous studies of the Aristotelian verb classification has been that only a few examples from each category are discussed, possibly giving the reader (not to mention the authors) a somewhat skewed impression of what the full ranges of verb phrases singled out by the given tests actually consist of. To try to rectify this situation, I have inserted here an informal list of different kinds of verbs in each category, subcategorized by both semantic and syntactic properties. The semantic headings should not be taken too seriously; I simply intend these to bring some of the different kinds of verbs in each class to the reader's attention, and I do *not* claim that these are either exhaustive or mutually exclusive categories, and I do not necessarily attach any theoretical significance to them or the way I have arranged them.

Some verbs are aspectually ambiguous in ways that have been alluded to already and will be described further later on.

As the reader may notice, the syntactic tests given for distinguishing the four categories do not give totally consistent results for all examples below. In fact, consideration of some of them will force us to make some

revisions in the Vendler-Kenny classification (this revision will be made after interval semantics is introduced in Chapter 3). But for expository purposes, I retain Vendler's four categories here and in the rest of this chapter.

By the term *transitive* as applied to verbs and adjectives, I mean that a second noun phrase essential to the meaning follows the adjective or verb immediately (i.e. semantically a two-place relation is involved). By *two-place phrasal* I mean that a semantically essential noun phrase follows after a preposition. For example, *love* and *like* are transitive in *John loves Mary* and *John is like Mary*, but *listen* and *similar* are two-place phrasal in *John listens to Mary* and *John is similar to Mary*.

I. STATES (STATIVES)

A. Intransitive Adjectives

1. With individuals as subjects: *be tall, big, green, American, quadrilateral.*
2. With propositions as subjects: *be true, false, likely, doubtful.*

B. Intransitive Verbs

1. *exist, stink, itch, burn, live* (as in *Bird lives*).
2. "Pseudo-passives" that have no real active forms, with propositions as subjects: *be rumored, be (widely) believed.*

C. Transitive and Two-place phrasal adjectives

1. *like; similar, identical, related to NP* [These are the symmetric predicates of Lakoff and Peters 1969].
2. *proud, jealous, fond of NP.*

D. Transitive Verbs

1. Animate subjects: *love, hate, dislike, know, have.*
2. Symmetric predicates: *resemble, equal, be.*
3. With propositional object and propositional or human subject: *mean, prove, show, indicate, suggest, imply.*
4. Propositional subject: *involve, concern.*
5. Physical perception verbs [all are achievements as well as states] *see, hear, smell, taste, feel, perceive.*
6. Cognitive verbs with propositional objects [also achievements] *understand, know, believe, doubt, regret.*

7. "Psych-Movement" Verbs [propositional subject, human object; also achievements] *dismay, worry, please, surprise, astonish.*
8. Non-extensional Objects: *need, want, desire, fear.*

E. Two-place phrasal Verbs

1. Locatives
   a. *be in, on, around, under, at NP.*
   b. Pseudo-passives: *be located, be found at, on, around* NP.
   c. *sit, stand, rest, hang, lie, perch, adhere to, on, at, in* NP.
   d. Pseudo-motional locatives, predicated of roads, rivers, etc.: *run, flow, meander* (transitive: *cross*).
2. "Psych-movement" [May be transformational variant of D.7] *be pleased, astonished, dismayed at* NP; *like* NP.

II. ACTIVITIES

A. Adjectives [all adjectival and predicate nominal activities are volitional]

1. Intransitive: *be brave, greedy.*
2. Two-place phrasal: *be rude, nice, polite, obnoxious to* NP.

B. Predicate Nominals: *be a clown, hero, bastard, fool, stick-in-the-mud.*

C. Intransitive Verbs

1. Animate or inanimate subjects: *vibrate, rotate, hum, run, rumble, roll, squeak, roar.*
2. Cosmological: *thunder, rain, snow.*
3. Animate subjects: *cry, smile, walk, run, swim, talk, dance.*
4. Transitive absolute, or "object deletion" verbs: *smoke, eat, drink, play* (*music*).

D. Transitive Verbs of movement: *drive, carry, push* NP.

E. Two-place phrasal [though perhaps the prepositional phrase is a modifier] *sit, write, ride on, in* NP.

F. Non-extensional Object [both transitive and two-place phrasal] *seek, listen for, look for, search for.*

G. Physical Perception Verbs [transitive and two-place phrasal] *listen to, watch, taste, feel, smell* (the last three are also states and achievements).

H. Pseudo-three place idioms: *pay attention to, pay heed to, keep track of* NP.

I. "Aspectual" Complement Verbs: *keep, continue.*

III. ACHIEVEMENTS (May be coextensive with inchoatives)

A. Locatives

1. Transitive verb: *reach, leave, touch* NP (*touch* also stative and active).
2. Two-place phrasal verbs: *arrive at, land on, depart from, fall from* NP.

B. Change of Physical State (Absolute states; cf. 2.3.5 for distinctions between absolute and degree achievements)

1. Intransitives: *melt, freeze, die, be born* (Pseudo-passive), *molt, ignite, explode, collapse.*
2. Two-place phrasal: *turn into a* NOUN, *turn to* NOUN, *become* ADJ.

C. Change of Physical State (Degree state)

1. Intransitive: *darken, warm, cool, sink, improve.*
2. Phrasal: *become* ADJ-*er.*

D. "Aspectual" Complement Verbs

1. Infinitive complement: *begin, start, cease.*
2. Gerundive complement: *stop, resume, begin, start.*
3. With event nominal as subject: *end, stop, resume, start, begin.*

E. Possessive: *acquire, receive, get, lose.*

F. Cognitive (many both achievements and states)

1. Physical perception: *notice, spot, see, catch sight of, hear, taste, smell, feel, lose sight of.*
2. Abstract cognitive: *realize, recognize, understand, detect, find* (also accomplishment), *remember, forget.*

G. Change of State of Consciousness: *awaken, fall asleep.*

IV. ACCOMPLISHMENTS

A. Locatives

1. Transitive verb involving enclosure: *hide, cover, box, uncover, crate, shell* NP.
2. Two-place phrasal: *walk, swim, fly to* NP.
3. Two-place phrasal, can also be stative: *sit, lie, stand on* NP.
4. Pseudo-transitive motion verbs with extent NP – this NP is not a real direct object, as can be seen from absence of passive: **A mile was walked by John: walk a block, swim a mile.*
5. Two-place phrasal derived from activity verbs with locative result state: *drive, carry, push* NP *to* NP.
6. Two-place phrasal not derived from activity verbs: *put, place, set* NP *into* NP.
7. transitive with extent NP: *carry, push, drive* NP *a mile, a block.*

B. Intransitives that are not locatives [may be empty?]: *shape up, grow up* (fig.).

C. Transitive verbs of creation (*accusativus effectivus*)

1. [derived from activities] *draw* (*a picture*), *knit* (*a sweater*), *dig* (*a hole*).
2. [Not derived from activities] *make, build, create, construct, erect.*

D. Transitive Verbs of Destruction: *destroy, obliterate, raze* NP; *melt* (*an icecube*), *erase* (*a word*), *eat* (*a sandwich*).

E. Transitive Change of State: *kill, transmogrify, petrify* NP; *marry* NP *to* NP, *cook* (*a turkey*), *paint* (*a house*), *tan* (*leather*).
[Note that the same verb can be understood to express different semantic relationships to its object and thus belong to IV.D, IV.C, or IV.E accordingly. Cf. *paint a picture* (picture comes into existence) vs. *paint a house* (house undergoes change, but existed already). Also cf. *erase a word* (word ceases to exist) vs. *erase a blackboard* (blackboard undergoes change, but still exists).]

F. Creation of a "Performance Object"

1. Concrete Representation Created: *paint a landscape, photograph a senator, draw a unicorn, record a conversation, transcribe a lecture.* [Here something is created, but not literally

the thing named by the object NP. Rather, a representation of that object is created, and the object itself does not undergo any change. Cf. *draw a picture* vs. *draw a unicorn*. Also, note *paint a picture* (IV.C) vs. *paint a house* (IV.E) vs. *paint a scene* (IV.F.1).]

2. Abstract "Performance Object" Created:
   a. "Agent Performance": *perform a sonata, recite a poem, sing a song, prove a theorem, produce a play*.
   b. "Experiencer Performance": [Here the subject of the sentence does not bring about the performance as in F.2a, but the phrase is an accomplishment by the syntactic tests just the same]. *listen to a symphony, watch a play, attend a course, read a book*. [Note that *listen to the sound of the waterfall* is an activity but *listen to the symphony* is an accomplishment.]
   c. unclassified: *play a game of chess, basketball*.

[It is hard to know whether *prove a theorem* and *sing a song* should be considered ambiguous. If the theorem is being proved or the song sung for the very first time, then the theorem or song is created, just as in *build a house*, though the object is abstract. But if a previously composed song is sung or a theorem in a textbook is proved, there is at most a "re-creation". Yet no strong ambiguity is felt. Also, should *read a poem* be taken as ambiguous between agent and experiencer performances, according as it is read aloud or not? Probably not. Again, these categories are only for expository purposes.]

G. Other syntactic types of accomplishments. [These are not subcategorized semantically, and I have not tried to determine how many of the above semantic types occur in each of these forms.]

1. *That*-complement verbs: *bring about that S*.
2. Infinitive-complement verbs: *make* NP VP, *cause* NP *to* VP.
3. Prepositional Phrase complements: see under Locatives above; also *turn* NP *into a* NOUN, *put* NP *to sleep, drive* NP *to drink, read oneself to sleep*.
4. Factitive (Adjective of Result): *hammer* NP *flat, wipe* NP *clean, wiggle* NP *loose*.
5. Factitive (Nominal of Result): *elect* NP *president, chairman, appoint* NP *chairman*.
6. Verb particle constructions: (i) Transitive: *take* NP *out, chase* NP *away, turn* NP *off*; (ii): Intransitive: *go out, run away, sit down, dry out*. [As Bolinger (1971) points out, verb-particle constructions are almost invariably accomplishment verbs. In many cases, the particle makes no significant contribution to the meaning of the whole except to indicate unambiguously that an accomplishment is intended (cf. *clean the room* vs. *clean the room up*), so in a sense this particle is the closest thing English has to a marker of perfective aspect.]

2.3. AN ASPECT CALCULUS

2.3.1. *The Goal and Purpose of an Aspect Calculus*

In this section an explanatory hypothesis about the four Vendler categories will be explored (though actually more than four categories will result). This hypothesis is essentially that of Dowty (1972). The idea is that the different aspectual properties of the various kinds of verbs can be explained by postulating a single homogeneous class of predicates – *stative predicates* – plus three or four sentential operators and connectives. English stative verbs are supposed to correspond directly to these stative predicates in logical structure, while verbs of the other categories have logical structures that consist of one or more stative predicates embedded in complex sentences formed with these "aspectual" connectives and operators. These aspectual operators and connectives are treated as logical constants – a standard model-theoretic interpretation is to be given for each – and the stative predicates are non-logical constants.

This hypothesis, then, is essentially a reductionist analysis of the aspectual classes of verbs. The goal is for a puzzling diversity of kinds of verbs to be explained as combinations of an aspectually simple and unproblematic kind of verb – the stative – with an explicitly interpreted operator or operators. The success of this depends not only on the formal interpretation of the operators, but also on the assumption that statives are clearly understood and unproblematic. Intuitively, the notion of a stative predicate will seem clear. Statives can be judged true or false of an individual by reference to the state of the world at only a single movement of time (while other classes of verbs require "information" about more than one point in time and in some cases, from more than one possible world). To make this hypothesis into a substantive claim about possible versus impossible word meanings in a referential framework such as that of UG will require being more specific

about "true or false by reference to the state of the world at only a single moment of time", but this problem will be deferred to section 2.4 below.

It seems to me that a goal of this kind can also be seen implicitly in the following passage from Lakoff (1972, pp. 615-616):

> In the analyses offered above [certain lexical decomposition analyses – DRD], certain atomic predicates keep recurring: CAUSE, COME ABOUT, SAY, GOOD, BAD, BELIEVE, INTEND, RESPONSIBLE FOR, etc. These are all sentential operators, that is, predicates that take sentential complements. It seems clear that we would want these, or predicates like these, to function as atomic predicates in natural logic. Since these keep recurring in our analyses, it is quite possible that under the lexical decomposition hypothesis the list would end somewhere. That is, there would be only a finite number of atomic predicates in natural logic taking sentential complements. These would be universal, . . . Moreover, verbs like 'kick' and 'scrub' in [Sam kicked the door open] and [Sam scrubbed the floor clean] could be ruled out as sentential operators since they could be analyzed in terms of already existing operators, as in [Sam caused the door to come to be open, by kicking it] or [Sam caused the floor to come to be clean, by scrubbing it]. This seems to me to be an important claim. Kicking and scrubbing are two out of a potentially infinite number of human activities. Since the number of potential human activities and states is unlimited, natural logic will have to provide an open-ended number of atomic predicates corresponding to these states and activities. Hopefully, this can be limited to atomic predicates that do not take sentential complements . . . It seems to me that under the lexical decomposition hypothesis we have a fighting chance of limiting sentential operators to a finite number, fixed for all natural languages.

(The hypothesis I am considering here differs from Lakoff's in two ways, however. I will suggest that states and activities might be reduced to non-logical predicates of the same sort, and I am not claiming that all words with 'sentential complements' can be analyzed in terms of fixed, language universal operators – I think this claim is probably false – but only that aspectual categories of verbs might possibly be reduced in this way.)

An important methodological assumption of this enterprise is that the appropriate syntactic distribution of these operators in logical structures, as well as the appropriate model-theoretic interpretation of them, can be adduced by careful attention to syntagmatic and paradigmatic contrasts and restrictions evidenced in the language itself. Though this methodology is highly characteristic of GS, I do not think it is one that linguists other than generative semanticists would repudiate; rather, most would merely deny that the conclusions reached in this way applied to a level of *syntactic* (as opposed to semantic) representation. I should be careful to add that I am not presupposing that the structuralist methodology is a wholly reliable one, much less that it is sufficient to discover all we need to know to construct an adequate semantic theory of a natural language (as I think many linguists do assume without question). But I think it is a methodology worthy of further investigation, even in a referential theory like UG.

Ultimately, there will remain some features of the verb classes that cannot be attributed to any structurally-motivated operators I am able to devise (though adequate conditions on model-theoretic interpretations of the verbs involved can be stated precisely anyway). Nevertheless, I think the idea of a structurally motivated natural logic is important enough to justify the presentation of my 1972 aspect calculus before the revisions are introduced. I believe that much can be learned from the attempt to construct such a calculus, no matter whether the resulting analysis is stated entirely in terms of it or not.

In Chapter 4, the possibility of using this aspect calculus to "decompose" verbs via the translation relation will be considered. As I have mentioned that the translation procedure of UG is a theoretically unnecessary step, it may be wondered whether this aspect calculus can have any real significance in such a theory. I think in fact it can be significant. Stated in a way that does not presuppose a translation step, the claim the aspectual calculus makes about the Fregean interpretation $\langle B, G_\gamma, f\rangle_{\gamma\in\Gamma}$ for English (whether induced by translation, directly, or otherwise specified) is merely that there exists a finite set of functions $f_1 \ldots f_n$ (which correspond to the interpretations of aspectual operators) and a set of objects A (which can be interpretations of stative predicates), such that for each verb α of English, the interpretation of α is equivalent to some composite function constructed out of (a finite number of) $f_1 \ldots f_n$ and members of A, and that moreover, this way of specifying the interpretation of α is more economical, elegant, useful, insightful, (or whatever) than any other comparably explicit way of defining the interpretation of α.

2.3.2. *Statives, von Wright's Logic of Change, and BECOME*

Classical propositional and predicate logic is said to deal with "timeless" states of affairs, propositions which are either true or false once and for all. The notion of a state of affairs being true over a certain period of time can, however, be accommodated in a straightforward way. One would need to add to the predicate logic only a set of variables and constants representing points in time, quantifiers for these time variables, and an operator representing the notion of a proposition being true *at* a time. A sentence containing a stative verb and a *for*-phrase time adverbial (e.g. (65)) could be represented logically as in (66), ignoring for the moment the past tense.

(65) John loved Mary for three years.

(66) (Λt: $t \in$ *three years*) AT(*t*, *John love Mary*)

Such formulas could be given a model-theoretic interpretation as follows: An appropriate semantic model for this system would include a set of times $t_i \ldots t_n$ with a transitive, asymmetrical relation defined on them (the "earlier than" relation). Interpretations of non-logical constants would be given relative to each time *t*, and thus formulas may be true or may be false, depending on which time they are evaluated at. Assuming that time adverbs like *three years* denote (contiguous) sets of these times and that we have some way of identifying the "stretch" of time which an adverb refers to, we can give truth conditions for formulas like (66) very simply: (66) would be true relative to some semantic model if the individuals *John* and *Mary* exist in all of the times in the interval *three years* and the sentence *John loves Mary* is true at all times in the interval. This, in fact, would be the only logical mechanism needed for a "Natural Logic" capable of handling statives and durational adverbials. (Though Montague's intensional logic does not contain variables and constants denoting times directly, evaluation of expressions relative to a time is of course part of the intensional semantics, and we will see later how means of referring to times directly can be introduced easily. Temporally-interpreted languages with expressions denoting times are of course not new in the tense logical literature; one might cite Prior's "B-series logic" (Prior, 1967, p. 38) and Rescher and Urquhart's "R-calculus" (Rescher and Urquhart, 1971, pp. 31-35) as antecedents. For simplicity of exposition, I will continue to assume in this section a simple, predicate-logic-like formal language with temporal interpretation, enlarging this language and its semantic apparatus as the need arises.)

A different solution would be required for events, however, since they are not literally true or false *for* a period of time or even at a point in time. Rather, events somehow "take place" *in* time. Some further logical concepts are therefore necessary to capture this notion.

Georg Henrik von Wright (1963; 1968) observed that an event, such as the closing of a door, is understood to have taken place at a certain time if one state – the state of the door's being open (or being not closed) – is replaced at that time by a second state – the state of the door's being closed. Von Wright claimed that this "change of state" definition of an event was generalizable: that *any* event can be defined as a change of state where the two states are of a particular form. Namely, one of the states is the negation

of the other. An event is a change from state p to state q, where $p = \neg q$ (or, to say the same thing, $q = \neg p$).

Von Wright devised a formal calculus of change-of-state which consists of classic propositional logic with the addition of a dyadic operator *T* (called "And Next"). In the T-calculus, all formulas can be reduced to one of four basic types. These are given in (67) along with their intuitive interpretations:

(67)

$\neg$pT$\neg$p	"the state p comes about"
pT$\neg$p	"the state p is destroyed, comes to an end"
pTp	"the state p remains, continues to obtain"
$\neg$pT$\neg$p	"the state $\neg$p remains" or "the state p fails to come about"

Consider now the relationship between Lakoff and McCawley's abstract verb BECOME (or COME ABOUT) and von Wright's analysis of events. The example *The soup cooled* bears the same relation to *The soup is cool* as *The door closed* bears to *The door is closed*. The first sentence can only be true if the soup's being not-cool was replaced, at the time referred to by that sentence, with the soup's being cool. The same will be true of all sentences analyzed by generative semanticists as containing the operator BECOME.

This observation suggests the possibility of defining BECOME sentences in terms of von Wright's logic of change. Moreover, the atomic predicates END (or STOP or whatever the inverse of BECOME is called) and REMAIN can also be defined in terms of von Wright's formulas:

(68)

BECOME (p)	$=_{\text{def.}}$	$\neg$pTp
END (p)	$=_{\text{def.}}$	pT$\neg$p
REMAIN (p)	$=_{\text{def.}}$	pTp

Semantically, this claim is simply that one can utter truthfully a sentence like *The soup cooled* when one first observes that the soup is not cool, and thereafter that it is; the meaning of the sentence is that those two states of affairs were true in temporal succession, no more and no less. This analysis makes explicit the temporal relationship among the three pro-verbs and the simple statives.

Furthermore, this analysis would give a semantically correct account of the beginnings and endings of states and of activities such as *It started to rain, John stopped running, Harry just continued eating his ice cream,* etc. That is, the operators in (68) underlie a large number of individually lexicalized "aspectual" verbs like *begin* as well as the "disappearing" operators in *John cooled the soup*:

(69) a. It started to snow.
b. John came to believe that the earth is flat.
c. John went crazy.
d. John got drunk.
e. John sat on the bench. (ambiguous between stative/inchoative)
f. John lay on the sofa. (ambiguous between stative/inchoative)
g. She went t' singing. (some dialects)

Von Wright did not provide a formal semantic treatment of his logic of change, though it is easy enough to construct one. However, there is no need to go through the intermediate step of defining structures with BECOME in terms of the logic of change and then defining truth conditions in terms of von Wright formulas: COME ABOUT, END, and REMAIN can simply be regarded as sentential operators in a "Natural Logic", and truth conditions can be defined directly in terms of these and the same kind of semantic model as was described above. If time is discrete in the model – that is, if for any moment there is a unique moment that most immediately follows it – then we can identify the set of times in the model with the set of positive and negative integers and zero, hence refer to the time immediately preceding a time t as $t-1$, the time immediately following it as $t+1$.

(70) Where ϕ is any formula, and t is any time,
BECOME ϕ is true at t iff ϕ is true at t and false at $t-1$.
END ϕ is true at t iff ϕ is false at t and true at $t-1$.
REMAIN ϕ is true at t iff ϕ is true at t and true at $t-1$.

Alternatively, if time is taken to be dense in the model – if for any two moments no matter how close there is always another moment between the two (and hence an infinite number of moments between any two moments) – then the definitions could be reformulated along the following lines: BECOME ϕ would be true at t iff ϕ is true at t, ϕ is false at t' for some time t' earlier than t, and for all times t'' later than t' but earlier than t ϕ is also false at t''. I presently know of no linguistic reasons why time should be considered dense rather than discrete or vice-versa, so I will leave the matter open here.

It has often been suggested in the literature on presupposition (e.g. Givón, 1972) that the implication of a "negated" earlier state with change-of-state verbs is a presupposition (or conventional implicature) rather than a part of the "assertion" of the verb. This claim is based on the judgment that sentences like (71)-(73) seem to commit the speaker to the view that the gates were closed just before 8 PM:

(71) The gates didn't open at 8 PM.

(72) Did the gates open at 8 PM?

(73) It is possible that the gates opened at 8 PM.

Even more frequently discussed is the implicature of *John has stopped beating his wife* to the effect that John at one time beat his wife. (The aspectual complement verb *stop* would be analyzed on the present view with the operator END above.) If this claim is correct, then these initial state implicatures could be accommodated, I believe, in a treatment of conventional implicature such as that proposed by Karttunen and Peters, with implicatures generated by logical deep structures here rather than by English sentences.

Inchoative verbs derived from adjectives and "aspectual" complement verbs make up a major part of the class of achievement verbs. At this point we will take the further step of suggesting that *all* achievements have a logical structure consisting of BECOME plus an embedded clause.

The BECOME analysis seems to provide an intuitively satisfactory semantic account of the remaining achievement verbs. For example, *realize* (in its inchoative, not its stative sense) seems to be equivalent to "come to know (something which one did not know earlier)." *Forget* is its inverse, just as END is the inverse of COME ABOUT: *forget* is "come to not know (something which one did know earlier)". Likewise, *find* or *discover* is "come to have" or "come to know the location or existence of", with *lose* as the inverse. The locative achievements *arrive at* and *reach* are "come to be at (a place that one was not at just before)". Their inverses are *depart from* and *leave*.

This claim about achievement verbs embodies von Wright's position that all events correspond to a change of state of one form or another. As the analysis of accomplishment verbs suggested below also involves BECOME sentences, these change-of-state entailments are also treated as an essential part of the meaning of accomplishments. This seems to accord with Kenny's view of the essential characteristics of performances (his class that includes both achievements and accomplishments):

> Performances are brought to an end by states. Any performance is describable in the form: "bringing it about that p". Washing the dishes is bringing it about that the dishes are clean; learning French is bringing it about that I know French, walking to Rome is bringing it about that I am in Rome. In all of these cases, what is brought about is, by our criteria, a state: "is clean" "knows" "is in Rome" are all static verbs.
>
> (Kenny, 1963, p. 177).

As I mentioned, the beginnings and endings of activities can also be achievements (and for that matter, be involved in accomplishments), so the sentence embedded directly under BECOME will not always contain just a stative verb, but may be an activity or even, as Kenny suggests, another performance:

> A performance may be brought about no less than a state: if the policeman is forcing the prisoner to walk to the police-station, then the policeman is bringing it about that the prisoner is bringing it about that he is in the police-station. Thus in 'bringing it about that p'', "p" may contain a performance verb instead of a static verb. But every performance must be ultimately the bringing about of a state or of an activity; otherwise we could have an action which consisted merely in bringing it about that it was being brought about that it was being brought about that . . . If the description of the action in this form is ever to be completed, it must contain either a perfective verb or an activity-verb. One performance differs from another in accordance with the differences between the states of affairs brought about: performances are specified by their ends.
>
> (Kenny, 1963, pp. 177-178)

The independent syntactic evidence that might be cited for the analysis of achievements in terms of BECOME and an embedded sentence in generative semantics is of two kinds. First, simply the existence of a regular pattern of achievement verbs like *cool, harden*, etc. derived morphologically from stative adjectives might be considered evidence of a sort for this analysis, but acceptance of this pattern as evidence that *all* achievements have this structure depends on one's acceptance of the kind of "analytic leap" mentioned earlier which allows that a unit of meaning that is structurally distinguished in some words should be postulated as an independent part of the meanings of all words with similar overall meanings. Second, it can be argued that certain adverbs must have as their scope the embedded stative clause in an achievement verb, rather than the whole verb (i.e. the BECOME sentence). This second kind of evidence, which also applies to accomplishment verbs, would appear to be more significant than the first, and it will be discussed in detail in 5.6-5.8 below.

2.3.3. *A Semantic Solution to the Problem of Indefinites and Mass Nouns*

Finally, the BECOME analysis can be shown to exclude achievement verbs from the durative constructions (thus explaining the restriction on co-occurrence with *for*-phrases) except in just those cases where an indefinite plural or mass noun occurs in the sentence. This will be demonstrated by considering first what the model-theoretic interpretation of a deviant sentence like (74) would have to be.

(74) *John discovered the buried treasure in his back yard for six weeks.

I again assume that the durative adverbial *for six weeks* is to be represented in terms of a quantified time expression and a two-place AT operator; that is "for all times t such that t is a member of the period *six weeks*, it was true at t that p." (We shall ignore the past tense once again.) Proposition p in this case is that expressed by the sentence "John discovered the buried treasure in his back yard." This embedded sentence, in turn, will be a BECOME sentence, and embedded in this will be a stative sentence to the effect that "John knows the existence of the buried treasure in his back yard." (This sentence does not have to be further analyzed for our present purposes.) This logical form is roughly represented in (75):

(75) $(\Lambda t{:}t \in \textit{six weeks})$ AT(t, BECOME [*John knows that* . . .])

Now consider how the truth conditions for this logical structure would have to be satisfied in a model. The temporal quantifier entitles us to pick any arbitrary moment within the time period denoted by *six weeks*, say t_i, and it is asserted by the AT operator that the embedded sentence is true. This embedded sentence in turn is another tensed sentence, which asserts that one state of affairs, expressed by the sentence ϕ is true now (i.e. at t), and its negation, $\neg\phi$ was true at the previous moment, which in this instance is t_{i-1}. Let us represent the truth conditions in the model graphically by writing a horizontal series of t's representing successive moments in time proceeding from left to right, all within the bounds of *six weeks*. Under each t we will list the sentences true at that time.

(76)
$$\begin{array}{cccccccc} \ldots t_{i-3}, & t_{i-2}, & t_{i-1}, & t_i, & t_{i+1}, & t_{i+2}, & t_{i+3}, & \ldots \\ & & \neg\phi & \phi & & & & \end{array}$$

This is all well and good so far, but suppose we now pick t_{i-1} as the arbitrary moment. Because this is still part of *six weeks*, the embedded BECOME sentence must also be true then, namely, ϕ at t_{i-1} and $\neg\phi$ at t_{i-2}. Thus we have arrived at a contradiction: both ϕ and $\neg\phi$ are true simultaneously at t_{i-1}. In fact, if we compute the truth conditions for all t's in the interval *six weeks*, the contradiction will be present at each moment in the interval except the very last one. The graphic representation would look something like (76′).

(76′) $\ldots t_{i-3}, t_{i-2}, t_{i-1}, t_i, \quad t_{i+1}, t_{i+2}, t_{i+3}, \ldots$

$\neg\phi \quad \phi$
$\neg\phi \quad \phi$
$\neg\phi \quad \phi$
$\neg\phi \quad \phi$
$\neg\phi \quad \phi$
$\neg\phi \quad \phi$

Thus this analysis accounts for the semantic anomaly of (74), and I think it accounts for it in an intuitively satisfying way: to say that John has been "discovering" a certain fact (or the existence of a certain object) throughout a period of six weeks would seem to entail that he has repeatedly not known and then come to know the very same fact, which is obviously a contradiction (barring memory loss).

Now consider the cases where there is a plural indefinite or mass noun in a sentence with an achievement verb, e.g., (77)

(77) John discovered $\left\{\begin{matrix}\text{fleas on his dog} \\ \text{crabgrass in his yard}\end{matrix}\right\}$ for six weeks.

There may be reason to assume that indefinite plurals and mass nouns are to be logically represented as involving variables whose binding existential quantifier lies within the scope of the time quantifier of the surface sentence in which they arise. Notice that (77) can be given the pseudo-logical paraphrase (78a) but not (78b):

(78) a. For six weeks John discovered there to be some x such that x is crabgrass and is in his yard.
b. *There is some x such that x is crabgrass and for six weeks John discovered x to be in his yard.

(77) would have a logical structure like (79):

(79) $(\Lambda t: t \in \textit{six weeks})(\forall x)[\text{AT}(t, \text{BECOME}\ [\textit{John knows} \ldots x \ldots])]$

Consider how the truth conditions for (79) might be satisfied in a temporal model. (79) will be true if for each t_i in an interval of six weeks' duration, there is some value for x that makes the BECOME sentence true. Since the existential quantifier binding x is within the scope of the temporal universal quantifier, the value for x may differ from one t to the next and indeed will have to to avoid contradiction. If we let x_i denote some value for x that makes the BECOME sentence in (79) true and let f represent the propositional

function "John knows that x is in his yard" at each time, then the conditions under which (79) would be true can be represented schematically as follows:

(80) $\ldots t_{i-3}, t_{i-2}, t_{i-1}, t_i, \quad t_{i+1}, t_{i+2}, \ldots$

$\neg f(x_1) \; f(x_1)$
$\neg f(x_2) \; f(x_2)$
$\neg f(x_3) \; f(x_3)$
etc.

Again, the analysis makes an intuitively sound claim about (77): if John has been discovering fleas on his dog or crabgrass in his yard for six weeks, then he must have been discovering new patches of crabgrass or new fleas on his dog all the time, not the same one over and over again.

With achievement verbs it does not matter whether the indefinite or mass noun occurs as subject or as object. Since both of these would occur within the scope of BECOME (which is in turn within the scope of the adverb), any indefinite plural or mass noun in the sentence will allow achievements to be used durationally. Accomplishments will be analyzed in such a way that the direct object noun phrase falls within the scope of a BECOME sentence (as in McCawley's analysis of *kill*), hence indefinite plurals and mass terms in the direct object position of accomplishment verbs are predicted to pattern in the same way as the subjects and objects of achievements with respect to durational adverbials. It is therefore not necessary to postulate an elaborate system of syntactic restrictions as Verkuyl (1972) does to account for these distributional restrictions.

Two qualifications must be made about this treatment. First, it may be objected that even the grammatical sentence *John has been discovering crabgrass in his yard for six weeks* does not mean that John has come upon something new at literally every single moment in a six-week period. If we are to use the universal quantifier to represent durational adverbs like *for six weeks* in a natural logic at all, then the moments it quantifies over must be something like "relevant psychological moments" which are both vaguely specified and also contextually determined. Notice that when we utter a sentence like (81) we seldom feel it necessary to qualify it as in (82).

(81) I've done nothing for the past hour except read this damn book.

(82) Well, actually that's not true, there's the two and a half minutes that I went to the bathroom, and the two thirty-second periods I spent looking out the window, and all those fractions of seconds I was blinking . . .

To see that the relevant moments in a durational adverb are contextually determined, note that (83) is not odd in the same way as (84):

(83) John has been working in San Diego for the last five years. He usually spends his weekends at the beach.

(84) ?John has been serving his prison sentence for the last five years. He usually spends his weekends at the beach.

Because of our knowledge of facts about the real world, we know that the relevant moments included in *the last five years* in (83) do not include weekends, vacations, etc., whereas the relevant moments covered by the same quantifier in (84) are much more inclusive. I doubt that anyone would claim that the time adverb itself has a different logical structure in (83) and (84). I realize that "relevant psychological moment" may sound like a vague notion at this point, but it seems that we must either adopt it for the time being or else stop using the universal quantifier to represent durational adverbs. Note that in the analysis presented above the actual number of moments in an interval is not important; as long as there are at least two, then (75) is contradictory.

A second objection to the analysis would be that there are potential counter-examples to it in the form of sentences like (85):

(85) John found his son's tricycle in the driveway for six weeks.

(85) appears to be well-formed, despite the fact that it contains an achievement verb, a durative time adverbial, and no indefinite plural or mass noun.

Part of the solution to this problem is that (85), on its acceptable reading, is understood to be elliptical, in that a second time adverbial of some kind is implicit:

(85′) John found his son's tricycle in the driveway { every day / once a week / frequently / etc. } for six weeks.

That is, the different occasions of "finding" are separated by intervals. (The same observation should perhaps be made about (77), but this is only part of the difference.) I am not sure what the best way of handling this matter is.

A second difference between (85) and (75) is that *discover* in (75) is more likely to mean "come to know the existence of" whereas *find* in (85) is more likely to mean "come to know that NP is at x place at y time." Coming to know the existence of something is a once-and-for-all event (barring memory lapse), whereas an object that reappears in unexpected places presents ever-new "facts" to be discovered. The nouns *buried treasure* and *tricycle* were thus not chosen at random; a buried treasure, once discovered, is not likely to surprise one a second time by reappearing unexpectedly, but a tricycle is just the kind of object that would. The main claim, that one does not discover the same fact more than once, still seems valid, and I think that this way of treating the anomaly of (74) vis-à-vis (77) is viable in spite of the problem of vagueness in durative adverbs.

2.3.4. *Carlson's Treatment of 'Bare Plurals'*

Though the treatment of indefinite plurals and achievements just given (which come from Dowty 1972) seems adequate as far as it goes, it leaves one important question unanswered: if it is correct to analyze an indefinite plural like *fleas* as involving an existential quantifier (i.e. as equivalent to *a flea* or *some fleas*), then just why must this quantifier have narrower scope than the durative adverbial? From what has been said, it might be supposed that the contradictoriness of the wide scope reading with an achievement verb is all that prevents this second reading from being apparent, but this is not so. Examples like (86) and (87) (from Carlson, 1977, p. 27) have stative and activity verbs respectively, yet the (b) sentences only appear to have readings in which this putative existential quantifier has narrower scope than the adverbial, while the (a) sentences with an explicit quantifier *a* or *some* clearly have a reading with the existential quantifier taking wider scope (as well as perhaps a less obvious reading with the quantifier taking narrower scope):

(86) a. { A cat has / Some cats have } been here since the Vikings landed.
b. Cats have been here since the Vikings landed.

(87) a. { A tyrant / Some tyrants } ruled Wallachia for 250 years.
b. Tyrants ruled Wallachia for 250 years.

This is only the beginning of a long story, however. Carlson (1977) examines a number of quantifier-like constructions (negation, other NP quantifiers, durative and frequentative adverbs, aspectual verbs like *continue*, anaphoric constructions) that might be expected to bring out a scope ambiguity with

these indefinite plurals, and in every case the only possible reading is one in which the "existential quantifier" underlying the indefinite plural appears to have narrower scope than the other quantifier or operator.

A further peculiar fact is that indefinite plurals (or what Carlson calls *bare plurals* following Chomsky) elsewhere seem to be interpreted as having a kind of universal, or *generic* quantifier, yet it is hard to find a single sentence (at least in certain tenses) in which the bare plural is truly ambiguous between an existential reading (as in (86b), (87b), and earlier examples) and a generic reading. The sentences of (88), for example, have to be taken as referring to smokers, cats, or elephants in general, not just a particular group of smokers, cats or elephants:

(88) a. Smokers are rude.
b. Cats meow.
c. Elephants are quite easily trained.

Note that in *Tyrants ruled Wallachia for 250 years*, some particular tyrants or other are clearly referred to, not tyrants in general. The same comment applies to the examples of indefinite plurals in the previous section.

Even more striking are cases observed by Carlson (1973; 1977) in which an anaphoric pronoun and its bare plural antecedent differ in whether a generic or "existential" interpretation is given. Consider the examples in (89) and (90):

(89) a. May hates *racoons* because *they* stole her sweet corn.
b. *Racoons* stole May's sweet corn, so now she hates *them* with a passion.

(90) a. I didn't think that *goats*$_i$ actually liked *tin cans*$_j$ until I saw *them*$_i$ eating *them*$_j$.
b. Before I actually saw *goats*$_i$ eating *tin cans*$_j$, I didn't think that *they*$_i$ liked *them*$_j$.

(Anaphorically related pronouns and bare plurals are italicized.) In each case, a bare plural and a pronoun can only be understood in one way, but an existential can be the antecedent of a generic pronoun (as in (89b) and (90b)) or a generic can be the antecedent of an existential pronoun (as in (89a) and (90a)). This failure of pronominalization to heed the difference between existential and universal quantification is unheard of elsewhere.

All of these unusual syntactic facts really point unambiguously to one conclusion, but it is so bizarre that it almost escapes notice. This is that

first, there is no scope ambiguity with indefinite plurals ("existential" bare plurals) simply because there is no quantifier involved in these noun phrases at all[10] and second, the apparent difference between "generic" and "existential" interpretations is due to the meanings of the verbs they interact with, *not* the meanings of the noun phrases themselves. Inspection of the sentences in (89) and (90) shows, for example, that the bare plural subjects and objects of *steal* and *eat* always have an existential interpretation while those of *like* and *hate* always have generic interpretations. (There is a general class of exceptions to this statement involving generics in subject position; cf. Carlson (1977, pp. 247ff.).) Thus the pronouns and their antecedents in (89) and (90) should be said to have the same meaning in a real sense, though the interaction of the meanings of the verbs with these must somehow obscure this fact.

Though it might at first appear impossible to come up with an explicit semantic analysis of bare plurals that satisfies these syntactic desiderata, Carlson is able to do so by means of some fundamental ontological innovations. Bare plurals, we are told, are the proper names of *kinds*. There are as many kinds as there are bare plurals, so we must note that Carlson's kinds are not just the *natural kinds* of Kripke (1972) and Putnam (1975) but include "unnatural" kinds as well, such as pillows, coffee mugs, and pipe wrenches. A kind cannot, however, be identified with the set of individuals that "make up" the kind or even with the property they all share, but for various reasons must be taken as a basic entity (member of D_e in the UG model) in its own right. A relation R is then introduced in the semantic apparatus that specifies what things *realize*, or "make up", a kind; if a is a thing and b is a kind, then R(a, b) asserts that the thing a realizes the kind b, as for example a particular cat realizes the kind cats.

It is important for Carlson to provide a somewhat parallel ontological treatment of individuals themselves. He distinguishes between *individuals* and what he calls the *stages* of individuals – these might be thought of as "temporal slices" of individuals, their manifestations in space and at individual times. An individual is that "whatever-it-is" that ties stages together and makes them a single unit. This ontology is similar to views of individuals suggested at times by Kaplan (1973), Gabbay and Moravcsik (1973), and Montague (1973), but not quite identical with any of these. It is crucial that the same R relation that relates kinds to their members also relate individuals to their stages. (This may seem curious at first, but is justified by the consequences that result.) If c is a stage and d is an individual then R(c, d) asserts at any time that the stage c realizes the individual d at that time. It is also to

be noted that R is transitive, so if stage c realizes individual d at a time and individual d realizes kind b at that same time, then stage c also realizes kind b at that time.

Now it turns out, according to Carlson, that some verbs and adjectives that apparently predicate things of individuals and kinds actually amount to predications about *stages* that realize those individuals or kinds at the current time, while other verbs and adjectives really do predicate things of the individuals (or kinds) themselves. Thus while the relation *loves* is true of individuals x and y at a time just in case the individual x stands in the *love*-relation to the individual y, the relation *eats* is true of individuals x and y just in case there exists some stage x' that realizes x at that time, some stage y' that realizes y at that time, and the stages x' and y' stand in some relation defined on stages, which we may call the *eat'*-relation. For example, *Goats like tin cans* would have the representation (91), but *Goats were eating tin cans* would have roughly the representation (92), ignoring tense. Here, g is the constant denoting the kind goats, t the kind tin cans:[11]

(90) $like(g, t)$

(91) $(\forall x)(\forall y)[\mathrm{R}(x, g) \wedge \mathrm{R}(y, t) \wedge eat'(x, y)]$

(This is somewhat similar to the way Montague "decomposes" a relation between an individual and a property of properties to an extensional relation between individuals, but the semantic entities involved are here quite different.) In the case of ordinary individuals (i.e., individuals that are not kinds), there is at most one stage that realizes the individual at any given time, so the difference between predicates applying to individuals themselves and predicates applying to their stages is likely to go unnoticed. (However, there may be a few observable syntactic consequences of this difference, some of which will become relevant later in this work.) But with kind names (bare plurals and a few other expressions such as *that kind of animal*), predicates that apply to realizations give rise to an "existential" interpretation, since there will be more than one realization of the kind, and the predicate merely asserts that at least *some* realization has the relevant property. If the predicate applies to kinds themselves rather than stages, then the generic interpretation arises because nothing is being predicated of any realization of the kind, i.e. of any ordinary individuals or stages of them.

I do not have the space here to go into the numerous technical details of Carlson's proposals that are required to make it complete (for example, a three-sorted logic) nor the impressive evidence Carlson amasses for his

proposals and against the obvious alternatives to it. Because the proposal may initially sound somewhat implausible, I encourage the reader to refer to Carlson (1977; 1977a) for these details and arguments.

What is important for the present discussion of achievement verbs and durative adverbials is that Carlson's analysis attributes an existential quantifier binding the variable over realizations to the meaning of the verb, not to the meaning of the indefinite plural noun phrase. The indefinite plural noun phrase itself is a proper name wherever it occurs and so it obviously cannot have scope wider than an adverbial quantifier or any other quantifier in the sentence. (Carlson formulated his solution in the PTQ theory, so the "decomposition" of predicates into realization-predicates is accomplished through the translation procedure; when we compare translational decomposition with classical GS decomposition, we will look in detail at ways of insuring in each theory that this existential quantifier necessarily comes from *within* the logical structure of the verb and has narrowest scope. For now, I am assuming that his solution can be accommodated in the generative semantics theory under discussion.) Incorporating Carlson's analysis into the BECOME analysis of achievement sentences like *John discovered fleas on his dog for six weeks* would result in a logical structure roughly represented by (93), where f denotes the kind fleas:

(93)

$(\wedge t\colon t \in$ *six weeks*$)\mathrm{AT}(t, \mathrm{BECOME}[$*John knows that* $(\forall x[\mathrm{R}(x, f) \wedge$ *x is on his dog*$])])$

The BECOME analysis here, as before, explains why we understand this example to mean that John did not discover the same fleas over and over (i.e., the same realizations of the kind fleas). If Carlson's analysis is correct, then it is possible to retain the insight from Dowty (1972) that the acceptability of examples like this is to be explained with the BECOME analysis in terms of an existential quantifier with narrow scope but to add the independently motivated account of the narrow scope quantifier that was lacking earlier. Mass terms turn out to have all the same distributional properties as Carlson discovered for bare plurals, and though he does not provide a detailed analysis of mass terms, these parallels suggest that a similar treatment ought to be possible if Carlson's proposal is correct (cf. Carlson, 1977, pp. 462ff., for some suggestions).

2.3.5. *Degree-Achievements*

There are some cases of verbs which would seem to be achievements on some semantic and syntactic grounds but which nevertheless allow durational adverbs (even without indefinite plurals or mass terms):

(94) The soup cooled for ten minutes.

(95) The ship sank for an hour (before going under completely).

(96) John aged forty years during that experience.

These seem to express a change of state like other achievements: *cool* is definitely an inchoative meaning "come to be cool", *sink* here means "come to be not afloat", and *age* is "come to be old." Yet there is no contradiction in (94)-(96), no implication that the same change of state took place over and over.

Upon inspection, it turns out that the class of inchoatives that can occur with durative adverbials are just those which have been called *degree words* by linguists (Sapir, 1949; Bolinger, 1972) and *vague predicates* by philosophers (Lewis, 1970; Kamp, 1975). These involve properties such as *big, wide, good, tall,* etc. of which we cannot definitely say once and for all how to determine what their extension is, but can only say so relative to some agreed-upon standard of comparison or some particular context of use. The most typical vague predicates seem to be adjectives, specifically, those that form the comparative without semantic anomaly. As we have *this is cooler than that*, we also have (94) with the adjective *cool*, but as it is strange to say *Mary is more pregnant than Sue* (on a normal interpretation of *pregnant*), it is strange in the same way to say *Mary got pregnant for a month*.

Recent proposals for a model-theoretic treatment of vague predicates (Lewis, 1970; Ginet, 1973; Kamp, 1975) have all been based in one way or another on an appeal to multiple ways of resolving the vagueness of these predicates by assigning a definite extension to them, i.e. different ways of drawing the "boundary" between cool and non-cool things, big and non-big things, etc. Kamp (1975; pp. 136-137) explains it in this way:

> At the present stage of its development – indeed, at any stage – language is vague. The kind of vagueness which interests us here is connected with predicates. The vagueness of a predicate may be resolved by fiat – i.e. by deciding which of the objects which as yet are neither definitely inside nor definitely outside its extension are to be in and which are to be out. However, it may be that not every such decision is acceptable. For there may already be semantical principles which, though they do not determine of any one of a certain group of objects whether it belongs to the extension or not, nevertheless demand that if a certain member of the group is put into the extension, a certain other member must be put into the extension as well. Take for example the adjective *intelligent*. Our present criteria tell us of certain people that they definitely are intelligent, of certain other people that they definitely are not, but there will be a large third category of people about whom they do not tell us either way. Now suppose that we make our standard more specific, e.g., by stipulating that to have an I.Q. over a certain minimum is a necessary and sufficient criterion for being intelligent. Further, suppose that of two persons u_1 and u_2 of the third category u_1 has a higher I.Q. than u_2. Then, whatever we decide this minimum to be, our decision will put u_1 in the extension if it puts u_2 into it. Finally, let us assume for the sake of argument that any way of making the concept of intelligence precise that is compatible with what we already understand that concept to be is equivalent to the adoption of a certain minimum I.Q. Then there will be no completions in the partial model that reflect the present state of affairs and in which u_2 is put into the extension of the predicate but u_1 is not.

This approach leads directly to a way of deriving comparative adjectives from positive (non-comparative) adjectives (rather than deriving the positive form from the comparative, as earlier semantic treatments of comparatives have suggested). That is, *x is taller than y* will in effect count as true if and only if, for all "acceptable" ways of resolving the vagueness of *tall* by separating the tall from the non-tall, if *y* counts as tall then *x* counts as tall also by that method, but not vice versa.

Kamp's proposal is the most detailed that I have seen. He adopts an analysis based on Van Fraassen's supervaluations (Van Fraassen, 1969); that is, the basic interpretation is a partial model that leaves certain predicates undefined (neither true nor false) for certain individuals. Associated with the partial model are a set of (acceptable) completions of that model which fill in the "gaps" in the partial model in various ways – i.e. they assign a truth value for the undefined arguments in the partial model in different ways but otherwise agree with the partial model. In addition to providing a way of treating comparatives, Kamp can also assign a numerical degree of truth (between true and false) to vague sentences like *John is tall* by means of a probability function defined over the acceptable completions. (This method has considerable advantages over attempts to assign degrees of truth to vague sentences by means of multi-valued logics.) The partial model, its completions, and the probability function together form a *vague model* for a language. In a further development, contextual disambiguation of vague sentences is represented by a function from context to models which are less vague than the basic model. Though *John is tall* might be undefined for the basic model, it might well come out true or false (or have greater or lesser degrees of intermediate truth) for certain contexts.

Given such apparatus, an intuitively satisfactory solution to the problem of degree-achievements with durative adverbs begins to emerge. A sentence like *The soup cooled for ten minutes* should be analyzed as saying that for each time t within an interval of ten minutes duration, there is some resolution of the vagueness of the predicate *cool* by which *the soup is cool* is true at t but not true at $t-1$. Conditions on the acceptable resolutions of the predicate *cool* will in effect require that a different, higher threshold of coolness (i.e. a *lower* temperature for the threshold) be chosen for each successive time in the interval; otherwise the soup could not simultaneously count as cool with respect to one time and resolution of vagueness and also count as not cool for the next time and its resolution of vagueness. This seems to accord well with intuitions about how we understand the sentence, and also avoids having to derive *The soup cooled* from the morphologically unmotivated BECOME[*the soup is cooler*] rather than simply BECOME[*the soup is cool*].

What is necessary for this analysis to work is that the way of resolving vagueness must be capable of being chosen differently for each time t within the interval represented by the durational adverb. Just how this is best done is not yet clear to me. If we do not mention resolutions of vagueness at all in the recursive clauses of the semantic truth definition but merely let a complex sentence be true in a context if the context gives a resolution of vagueness for the elementary predicates that makes the whole sentence true, then different resolutions cannot be used for each time covered by a durational adverb. If on the other hand each recursive semantic definition counts a sentence as true if merely some resolution of vagueness makes it true under appropriate conditions, then *The soup cooled for an hour* could be vacuously true though the soup's temperature remained unchanged; there would still be some resolution at such time t which treated the soup as cool and some resolution (a different one) which made it not cool at $t-1$, so BECOME[*The soup is cool*] would be true at each time in the hour. What we must apparently do is this: a sentence BECOME ϕ should be true at t if and only if there is some resolution of vague predicates that makes ϕ true at t but false at $t-1$; then $(\wedge x: x \in$ *an hour*$)\phi$ must be true if and only if for all times t' within the interval *an hour* there is some resolution of vague predicates that makes ϕ true at t'. This effects the right restriction on the "scope" of quantification over times and resolutions. Whether some way will come to light of avoiding this explicit appeal to resolutions in the recursive clauses I do not know, and so I will leave the matter at this point.

2.3.6. *Accomplishments and CAUSE*

The verb *kill*, which appeared as an example in McCawley's influential article on word meaning (McCawley, 1968), is an accomplishment verb. If one examines the large literature on "causatives" in GS, the class of verbs there referred to as causatives seems to be co-extensive with the class of accomplishments, though aspectual syntactic tests like those in 2.2.3. have not been used to define the class. This convergence is not surprising when one recalls that Kenny considered all accomplishments to be describable as "bringing it about that p" for some proposition p. (This use of *causative* contrasts with the way it is used in traditional linguistics, according to which it refers only to verbs derived by a causative affix, an affix whose meaning is paraphrasable as "cause to", "cause to be" as English *ize* in *randomize*. When it is necessary to distinguish among syntactic and morphological varieties of causatives, generative semanticists generally distinguish among *lexical causatives*, such as *kill*, *derived causatives*, such as *randomize*, and *periphrastic causatives* – phrases containing a general causative verb plus a separate complement verb, such as *make him leave, cause him to leave*.)

In fact, I suggest that in the aspect calculus we construe all accomplishments as having the logical structure [ϕ CAUSE ψ], where ϕ and ψ are sentences. These embedded sentences ϕ and ψ may have various forms, the most common being the case where ϕ is a BECOME sentence or contains an activity predicate, and ψ is a BECOME sentence. For example, an accomplishment sentence like *John killed Bill* would have a logical structure with roughly the form of (97), and that of *John painted a picture* would have roughly the form of (98):

(97) [[*John does something*] CAUSE [BECOME¬[*Bill is alive*]]]

(98) [[*John paints*] CAUSE [BECOME[*a picture exists*]]]

This analysis differs from McCawley's original version in that CAUSE is here treated as a kind of two-place sentential connective, rather than as a relation between individuals and propositions.

This so-called "bisentential analysis" of CAUSE did not originate with Dowty (1972) but had been suggested in various contexts (Vendler, 1967a; Geis, 1970; Fillmore, 1971; J. McCawley, 1971;[12] Lee, 1971; N. A. McCawley, 1973; Rogers, 1972; Givón, 1972). I will not attempt to survey thoroughly the reasons for choosing one or the other analysis in a generative semantics theory, but merely cite a few advantages of the "bisentential" analysis and

refer the reader to the above literature, Wojcik (1974; 1976) and Shibatani (1976) for further details.

An obvious motivation for CAUSE as a "subject-complement verb" in generative semantics is Ryle's observation (Ryle, 1949, p. 150) that accomplishments are semantically bipartite in a way that activities are not, that "some state of affairs obtains over and above that which consists in the performance . . . of the subservient activity." Vendler (1967, p. 154) and Geis (1973, p. 211) make essentially the same observation in pointing out that accomplishment sentences like (99) are elliptical; one can conclude (100) and (101) from (99):

(99) John dissolved the Alka Seltzer.

(100) John dissolved the Alka Seltzer by doing something.

(101) John's doing something dissolved the Alka Seltzer.

Geis suggests that (101) is the underlying structure of (100), (100) being derived by a transformation of Agent Creation, a transformation that breaks up the subject complement into an agentive subject and a post-posed *by*-phrase. This transformation may derive some plausibility from the fact that its operation is quite similar to that of the well-motivated Raising (to Subject) transformation, the rule that derives (102a) from (102b) (compare with (101) and (100)):

(102a) John would be unlikely to win the contest.

(102b) John's winning the contest would be unlikely.

For what we may call general causatives like *kill, open* and *make* (in the sense of *create*) the sentential subject analysis might seem unmotivated, since the meaning of these verbs does not seem to specify anything about the kind of activity that is used to bring about the result, but only the result itself. One can kill a person or animal by any number of activities or procedures; one may open a door by pushing, kicking, striking it, by throwing something at it, by setting off an electronic device or maybe even by saying a magic word, and the ways of making a picture are likewise varied. However, many monomorphemic accomplishments do specify this associated activity in more or less detail. In the class of homicidal verbs (always popular as linguistic examples) are examples like *electrocute, strangle, poison, drown, hang*, etc. which give a specific method of bringing about a death (as well as examples like *assassinate* and *execute* which specify a particular motive

though not a means[13]), and one can not only make a picture, but can also paint, draw, sketch, etch, carve, or stencil a picture, these activities indirectly giving indications of the kind of picture that results. Thus we want to suppose that the embedded subject sentence of CAUSE in the underlying structure of general causatives like *kill* or *make* contains a quite general activity or event verb, while other accomplishments have a more specific predicate in this place. (Even *act* is not general enough for the causal event of *kill*, since its subject can be an inanimate (so-called "instrumental") subject, as in *The falling tree killed John*; perhaps *do something* is sufficiently general.)

An even more notable motivation for bisentential CAUSE is a kind of accomplishment construction called *factitive* in traditional grammar and *instrumental* in generative semantics (Green, 1970; 1972; McCawley, 1971):

(103) Jesse shot him dead.
She painted the house red.
She hammered the metal flat.
He swept the floor clean.

(104) He drank himself silly.

(The term *instrumental* is really inappropriate since the construction clearly includes examples like *She slammed the door shut, He shook her awake, She pulled it free* in which no "instrument" is involved.) Here, an activity (or accomplishment) verb combines with an adjective and an object noun phrase to give an accomplishment in which the verb describes the causal activity (or accomplishment) and the adjective gives the result state that the direct object comes to be in as a consequence. Given the sentential subject analysis of CAUSE, examples in (103) would have the kind of structure represented in (105):

(105) [[*He sweeps the floor*] CAUSE [BECOME[*the floor is clean*]]]

An interesting feature of the construction is that though the object of the causal clause is usually identical with the subject of the result-clause (cf. (105)), this need not necessarily be the case. In (104) the understood object of the simple verb *drink* is not the person denoted by *himself*, though *himself* clearly functions as object of the "whole phrase" *drink silly*, in the sense that his becoming silly was brought about by his drinking (something). Constructions semantically similar to (103) exist in which a predicate nominal or prepositional phrase replaces the adjective, such as *elect John chairman, cook the steak to a crisp*, as a parallel to (104) is *read oneself to sleep*.

(Sentences like (103), (104) and these last examples will be treated explicitly in 4.7 below.)

Another class of sentences that may motivate a bisentential analysis of CAUSE is a subset of the verb-particle constructions (cf. Fraser, 1965; 1974), those in which the particle expresses a location that the direct object comes to be in as a result of an activity identified by the basic verb, such as *put the book away*. Within the lexical restrictions of English it is often possible to hold the activity constant and vary the result state as in (106), or to hold the result constant and vary the activity as in (107):

(106) throw NP away
throw NP down
throw NP aside
throw NP in
throw NP up

(107) put NP away (aside, etc.)
throw NP away
send NP away
drive NP away
call NP away

The point of these paradigms is to suggest that at least a restricted subset of the verb-particle constructions should not be treated as single lexical units consisting of verb and particle together, but that they are to some real extent compositional accomplishment constructions of activity verb and particle that expresses a result state.

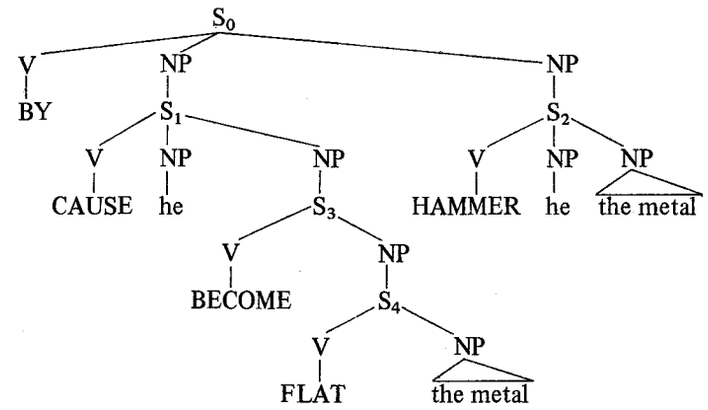
The alternative in GS to deriving *by*-phrases as just proposed is to treat CAUSE as a relation between an individual and a proposition as McCawley originally did and then derive *by*-phrases from yet a different abstract operator. Such an analysis is proposed by McCawley (1971), according to which all of (108)-(110), if not even more sentences, are derived from the structure (111):

(108) He made the metal flat by hammering it.

(109) He flattened the metal by hammering it.

(110) He hammered the metal flat.

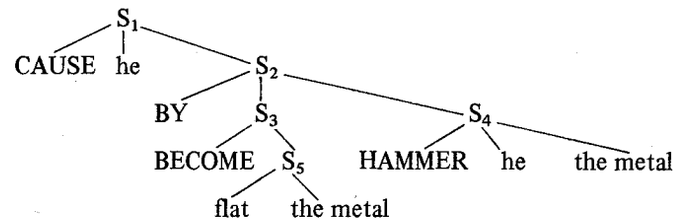
(111)



Here, BY is treated as a sentential connective (or in strict GS terms, a "two-place predicate", the NP arguments themselves dominating two S-nodes) in accord with the prevailing GS view that adverbials are derived from sentential operators ("predicates of higher sentences"). The derivation of (108) and (109) from (111) is fairly straightforward, but the derivation of (110) from the same source is somewhat more dubious. McCawley "conjectures" (1971: 31) that after predicate raising has attached BECOME and FLAT to CAUSE in S_1 and *the metal* from S_4 has become the derived direct object of this complex verb (via subject raising?[14]), (i) Equi-NP Deletion deletes the subject of HAMMER in S_2 on the basis of its identity with *he* in S_1 (the same deletion would take place in the derivation of (108) and (109)), then (ii) "a highly suspect transformation deletes the object of HAMMER under God knows what identity condition with S_1", and (iii) predicate raising combines CAUSE-BECOME-FLAT with BY, and then finally (iv) "a transformation hereby christened means-incorporation" combines this derived verb with the remaining verb HAMMER in S_2.

Georgia Green (1972, p. 97) finds that the derivation of (110) works out to her satisfaction if the underlying structure is not (111) but (112):

(112)



She claims that the derivation of (110) from this structure can be accomplished using only the three rules Subject Raising, Equi-NP Deletion and Subject Formation (a rule that Chomsky-adjoins a subject NP to the left of its verb) – plus lexicalization rules of course – though her derivation in fact involves no less than fourteen applications of transformations in this group and the assumption that transformations apply to their own outputs on the same cycle.

The apparent syntactic simplicity of the derivation I proposed at first might seem to give it an advantage over these two, but given the complexity of accepted GS derivations at that time, this complexity would not likely be taken as a very serious argument. (Needless to say, the proposal of GS derivations of this complexity has given rise in some quarters to the suspicion that potentially any form of surface structure must be derivable from any form of underlying structure whatsoever in a GS grammar, this suspicion then leading to despair over the possibility of ever actually testing whether a GS grammar could generate all and only the well-formed sentences of English or some fragment of English. This is a suspicion I am not unsympathetic with.) The source of all this complexity is of course the unquestioned GS assumption that (110) must have the same underlying syntactic structure as (108) and (109), despite its superficial dissimilarity. If one gave up this assumption, then it would seem much more natural syntactically to derive (108) and (109) from a structure like McCawley's and Green's and to derive (110) from a structure like (105).

Another possible reason for preferring a sentential connective CAUSE over McCawley's CAUSE plus BY is that the intuitive interpretation of BY (ϕ, ψ) seems quite similar to that of $[\phi \text{ CAUSE } \psi]$, except that the order of arguments is reversed.[15] If BY could be eliminated in favor of CAUSE, a kind of economy could be achieved that is much desired in the GS methodology. A more pragmatic reason for preferring CAUSE as a sentential connective in the present context is that the model-theoretic interpretation of $[\phi \text{ CAUSE } \psi]$ I want to consider requires that it be a sentential connective (or else that we in effect define McCawley's CAUSE in terms of this sentential connective).

Of the many problems that arise in attempting to analyze accomplishments from an underlying structure containing CAUSE, one deserves discussion here (others will be attended to later). It was noticed at the very first discussion of this kind of analysis that sentences with derived causatives may not be exactly paraphrasable by sentences with the English verb *cause*, though this is sometimes hard to judge. Hall (1965, p. 28) notes that "one

argument that probably does not convince anyone who does not already agree is that causing a window to break and breaking a window simply do not mean the same thing," adding examples where she finds a derived causative ungrammatical but the periphrastic causative paraphrase acceptable:

(113) a. A change in molecular structure caused the window to break.
b. *A change in molecular structure broke the window.

(114) a. The low air pressure caused the water to boil.
b. *The low air pressure boiled the water.

(115) a. The angle at which the door was mounted caused it to open whenever it wasn't latched.
b. *The angle at which the door was mounted opened it whenever it wasn't latched.

("Ungrammatical" may be too strong a term for (113b), (114b) and (115b) according to some people – I find them merely a little odd – but there is clearly some kind of difference between the (a) and (b) examples which has to be accounted for.) But as Hall immediately points out, this difference is not automatically evidence against the analysis of causative *break*, etc. in terms of CAUSE. The operator CAUSE is an abstract element and need not be considered identical in meaning with the English "surface verb" *cause*; this surface verb might contain other abstract predicates besides CAUSE in its underlying structure, or it might differ from CAUSE in its presuppositions. This possibility, however, presents the GS theory with a methodological dilemma that potentially all structuralist decomposition analyses are subject to: just how do we decide whether a given decomposition analysis in terms of completely abstract elements adequately represents the meaning of the analyzed word or not, given that the test of a decomposition analysis is not just whether a putative English paraphrase containing the "decomposing" words of the analysis is really synonymous with the analyzed word or not? If we say *kill* is CAUSE BECOME NOT ALIVE but have no independent way of deciding exactly what the meaning of these abstract elements is (once we admit that comparing them to *cause, become, not* and *alive* is no adequate test), then the analysis is in danger of approaching complete vacuity. Even if we were to accept the structuralist's doctrine (which I don't) that we only need to isolate the primitive semantic contrasts of a language, not further analyze these, we still face the problem of knowing whether the theoretical construct CAUSE used to analyze one kind of word is really representing the same meaning as it does when it is used in analyzing another kind of word.

In traditional linguistic analysis, the keen semantic intuitions of the linguist are the only test of whether the significance attached to an abstract element is really constant wherever that element is used, but such judgments are very tricky, especially when each analysis contains more than one abstract element, so that it may be difficult to know just what "part" of the meaning of a real word is being attributed to each abstract element.

In the case of the semantics of causation, further research has magnified rather than diminished the importance of the problem Hall observed. It is now widely assumed that there are at least two kinds of causation evidenced systematically in natural languages, direct (or *manipulative*) causation and indirect (or *directive*) causation (Shibatani, 1976, pp. 31-39) and some writers suggest even more distinctions (Talmy, 1976). Manipulative causation is said to necessarily involve the physical manipulation of the object affected by the agent, while directive causation does not; perhaps the clearest example of the distinction in English is *John stood the child up* (manipulative) vs. *John made the child to stand up* (directive). Shibatani claims that not only in English but in other languages (Korean, Japanese) as well, manipulative causation tends to be expressed by lexical causatives and directive causation by periphrastic causatives (though the generalization is not absolute). But granted that the distinction is well-motivated, the question of how best to analyze the distinction in GS remains open. Should we postulate two causative operators, CAUSE_m and CAUSE_d? Should we assume directive causation is expressed by a primitive causation operator and that manipulative causation is produced by combining this with an adverbial element meaning "by direct manipulation"? Or do we take manipulative causation as basic and posit an adverbial meaning "by indirect means"? Or are there a "general" causation operator and two kinds of specializing adverbials? Are any of these solutions equivalent to any others? (The distinction between kinds of purposeful and non-purposeful causation may possibly be captured by a DO operator introduced below, but this will not help with the kind of difference observed in (113)-(115) above, where no animate subjects are involved.)

The only sure remedy I can see for this problem is to attempt to assign an explicit model-theoretic interpretation to every such abstract element postulated. (Alternatively, one could provide a system of deductive rules which make the entailments derivable with such elements precise, but the model-theoretic method also makes entailments precise and defines meaning in terms of non-linguistic objects as well.) Only in this way will the entailments of a decomposition analysis be really clear, and only in this way can we be sure the same abstract element is used to the same semantic effect in different

analyses. The only case where we can satisfactorily make an exception to this rule is the one where one of the elements of a decomposition analysis *can* explicitly be equated with the meaning of an independent English word – for example, in McCawley's decomposition of *kill* it would seem acceptable to take the meaning of the abstract element ALIVE to be that of the adjective *alive*. For when we do this, we can still test the entailments of an analysis precisely in terms of other English sentences, even though these contain non-logical constants that are not given a standard interpretation. For example, if our analysis of *John killed Harry* gives (by virtue of the explicit analysis of CAUSE, BECOME and negation) the formal entailment that *Harry is not alive* is true under just the right conditions, then this serves as an adequate test of the analysis of *kill* even though we leave the stative predicate *alive* unanalyzed.

Accordingly, in the section that follows I will take CAUSE to be a logical operator (rather than as representing the meaning of English *cause* exactly) and attempt to give a model-theoretic interpretation for $[\phi \text{ CAUSE } \psi]$. As this is an ambitious undertaking which remains in the preliminary stages, I therefore do not feel the need to apologize for ignoring the apparent distinctions among the various kinds of direct and indirect causation mentioned in the literature, since I regard what I am doing as a necessary preliminary to exploring these distinctions coherently. In Chapter 6 I will present one way of dealing with unsystematic divergences of derived causatives from their predicted meanings, and I think it could still turn out that no more should or can be said about manipulative (as opposed to directive) causation than this. (Also, see McCawley (1978) for arguments that at least some of the above distinctions in kinds of causation, if not all of them, can be accounted for in terms of conversational implicature.)

2.3.7. *CAUSE and Lewis' Analysis of Causation*

In the long philosophical literature on causation, an intuitive connection between causal statements and counterfactual statements has frequently been observed. For example, G. H. von Wright (1963; 1968) observed that to assert that an agent has brought about an event (as in (116)), the speaker must believe that three kinds of facts obtain, in this case those in (117):

(116) John opened the door.

(117) a. The door was not open just before John acted.
b. The door was open just after John acted.

c. The door would not have become open on that particular occasion if John had not acted and all else had remained the same.

The first two conditions determine that the event of the door's opening took place; these entailments from (116) are accounted for by the truth conditions for the BECOME operator, assuming that [ϕ CAUSE [BECOME ψ]] entails BECOME ψ. (117c) is what von Wright calls the "counterfactual element in causation," and the tricky part of it is the phrase "and all else had remained the same." If for example the door in this case had been controlled by some electronic device which happened to open the door on that occasion independently of any of John's actions, then (116) does not truthfully describe the situation, no matter what John did to the door.

Von Wright proposed a simple axiomatic system for this notion of causation. In addition to his "And Next" operator T mentioned earlier, he introduced a two-place operator I, read "Instead of." A formula $((\neg pTp)I\neg p)$ is read "the agent brought it about that $\neg p$ became p instead of remaing $\neg p$. (Von Wright's I-calculus would not be directly adaptable to a counterfactual analysis of causation for our purposes since no explicit reference is made to the agent or to the agent's actions which brought about the result.)

Despite this intuitive connection, attempts to analyze causation in terms of counterfactual statements have not been popular in the literature on causation, no doubt primarily because counterfactuals have traditionally been considered to be as problematic if not more problematic than the idea of causation itself. This situation has changed somewhat with the publication of interesting theories of natural language conditionals (or counterfactual conditionals) by Stalnaker (1968; 1970 with Thomason) and David Lewis (1973). Stalnaker considered the logical properties of the *if . . . then* connective of natural language as it appears in examples like (118) (recall how this would have been taken in the 1968 context of Stalnaker's article when the Vietnam war was still going on):

(118) If the Chinese enter the Vietnam conflict, the United States will use nuclear weapons.

After reviewing the well-known reasons why neither the material implication of standard first-order logic ($p \rightarrow q$) nor stronger kinds of logical connection between antecedent and consequent represent the meaning of (118) adequately, Stalnaker suggests that the way we decide the truth value of an

example like this is the following. We take our beliefs, as it were, about the actual world, then somehow "add" to these beliefs the proposition expressed by the antecedent clause *if the Chinese enter the Vietnam conflict*, making "whatever adjustments are required to maintain consistency". Then finally we try to decide whether in this new situation the sentence *the US will use nuclear weapons* is true. If so, then the conditional as a whole is true.

To analyze this notion of beliefs about the actual world "plus some changes," Stalnaker turns to possible worlds semantics. The truth conditions for conditionals are then construed in this way (Stalnaker, 1968, p. 102): "Consider a possible world in which A is true and which otherwise differs minimally from the actual world. *'If A then B' is true (false) just in case B is true (false) in that possible world.*" To formalize this idea we are to add to the semantic apparatus (which will include a set of possible worlds and an interpretation of the language relative to worlds in this set) a *selection function f* which takes a proposition and a possible world as arguments and gives a possible world as value. The world $f(A, \alpha)$ selected for each proposition A and world α is to be one in which A is true and which otherwise differs minimally from α (if it is not in fact identical with α), i.e. it differs in only those ways that are required explicitly or implicitly by A. The truth conditions for the natural language conditional $\Box\!\!\rightarrow$ are formally stated as follows:[16]

(119) $A \Box\!\!\rightarrow B$ is true in α if B is true in $f(A, \alpha)$.
$A \Box\!\!\rightarrow B$ is false in α if B is false in $f(A, \alpha)$.

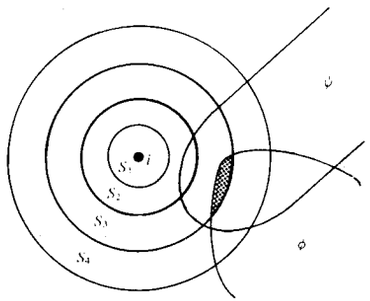
(For further details cf. Stalnaker, 1968, and for meta-logical results, Stalnaker and Thomason, 1970.)

In Lewis (1973), a number of formal systems of conditional (or as Lewis prefers, *counterfactual*) logic are proposed and studied, most of which differ from Stalnaker's system in one main way. Stalnaker's treatment requires that for each world and proposition there be a unique possible world differing from it minimally in which that proposition is true. But there are reasons to believe this is an unreasonable assumption, these being most obvious in examples like the following pair of conditionals (noted by Stalnaker and Thomason as well as Lewis):

(120) If Bizet and Verdi had been compatriots, Bizet would have been Italian.
If Bizet and Verdi had been compatriots, Verdi would have been French.

Stalnaker's assumption would apparently require that only one of these conditionals can be true (given that in the actual world Bizet was French and Verdi Italian), yet it is implausible that either one is more likely than the other (though we can readily assent to the statement that if Bizet and Verdi had been compatriots, then *either* Bizet would have been Italian *or* Verdi would have been French). To avoid this difficulty, Lewis instead assumes that relative to a given world, the rest of the possible worlds can be partitioned into an ordered set of equivalence classes, each class of which is definitely more similar or less similar to the actual world than all other classes, but within each class of which the worlds are neither more nor less similar to the actual world than the other members of its class. A (counterfactual) conditional $A \Box\!\!\rightarrow B$ is then true, on Lewis' account, if either (1) there is no world in which A is true, or (2) the "closest" world(s) in which A holds (the world(s) most similar to the actual world in which A holds) and B holds as well is (are) "closer" (more similar to the actual world) than any world in which A holds but B does not. Lewis conceives of the set of more and more similar sets of possible worlds (relative to a given world i) as a set of nested spheres with i as center, each sphere containing possible worlds not contained in the next larger sphere; the smaller the sphere, the more similar to i are the worlds contained within it. Thus we can diagram a situation in which $\phi \Box\!\!\rightarrow \psi$ is true and $\phi \Box\!\!\rightarrow \neg\psi$ is false as in (121):

(121)



(Here $\phi \Box\!\!\rightarrow \psi$ is true because some worlds in which ϕ holds – in this case, those in the shaded area – are more similar to i than any worlds in which ϕ holds but ψ does not; the shaded worlds are in S_3, but one has to go to less similar worlds in S_4 to find one in which ϕ is true but ψ is false.)

Though formulated somewhat differently, Stalnaker's system is equivalent to Lewis' under the assumption that in the latter system there is, for each world i and antecedent A entertainable at i, a class of equally-similar

A-worlds containing exactly one member. (There is some slight oversimplification in this; cf. Lewis (1973, pp. 77-83) for exact comparison and some "compromises" between the two.) As is the case with Stalnaker's selection function, Lewis makes no attempt to say just how the similarity relation is to be determined; it is a primitive notion in his theory.

In Dowty (1972a; 1972b) I attempted to give truth conditions for [ϕ CAUSE ψ] in terms of a counterfactual analysis of causation based on Stalnaker's conditional logic, though I did not make a real attempt to respond to all the traditional philosophical problems in defining causation. Lewis (1973a) presents a more sophisticated attempt at a counterfactual analysis of causation which does attend to these problems, and I will adopt a version of his analysis here.

Though causation is traditionally taken to be a relation between events (whatever these are), to use the counterfactual analysis to define causation Lewis must instead deal with propositions: in place of "event c causes event e" he will have a relation between the propositions $O(e)$ and $O(c)$, where $O(e)$ is the proposition that event e occurs, etc. This is fortunate for our present purposes, since I have treated CAUSE as a sentential connective. Thus I will avoid the problem of constructing expressions denoting events and forming from these event expressions sentences asserting that events occur, since it is only the sentences themselves that are needed as "arguments" for CAUSE (e.g., a BECOME-sentence is one asserting that an event occurs). No further "ontology of events" will be necessary in this book. But in discussing Lewis' theory of causation, I will continue to speak informally of "events e, c" and sentences $O(c)$ and $O(e)$. Moreover, there may well be causal sentences of natural language which we would not want to analyze as relations among events, such as the "stative" causative sentence (122) cited by Fillmore (1971):

(122) Mary's living nearby causes John to prefer this neighborhood.

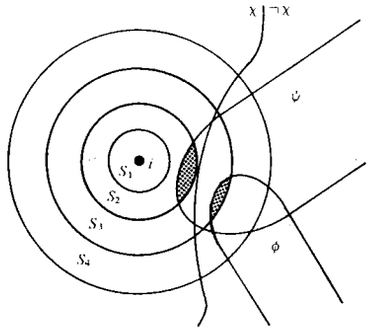
Finally, English has the "surface" sentential connective *because* which connects two sentences – both those expressing the occurrence of events (*John left because Mary arrived*) and those expressing states (*John prefers this neighborhood because Mary lives nearby*).

Lewis defines the relation of *causal dependence* between events e and c as counterfactual dependence between the propositions that these events occur: *e depends causally on c* if and only if both $O(c) \Box\!\!\rightarrow O(e)$ and $\neg O(c) \Box\!\!\rightarrow \neg O(e)$. In the case of two actually occurring events c and e the first conditional is vacuously satisfied[17] (since $O(c) \wedge O(e)$ entails

$O(c) \Box\!\!\rightarrow O(e)$), so we might as well say e depends causally on c if and only if $O(c)$ and $O(e)$ and $\neg O(c) \Box\!\!\rightarrow \neg O(e)$.

For Lewis, causal dependence is not quite the same relation as causation itself: causation is to be a transitive relation, while causal dependence is not. This latter fact already follows because transitivity fails for Lewis' counterfactual connective $\Box\!\!\rightarrow$; it can be true that $\phi \Box\!\!\rightarrow \psi$ and $\psi \Box\!\!\rightarrow \chi$ but at the same time false that $\phi \Box\!\!\rightarrow \chi$, as in the situation represented by the diagram in (123). (cf. Lewis 1973a, p. 563):

(123)



Causation proper is defined by Lewis in terms of causal dependence as follows: Event c *causes* event e just in case there is a series of events $c, c_1, c_2, \ldots, c_n, e$ such that c_1 depends causally on c, c_2 depends causally on c_1, and so on throughout the series (for any $n \geqslant 0$, so that a series of only two causally dependent events c and e counts as causation as well as longer "chains" of events). Because of the failure of transitivity for causal dependence, c may cause e even though e does not depend causally on c. (The advantage Lewis sees in this distinction between causation and causal dependence will became clear shortly.)

The first traditional problem Lewis deals with is the problem of the *direction* of causation, i.e. of insuring that the analysis will distinguish between "c causes e" and "e causes c". Presumably, the fact that the barometer has a certain reading depends counterfactually on the fact that the air pressure has a certain strength: if the air pressure had been different, then the barometer reading would have been different. But is it also true that if the barometer reading had been different, then the pressure would have been different? If so, then cause and effect are not distinguished by the counterfactual analysis. But Lewis denies that the second counterfactual is true; perhaps the barometer was merely malfunctioning. The key to the distinction, as Lewis sees it, is in how overall similarity of worlds is understood:

> To be sure, there are actual laws and circumstances that imply and explain the actual accuracy of the barometer, but these are no more sacred than the actual laws and circumstances that imply and explain the actual pressure. Less sacred, in fact. When something must give way to permit a higher reading, we find it less of a departure from actuality to hold the pressure fixed and sacrifice the accuracy, rather than vice versa. It is not hard to see why. The barometer, being more localized and more delicate than the weather, is more vulnerable to slight departures from actuality.
>
> (Lewis, 1973a, p. 564f.)

(Lewis distinguishes (1973a, pp. 563-565) between counterfactual dependence and a similar relation which he calls *nomic dependence* which *is* reversible in a certain sense.)

Another problem is that of *epiphenomena*. Suppose (to take an example from Lewis again) that the axe falls (event c), its shadow moves (event d) and the king loses his head (event e). Can we be sure that c, rather than d, causes e? If c had not occurred then d would not have occurred, but it also seems that if d had not occurred then again e would not have occurred. As with the problem of the direction of causation, Lewis here denies the counterfactual that is a problem: it is false that if the shadow had not moved then the kind would not have lost his head. Or in other words, a possible world in which d was absent but e occurred anyway, caused as in actuality by c, is closer on balance to actuality than a world in which d is absent because c is absent and where e is absent as well.

A third problem is the *preemption* of one cause by another. Suppose Colonel Mustard poisons the coffee with poison X and Professor Plum poisons it with poison Y. The victim drinks the coffee and dies. However, it turns out that poison X catalyzes poison Y into an inert substance without losing its lethality, so Colonel Mustard's use of X (event c_1) preempts Professor Plum's use of Y (event c_2) in causing the death (event e). The problem is that neither c_1 nor c_2 may count as causes under the counterfactual analysis, since it is false that if c_1 hadn't occurred then e would not have occurred (the other poison would have done the trick) and it is false that if c_2 hadn't occurred then e wouldn't have occurred (the first poison would have done it). It is at this point that Lewis appeals to the failure of transitivity of causal dependence but not causation itself. There is here a third event (if not more) involved in the causal chain from c_1 to e, namely the victim's ingestion of a lethal dose of X (event d). Here d depends causally on c_1, and e can be said to depend causally on d (because if the victim had not ingested poison X in drinking the coffee then – assuming poison Y had been already decomposed as before – e would not have occurred). So here c_1 still counts as a cause of

e, not because e depends causally on c_1 (which it does not) but because of the chain of causal dependence from e back to d and from d back to c_1; it is in this sort of case that we have causation without causal dependence.

A vexing problem for the counterfactual analysis that Lewis does not attempt to solve is the problem of *overdetermination* of an event by two independently sufficient causes. Suppose that an electrical short starts a fire in one part of a house, and at exactly the same time a cigarette ash starts a fire in another part. The house burns down. Also suppose that in this situation either accident would have led to the destruction of the house if the other had not occurred. Under the counterfactual analysis it seems that neither accident counts as a cause of the destruction of the house, since if one accident had not occurred the house would still have burned down, and if the other accident had not occurred the house would still have burned down.[18] Cf. Lyon (1967) and Loeb (1974, pp. 540-543) for possible ways of resolving this paradox under counterfactual analyses.

Another traditional problem that Lewis does not really attempt to deal with directly is what he calls *causal selection*. As has often been noted, natural language causation statements (accomplishment sentences) ordinarily single out one event as *the cause* of the second, whereas the counterfactual analysis as it stands allows quite a number of events and surrounding circumstances to count as causes. In reply to Lewis it has been pointed out by Kim (1973) and Abbott (1974) that quite a large number of counterfactuals give quite peculiar sentences when converted to causal statements (examples are from Abbott (1974); Kim's examples are similar):

(124) a. If I had not lit John's cigarette, he would not have smoked it.
b. My lighting John's cigarette caused him to smoke it.

(125) a. If Mary had not gotten married, she would have not become a widow.
b. Mary's getting married caused here to become a widow.

(126) a. If I had not been born I would not have come to Amherst.
b. My being born caused me to come to Amherst.

(127) a. If the jewels had not been stolen, the police would not have discovered it.
b. The theft of the jewels caused the police to discover it.

Lewis seems to suggest that this is not an important problem from his point of view. "We may select the abnormal or extraordinary causes, or those under

human control, or those we deem good or bad, or just those we want to talk about. I have nothing to say about these principles of invidious discrimination. I am concerned with the prior question of what it is to be one of the causes (unselectively speaking)" (Lewis, 1973a, p. 559). This may be one of the places (cf. below) where philosophical and linguistic desiderata for an analysis of causation differ, since the above examples of causal statements are strikingly abnormal, and as far as I know, almost all accomplishments in English require causal selection in this way. (An exception is the nominalization *cause* of the verb *cause*, where we can speak of *a cause of X, one of the causes of X*.)

Lest it be suggested that Lewis' mention of "those we want to talk about" invites a Gricean analysis (Grice, 1975) of the causal selection problem, note that the counterfactual analysis treats causal statements and counterfactuals as logically equivalent (or to be more exact, "*A* causes *B*" is equivalent to "*A* and *B*, and if *not-A* then *not-B*"). If equivalent, then the two kinds of statements ought to have exactly the same conversational implicatures, according to Grice' definition. Nor does an implication that the causal event mentioned is the most important of several causal factors qualify as a conventional implicature (presupposition) by the usual linguistic tests (cf. Karttunen and Peters, 1974).

It will not help, as Abbott (1974) notes, to try to add to the truth conditions for *c causes e* a clause stating that $\neg O(e) \Box\!\!\rightarrow \neg O(c)$, even though this might seem to solve the selection problem by requiring the causal event to be one that would not have occurred in worlds most similar to the actual world except that the effect did not occur (cf. McCawley, 1976). That is, such a clause would make the asserted cause a kind of sufficient as well as a necessary condition for the result. This seems to pick out the one "causal condition" that most likely would have been otherwise. As Abbott points out, this immediately destroys the assymetry between cause and effect (since both $\neg O(c) \Box\!\!\rightarrow \neg O(e)$ and $\neg O(e) \Box\!\!\rightarrow \neg O(c)$ would be part of the truth conditions) and has other technical problems within Lewis' system as well.

However, there may be another approach to the causal selection problem similar to this but which is less problematic. It does seem that often, if not always, we select as the "cause" of an event that one of the various causal conditions that we can most easily imagine to have been otherwise, that is, one whose "deletion" from the actual course of events would result in the least departure from the actual world. As Abbott points out, it may or may not sound odd to deem a certain causal condition "the" cause, depending on what the other causal conditions were. Though it would normally be odd to say that my lighting John's cigarette caused him to smoke it, this statement

might be considered appropriate if at the time I lighted it John was being held down by someone while a cigarette was held in John's mouth and his nostrils were held closed. And though it would be strange to say that Mary's getting married caused her to become a widow if she married her husband as a healthy young man, it might be natural to say this if she married a man on the verge of death. If we had some way of quantifying over all the multiple causes (in Lewis' sense) of an event, then we might identify what we call "the cause" in natural language as that one causal condition whose "deletion" (i.e. its non-occurrence) can be found in worlds more similar to the actual world than can the "deletion" of any of the other causal conditions. The above examples suggest that causal conditions or events happening just prior to the resulting event are "easier to get rid of", as it were, than causal conditions or events that occur further back in the causal chain of events. This would accord with Lewis' suggestion that in determining overall similarity among worlds, "comprehensive and exact similarities of particular fact throughout large spatiotemporal regions seem to have special weight." And if this view of causal selection is right, the fact that we so often label human actions as "the cause" when they appear in a causal chain of events could be explained by the widespread view that the actions of human agents are usually less determined (could more easily have been otherwise) than events involving only inanimate objects. (But see Abbott (1974) for what may be problems for this view.)

Let us relabel Lewis' definition of the causation relation as the *causal factor* relation and approach the truth conditions for [ϕ CAUSE ψ] by the following series of definitions. I will state the definitions in terms of arbitrary sentences ϕ and ψ, leaving it open whether we must eventually restrict these to sentences expressing the occurrence of events or add some other restrictions on them.

(128) ϕ *depends causally on* ψ if and only if ϕ, ψ and $\neg\phi \mathrel{\Box\!\!\rightarrow} \neg\psi$ are all true.

(129) ϕ *is a causal factor for* ψ if and only if there is a series of sentences $\phi, \phi_1, \ldots, \phi_n, \psi$(for $n \geqslant 0$) such that each member of the series depends causally on the previous member.

(130) [ϕ CAUSE ψ] is true if and only if (i) ϕ is a causal factor for ψ, and (ii) for all other ϕ' such that ϕ' is also a causal factor for ψ, some $\neg\phi$-world is more similar to the actual world than any $\neg\phi'$-world is.

As far as I am aware, this avoids the difficulties we encounter in attempting to add the inverse counterfactual $\neg O(e) \mathrel{\Box\!\!\rightarrow} \neg O(c)$ to the definition of causation. Definition (130) requires the assumption that there be a unique "selected" causal factor for each true CAUSE sentence, but perhaps this is too strong. We might instead wish to allow that in some cases two or more causal factors will be equally easy to get rid of (i.e. their absences will be first encountered in equally similar worlds) and can both (all) count as causes, while nevertheless ruling out other, more irreversible causal factors as causes. Thus if a set of equally fortuitous traffic conditions led to an accident we might want to say that all of them caused the accident, while still denying that the driver's having started the car at the beginning of the ill-fated trip also caused the accident. If so, (130) should be changed to (131):

(131) [ϕ CAUSE ψ] is true if and only if (i) ϕ is a causal factor for ψ, and (ii) for all other ϕ' such that ϕ' is also a causal factor for ψ, some $\neg\phi$-world is as similar or more similar to the actual world than any $\neg\phi'$-world is.

Though I will have to leave many aspects of the semantics of causation unresolved, I think I have presented one interesting and promising treatment that gives the reader enough of an idea of the problems and possibilities involved to convince him of the interest in trying to specify the conditions under which CAUSE sentences are true and appropriate. The basic analysis presented here already suggests points at which one might tinker with definitions in order to introduce a distinction between direct and indirect causation, should such a distinction really be needed – for example, restrictions on the number of events in the causal chain, restrictions on the kind of causal event, or on the way causal selection is determined.

The problem of causation itself is a profound and complex one in philosophy, particularly as it pertains to the philosophy of science, and has a much longer history than the study of causative/accomplishment verbs in linguistics. The present discussion does not really do justice to this philosophical literature. I think it is important to leave open the possibility that the best analysis of causation for purposes of the philosophy of science may turn out to be quite different from the best analysiss for causatives in ordinary language. For example, Lewis considers it an important virtue of his treatment that it does not assume a relation of temporal priority between cause and effect and can thus potentially deal with phenomena such as backwards causation and closed causal loops among events, phenomena that are of real concern in some branches of modern physics. Aside from the

allowance for contemporaneous cause and effect as in the stative causative example (122), I know of no case where effect fails to be preceded by cause for ordinary language, so I would not consider it a significant defect of a semantic analysis of causation for ordinary language that such extraordinary kinds of causation were automatically excluded. On the other hand, causal verbs are frequently used in ordinary English discourse for relationships that philosophers would be careful to distinguish from true causation:

(132) a. The failure of universal instantiation in line three makes the proof invalid.
b. A kangaroo is a marsupial because it has a pouch.
c. Mary's living nearby causes John to prefer this neighborhood. (= 122)

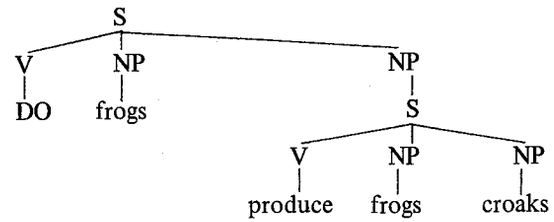
I am told that the use of causal verbs and connectives for such cases as (132) is characteristic of most natural languages. Thus far from ignoring examples like these, an adequate linguistic analysis of causal discourse should explain just what the connection between (132) and "true" causation is that accounts for this verbal concurrence, if in fact these are not analyzed as the same thing as causation. Perhaps a family of related causal and nomic relationships is called for, some general enough to cover all these cases and some more narrow. Of even greater potential interest to the linguist than the use of causal language in ordinary English discourse are the aspects of the meaning of causative and/or accomplishment verbs shared by *all* natural languages (as such verbs apparently occur in some form in all languages), including the languages spoken by non-literate, non-technological societies whose "philosophical" conception of causation might be quite different from ours.

2.3.8. *DO, Agency and Activity Verbs*

In John Ross' article "Act" (Ross, 1972), he proposed that "every verb of action is embedded in the object complement of a two-place predicate whose phonological realization in English is *do*" (p. 70). A sentence like (133) is claimed by Ross to have an underlying structure something like

(133) Frogs produce croaks.

(134)



(133) would be derived from (134) via a rule of DO Gobbling, a rule which replaces DO by the verb from the lower sentence. As Ross later observes, however, such a rule as DO Gobbling would be unnecessary in a Generative Semantics theory, where the function of DO Gobbling would be taken over by McCawley's *Predicate Raising*.

This DO would have to be considered a *like-subject verb*, i.e. a complement-taking verb like *try* and *condescend* for which the subject of the embedded clause is (somehow) required to be identical with the subject of the matrix verb. It has been suggested that this requirement be effected by making Equi-NP deletion (which deletes the identical complement subject) obligatory for such verbs (Lakoff, 1965) or by a constraint on well-formed underlying structures (Perlmutter, 1971); cf. Fodor (1974) for discussion of the alternatives. (I will later discuss the possibility of avoiding the like-subject problem altogether by treating DO as a predicate-modifier rather than as a sentential operator, an alternative that generative semanticists did not consider.)

Ross argues that the occurrences of the morpheme *do* (or *did*) in sentences (134) can be accounted for more economically by the grammar if they arise from underlying DO than if they must be introduced transformationally:

(135) a. You've bungled a lot of hands, Goren, but fortunately Jacoby has done $\left\{\begin{matrix}\text{so}\\ \text{it}\end{matrix}\right\}$ too.
b. That Bob resigned, which I think I should do, was a good idea.
c. You do one thing right now: apologize.
d. What I did then was call the grocer.
e. Waxing the floors I've always hated to do.
f. Solving English crossword puzzles is impossible to do.
g. Kissing gorillas just isn't done (by debutantes).

Ross argues that the rules of *do-so replacement* (involved in (a)), *Swooping* and *Relativization* (Involved in (b)), *Equative Deletion* (involved in (c)), *Pseudo-Cleft Formation* (involved in (d)), and *Passive* (involved in (g)), would

all have to be complicated if the morpheme *do* had to be inserted in these cases. The main complication, of course, is that *do* never occurs in these environments if the verb is stative:

(136) a. *You've known a lot of answers, George, and Harry has done so too.
b. *That John believes me, which everyone should do, is obvious.
c. *John did what I wanted to do: dislike Henrietta.
d. *What I did then was be in Boston.
e. *Knowing how to type I've always hated to do.
f. *Consisting of five members is impossible for the committee to do.
g. *Preferring hot dogs just isn't done (by debutantes).

If the verbs in (136) have no higher DO in their underlying structure, then the ungrammaticality of these examples is predicted by Ross' hypothesis. (For additional complications which the underlying-DO-analysis avoids, see Ross 1972.)

Ross suggests that the case grammarian's notion of *Agent* might be replaced by the notion "possible subject of *do*" (Ross, 1972, p. 105). (Ross' qualms about this suggestion will be discussed below.) The tests which case grammarians usually use for the presence of an agent (cf. Lee, 1971, p. 8) are tests like those in (137):

(137) A sentence contains an *agent* if
(i) it can occur as complement of *persuade, command,* causative *have*.
(ii) it can have an instrumental phrase.
(iii) intentional adverbs can be added to the sentence.
(iv) it can occur as an imperative.

But these tests are of course a subset of the tests Lakoff proposed to distinguish statives from non-statives. Lee, in fact, proposes the useful term "A-tests" to distinguish these agency tests from the other stativity tests (the ability to occur in the progressive and in pseudo-cleft constructions), which he calls "P-tests."

For the purposes of constructing an aspect calculus then, one might hypothesize that the occurrence of an operator DO is what distinguishes a stative sentence from an activity sentence in logical structure. If so, one would also have to suppose that DO may appear in the underlying structure of some (not all) accomplishments but not in that of achievements. Notice

that paradigm examples of achievement verbs,[19] exemplified by (138), can never occur in agentive contexts like (139-41):

(138) a. John recognized his long-lost brother in the crowd.
b. John detected a strange odor in the room.

(139) a. *Harry persuaded John to recognize his long lost brother in the crowd.
b. *Harry ordered John to detect a strange odor in the room.

(140) a. *John deliberately recognized his long-lost brother in the crowd.
b. *John carefully detected a strange odor in the room.

(141) a. *Recognize your long-lost brother in the crowd!
b. *Detect a strange odor in the room!

This present conception of DO is somewhat different from that of Ross (1972). Whereas Ross seemed to be supposing that stative verbs and active verbs are disjoint classes of primitive predicates, the latter class differing in that they are required to occur with higher DO in underlying structure, I am supposing that both stative and active verbs are constructed from the some homogeneous class of primitive stative predicates, thus the presence of DO is the *only* thing that distinguishes the meaning of a stative from that of an active verb. From Ross' paper at least one would conclude that no cases exist of the same predicate "surfacing" both with and without its higher DO, and indeed typical activity predicates like *walk, swim, smile, giggle* seem not to have any stative counterparts.

Nevertheless, I think at least three kinds of cases can be observed where the difference between a predicate with and without its higher DO makes itself apparent "on the surface."

In his article 'Three kinds of Physical Perception Verbs', Rogers (1971) distinguishes three classes of verbs described the physical perceptions, the first two of which, *cognitive* and *active*, interest us here:

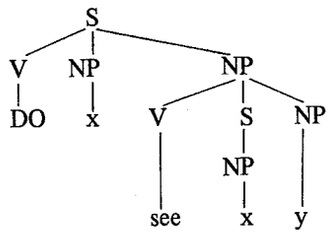
(142)

Cognitive	*Active*
see	look at, watch
hear	listen to
feel	feel
smell	smell
taste	taste

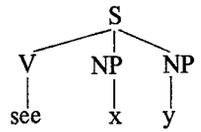
Rogers observes (1) that the cognitives are syntactically stative[20] (according to Lakoff's tests) whereas the actives are syntactically non-stative: and (2) that an active verb imputes to its subject intention, purpose, and responsibility, while the corresponding cognitive does not. One can see or hear something inadvertently or accidentally, but not watch or listen to something inadvertently or accidentally. Though no morphological difference exists between stative and active forms of *feel, smell* and *taste*, their participation in both kinds of syntactic environments with appropriate meaning differences justifies the distinction here as well.

These differences in grammatical properties suggest that the actives should be analyzed as consisting of the corresponding cognitive (stative) embedded in DO. The structure of *look* and *see* would then be something like (143) and (144):

(143) *look*:



(144) *see*:



If this is correct, then a semantic factor which DO contributes is roughly the notion of volition (and/or intention), contemporaneous with the act, on the part of the subject. Moreover, there seems to be no other systematic[21] difference between the meaning of the actives and their respective cognitives.

A second case of such stative/active counterparts would be the so-called non-stative adjectives and nouns (*be careful, be a hero*, etc.), which I believe actually have *both* stative and agentive readings. A context like (145) illustrates the agentive reading, (146) and (147) illustrate the stative:

(145) John is being { polite. / careful. / a hero. / an obnoxious bastard.

(146) John is { polite. / careful. / a hero. / an obnoxious bastard.

(147) I consider John { polite. / careful. / a hero. / an obnoxious bastard.

The difference here is a fine one. In (146) and (147), a more or less permanent property is ascribed to an individual, a property which one believes an individual to have because of one's total experience with the individual, even though the individual is not evidencing the property at the moment. In (145), on the other hand, a property currently in evidence is being described. Moreover, it seems to be a kind of activity which is in some sense under the control of the individual. If John is being rude (polite, a bastard, etc.) and someone points this out to him, he can if he wishes stop doing it at once, assuming he agrees that this is a correct description of his behavior. On the other hand, a person cannot immediately alter his stative properties (*tall, erudite*, etc. and – I would maintain – the kind of property expressed in (146)) simply by willing them away.

Under the "higher DO" hypothesis, it could be claimed that the "extra" auxiliary *be* in (145) that does not appear in (146) is the surface manifestation of DO (cf. the "active *be*" postulated by Partee (1977) for these examples). That is, an underlying DO will either (1) lexicalize as *be* when it precedes a surface adjective as in (145), (2) lexicalize as *do* when its complement has been deleted upon identity with a verb phrase elsewhere in the sentence as in Ross' examples (134a)-(134g), or (3) is otherwise "gobbled" – or in GS is predicate raised before it and its complement are together lexicalized as an active verb.

A somewhat different case involving DO is discussed in Quang (1971). The pairs of examples in (148) and (149) are supposedly related by Lakoff and Peters' *Conjunct Movement* transformation (Lakoff and Peters, 1969). But whereas (148a) and (148b) are synonymous, (149a) and (149b) are almost but not quite synonymous:

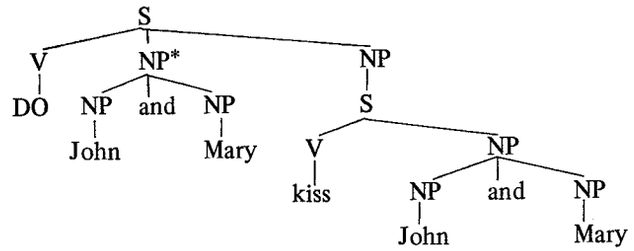
(148) a. John and Mary are similar.
b. John is similar to Mary.

(149) a. John and Mary kissed.
b. John kissed Mary.

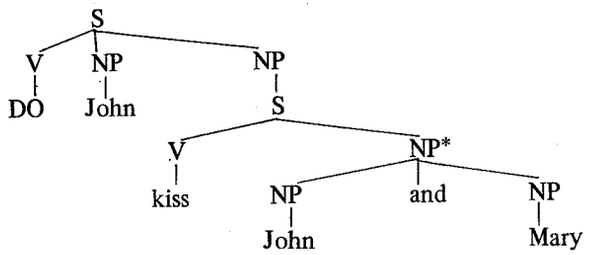
As Quang observed, the difference in meaning seems to be that responsibility for the action is attributed to both individuals in (149a) but only to one of them in (149b), despite the fact that the same basic physical relationship between the two individuals can obtain in both cases. Parallel differences in meaning result when one constructs examples like (149) with the verbs *fuck* (Quang's example) and its synonyms, *commit adultery* (*with*), *hold hands* (*with*), *rub noses* (*with*), *neck* (*with*), *pet, play footsie* (*with*) and also *agree with* (in non-stative sense), *argue* (*with*), *communicate* (*with*), *quarrel* (*with*), *fight* (*with*), *meet*, etc.

Quang proposed that (149a) and (149b) be derived from underlying structures (150a) and (150b) respectively:

(150) a.



b.



Here, the difference in meaning between (150a) and (150b) is to be accounted for by whether *both* subjects of the lower sentence appear as subject of DO or whether only one of them is subject of DO: this treatment would mesh precisely with the semantic notion of DO developed above. The difference in meaning between such pairs of sentences is just whether one or both individuals are asserted to be voluntary participants in the act. This distinction in logical form would likewise explain the unnaturalness of (151b) as opposed to (151a). (The examples are attributed to Chomsky):

(151) a. The drunk embraced the lamppost.
b. *The drunk and the lamppost embraced.

The semantic anomaly of (151b) under the higher-verb-DO analysis is due to the fact that it ascribes agency to a non-sentient being.

In the derivation of the surface structure (149b) from (150b), Conjunct Movement first separates the noun phrase *Mary* from the conjoined subject, making *Mary* a derived object. Then Equi-NP deletion would be able to apply on the higher cycle, deleting the lower noun phrase *John* on identity with the higher noun phrase. (Though Conjunct Movement is an optional transformation, if it did not apply here, Equi could not apply and the derivation would therefore be blocked, assuming that Equi has to apply in *all* successful derivations where DO occurs.) The successful derivation of a surface structure from (150a) would depend on Conjunct Movement's *not* applying on the lower cycle, since only in this way can Equi apply, deleting the whole lower conjoined noun phrase. (A troublesome point that Quang does not comment on is the question of what prevents conjunct movement from applying in the *higher* sentence in (150a).)

2.3.9. *The Semantics of DO*

Having now seen three cases where the semantic effect of DO can presumably be isolated, we can turn to the question of what semantics should be given to this operator. It should first be noted that DO does not necessarily connote action in the usual sense, because of examples like *John is being quiet, John is ignoring Mary, What John did was not eat anything for 3 days* (Cruse, 1973) which seem to entail merely deliberate avoidance of action of a certain kind. Thus on this view of DO, those (stative) predicates that become activities when combined with DO are distinguished from stative predicates which cannot be activities in that the former are states a person can put himself in by "act of the will" so to speak, and are states that he remains in only so long as he wills to. Thus while *seeking the answer, being polite*, and perhaps *driving* (*toward Chicago*) are activities, *being in Chicago, being blond*, and *knowing the answer* are not (Cf. **John is being in Chicago, *Mary is being blond, *John is knowing the answer*), apparently because one cannot be in Chicago or cease to be in Chicago (or be blond, etc.) simply by deciding that that's what one wants to do (though one can of course bring it about by a causal chain of activities and accomplishments that one is in Chicago, is blond, etc.).

It is almost but not quite possible to equate the meaning of DO with the notion of intentionality or volition (though I have had to use these terms in talking about DO for want of better ones). Note that examples like *John*

is being obnoxious, John is being a fool do not really entail that John is intending to be obnoxious or intending to be a fool, but they nevertheless entail that some property under his control qualifies him as obnoxious or a fool, something or other that he could avoid doing as soon as he really chose to. It is this which distinguishes these examples from ungrammatical cases like **John is being six feet tall* and stative sentences like *John is a fool*. A low I.Q. may be sufficient reason to assert that John is a fool, but that alone can never be sufficient for asserting that he is *being* a fool. Thus "state under the unmediated control of the agent" may be the best phrase for describing the DO that our syntactic contrasts seem to isolate.[22] The meaning of adverbs like *deliberately, willingly* and *intentionally* is more complex than this in that they require not only that the predicate they combine with denote a controllable property but they entail also that the agent intend that the property denoted by this predicate be one he has, rather than some other controllable property. *John is deliberately being obnoxious* is a stronger statement than *John is being obnoxious*, and there is no contradiction in saying *John is unintentionally being obnoxious*.

Thus whatever the interpretation given to DO (α, ϕ), where α is an individual term and ϕ a sentence), it should satisfy something like the following condition in all models:

(152) $\Box[\text{DO}(\alpha, \phi) \leftrightarrow \phi \wedge u.t.u.c.o.a.\ (\phi)]$

In (152) the abbreviation stands for "is under the unmediated control of the agent (individual denoted by α)" and this is of course a blatant fudge since I have no way of giving a standard (explicit model-theoretic) interpretation for this notion. The second conjunct on the right side of (152) should, in any case, be relegated to the status of a conventional implicature, since the notion of controllability which DO requires must also be satisfied in contexts that test for implicature, e.g. **John isn't being six feet tall, *It's possible that John is knowing the answer* are just as anomalous as the examples discussed above. Thus in Karttunen's (1970) terms, DO would have to be an implicative verb like *manage*; DO (α, ϕ) entails ϕ and $\sim$DO(α, ϕ) entails $\sim\phi$. The contribution to meaning that DO makes is entirely in its conventional implicature.

The troublesome like-subject constraint could be eliminated for DO (as it could for all like-subject sentential complement verbs) by treating DO as a predicate modifier (expression of type $\langle\langle s, \langle e, t\rangle\rangle, \langle e, t\rangle\rangle$) instead, just as Montague did with *try*. This alternative is never considered in generative semantics because of the belief that there are no "verb-phrase complements"

in logical structure, only sentence complements. (The semantic advantages of predicate modifiers have been shown by Stalnaker and Thomason (1973) and, for passive examples like *John was willingly sacrificed by the natives*, by Partee (1975).)

It would even be possible to give a trivial kind of standard interpretation to DO by designating some proper subset of the properties of individuals (i.e. some subset of $(\{0, 1\}^{D_e})^{I \times J}$ in the PTQ model) as the potentially "controllable" ones, introducing a sorted logic in which these controllable properties belong to a separate sort, and making DO$(\hat{}\delta)(\alpha)$ well-defined only where $\hat{}\delta$ denotes a property of the proper sort. (Note that potentially controllable properties are not always actually controlled. Cf. the contrast between (145) and (146) – so $\delta(\alpha)$ is well-formed (without DO) even if $\hat{}\delta$ is controllable.) However, this still leaves the notion of controllable property as primitive as before, and I can see no useful purpose that is served by the technical maneuver.

In spite of the structural semantic arguments from English for postulating DO, the evidence for DO is less persuasive than that arguing for CAUSE and BECOME, and the role played by DO in the aspect calculus is less significant than that played by CAUSE and BECOME. There is no productive word formation process "adding" a DO to a verb in English (much less in other languages[23] I know of) as there is in the case of CAUSE and BECOME in a large number of languages, and the only case of a large number of systematically contrasting sentences with and without DO is the *John is polite/John is being polite* pattern. While CAUSE and BECOME (and the progressive BE of the next chapter) are like modal and tense operators in that their semantics involves other times and/or other possible worlds, DO at most maps an extensional predicate into another extensional predicate. In this respect, decomposition in terms of DO is much more like the Katzian decomposition of extensional predicates in terms of features like [human], [animate], etc. than decomposition with CAUSE and BECOME. Postulating BECOME turns out to allow us to describe certain scope ambiguities that could not be accounted for otherwise (cf. Chapter 5), but no such ambiguities with DO seem to be attested (with the exception of one rather dubious case mentioned in the next section). Finally, data to be considered in connection with interval semantics in Chapter 3 makes it doubtful that DO can really distinguish all activities from statives, after all. (Alternatives to postulating higher DO can be found for treating the *be being a hero* cases (cf. Partee (1977)), Ross' cases (cf. Chapter 3, note 13), and Quang's cases (cf. Chapter 7, note 17).) Thus though the evidence of this section shows that "Agency" is an important

semantic distinction in English from certain points of view, DO turns out to be relatively unimportant for the remainder of this book.

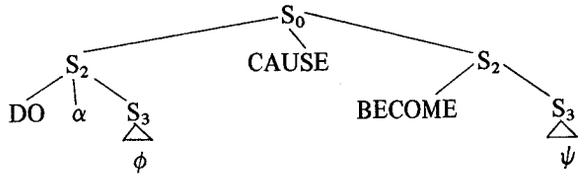
2.3.10. *DO in Accomplishments*

Accomplishments in many cases have the same agentive properties that are associated with higher DO in activities; they occur as imperatives, complements of *force* and *persuade*, etc. The hypothesis of the aspect calculus then leads us to postulate a DO somewhere in the logical structure of these.

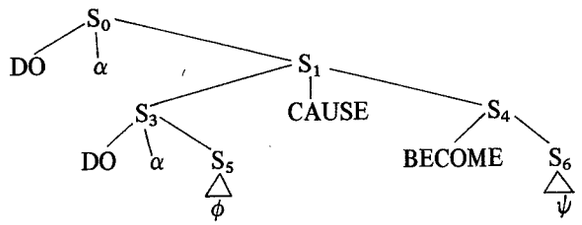
It has been argued (by Lakoff, 1970a) that certain accomplishments are ambiguous between an intentional and unintentional reading. For example, *John cut his arm* might describe either an accidental or a purposeful, masochistic action.

In view of this apparent ambiguity, I suggested in my earlier treatment that the ambiguity should be accounted for in terms of the position or positions of the operator DO in the logical structure of accomplishments. In the accidental reading of *John cut his arm* the subject was presumably engaged in some intentional activity or other involving the use of a knife, though he did not intend that this result in injury to his arm. In the other reading, the bringing about of this result was intentional as well. I suggested that the first case, which I called a *non-intentional agentive accomplishment*, have a logical form of (152) while the second case, an *intentional agentive accomplishment*, had the logical structure (153), in which the CAUSE sentence is within the scope of a second, higher DO.

(152)



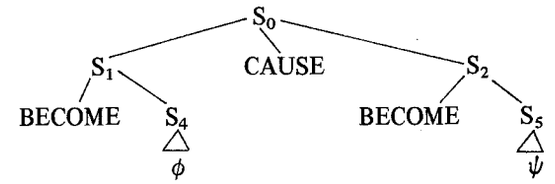
(153)



A third kind of accomplishment, a *non-agentive accomplishment*, would

be one in which no intentional action at all is asserted, hence no DO. For example, *John hit the wall* might be ambiguous between all three readings: the intentional agentive (hitting the wall was just what he intended to do), non-intentional agentive (he aimed at Bill and missed), and non-agentive or "instrumental" (someone pushed John against the wall). One kind of non-agentive structure would be (154):

(154)



I presented several kinds of possible syntactic motivation for (152) and (153) in my earlier treatment (cf. Dowty, 1972a, pp. 104-108, 1972b, pp. 66-67), but I will not review these here. I am now not sure of the viability of (153) in a GS grammar for several reasons. First, Lakoff's claim that the distinction between intentional and non-intentional causation is a true ambiguity has been called into question by Catlin and Catlin (1972); this issue is discussed at length in Zwicky and Sadock (1975) in the context of the reliability of the linguist's heuristic tests for ambiguity/vagueness (or ambiguity/generality), and they conclude that syntactic data given so far can not conclusively decide whether a true ambiguity is involved in this case. Second, if the semantic "content" of DO is not really intentionality but rather something like unmediated controllability, then it is questionable whether DO can legitimately be claimed to distinguish intentional from non-intentional accomplishments. Can we consistently claim that **John is being in Chicago* and **Mary is being blond* are unacceptable because the states of being in Chicago and being blond are not subject to unmediated control, yet at the same time claim that in the "intentional" reading of *John caused a disturbance by walking out* the state of being such that one of one's actions causes something else is unmediately controllable? Perhaps one can appeal to a kind of transitivity of controllability – if an activity like walking is controllable, then the causation of another event by that action is controllable. But even if this is consistent, the notion of immediate controllability is not intuitively the same thing as the intentional/non-intentional distinction that Lakoff claims to observe.

Finally, there are problems with the syntactic arguments that I cited in 1972 for (153), though I will forego discussion of these here.

2.3.11. *Summary of the Aspect Calculus*

The aspect calculus, as developed provisionally so far, is like a first-order logic except that it contains a number of non-standard tense and modal operators; it is thus to be a kind of *pragmatic language* in the sense of Montague (1968). Its vocabulary consists of a set of individual variables, a set of individual constants, a set of n-place predicate constants (stative predicates) π_n for various natural numbers n, all the logical symbols of standard first-order logic, plus at least the symbols AT, BECOME, CAUSE and DO. (The last operator is included for completeness, in spite of my qualms about it.) It might be advantageous to suppose it is a two-sorted logic, having variables $t_1, t_2, \ldots, t_n$ and constants ranging over times as well as variables $x_1, x_2, \ldots, x_n$ and constants ranging over ordinary individuals. The formation rules are the usual rules for first-order logic plus the following:

(155)
a. If ϕ is a formula, then BECOME ϕ is a formula.
b. If ϕ and ψ are formulas, then [ϕ CAUSE ψ] is a formula.
c. If ϕ is a formula and α is a term denoting an individual, then DO(α, ϕ) is a formula. [This must be subject to the like-subject constraint. Alternatively, we assume the language allows predicate modifiers and treat DO as a predicate modifier.]
d. If ϕ is a formula and τ is a term (variable or constant) denoting a time, then [AT(τ, ϕ)] is a formula.

(Other sentential operators might eventually be added,[24] such as the progressive BE discussed in the next chapter.) The semantic interpretation of this language has already been given somewhat informally in the preceding sections and will not be repeated. A more explicit treatment of a revised aspect calculus follows later.

The linguistic hypothesis embodied in such a formal language is that it is a fragment of a *Natural Logic*. Any formula of this language is claimed to be potentially the logical structure of some English sentence, subject to the restrictions of actually occurring lexical items that determine whether it can be fully lexicalized or not. We might then define *possible lexical item*, as any configuration of predicates and operators that can be collected under one node by Predicate Raising in a legitimate derivation from one of these formulas. (By *legitimate derivation* is meant a derivation in accord with the various global and other constraints on transformations that are claimed to be

motivated independently in a GS theory.) Alternatively, possible lexical items might naturally be restricted in terms of an explicitly defined subset of the formulas of the aspect calculus. It seems, for instance, that the possible underlying structures of verbs should be restricted to formulas using only clauses (a)-(c) of the recursive clauses, i.e., formulas not involving the AT operator. This is because verbs in natural languages apparently never by themselves have truth conditions depending on states or changes of states happening at specific times independent of the time of the use of the verb (which is what the AT operator would permit) but always have their temporal references determined indexically. (This point will be elaborated upon in section 2.4 below.) Adverbial phrases, on the other hand, do fix time reference "eternally" (for instance, *during the summer of 1945, on May 12, 1977*) as well as indexically (*during last week, tomorrow*), and the AT operator was included in the aspect calculus for the purpose of illustrating how these can be accommodated. The *actual lexical items* of a given language, in turn, are some finite proper subset of these possible lexical items.

The aspect calculus as it stands is still inadequate in several respects, but nevertheless, I think it comes close enough to being viable to illustrate what I consider to be the kind of semantic explicitness that any structural semantic analysis of the linguist's familiar sort must be expected to achieve if we are to be able to test its adequacy to any real extent in a referential semantic theory. If we are to do "structural semantics" of the GS sort (or any other kind, really) in Montague Grammar, then this is how it has to be carried out. The inadequacies of the present calculus could be due either to my own inability to see the right linguistic generalizations about the distribution of "atomic predicates" in logical structure and to give the appropriate semantics for these basic operators, or else the inadequacies arise because no consistent referentially interpreted lexical decomposition analysis will ever be possible for English. Unless we examine such analyses with the requisite detail, we will never really test the status of the "Natural Logic" hypothesis.

Below are the main representative kinds of formulas predicted by the calculus in each of Vendler's four categories. Here, α_i and β_i will stand for arbitrary individual terms, π_n and ρ_n stand for arbitrary n-place (stative) predicates, and ϕ and ψ are arbitrary formulas, either atomic or complex. Surface English examples are given for each kind of sentence.

A. *Statives*

1. Simple statives: $\pi_n(\alpha_1, \ldots, \alpha_n)$. (*John knows the answer.*)

2. Stative causatives: $[\pi_m\ (\alpha_1, \ldots, \alpha_m)$ CAUSE $\rho_n(\beta_1, \ldots, \beta_n)]$.
(*John's living nearby causes Mary to prefer this neighborhood.*)

B. *Activities*

1. Simple activities: $DO(\alpha_1, [\pi_n\ (\alpha_1, \ldots, \alpha_n)])$. (*John is walking.*)
2. Agentive Stative Causatives (?): $[DO\ (\alpha_1, [\pi_m\ (\alpha_1, \ldots, \alpha_m)])$ CAUSE $\rho_n(\beta_1, \ldots, \beta_n)]$. (The existence of this class was suggested to me by Harmon Boertien and would include examples like *He is housing his antique car collection in an old barn*, which are agentive and presumably causative but do not entail any change of state. However, these might be analyzed as $[DO(\alpha_1, [\pi_m(\alpha_1, \ldots, \alpha_m)])$ CAUSE $\neg$ BECOME $\neg$ $\rho_n(\beta_1, \ldots, \beta_n)]$ instead, since this latter formula would account for the durative character of these examples just as well.)

C. *Achievements*

1. Simple Achievements: BECOME$[\pi_n(\alpha_1, \ldots, \alpha_n)]$. (*John discovered the solution.*)
2. Inchoation of Activity: BECOME$[DO(\alpha_1, [\pi_n(\alpha_1, \ldots, \alpha_n)])]$. (Such forms apparently do not lexicalize in English as single verbs or do so only marginally; the only possible unambiguous example I have noticed is *germinate*, which might be analyzed as BECOME plus *grow*, where *grow* is in turn an activity. Otherwise, complex sentences like *John began to walk* represent this class.)
3. Inchoation of accomplishments: BECOME ϕ, where ϕ has one of the forms in D1-D3 below. (Again, no single verbs seem to lexicalize this form, though complex sentences like *John began to build a house* represent the class.)

D. *Accomplishments*

1. Non-agentive Accomplishments: $[[$BECOME $\phi]$CAUSE$[$BECOME $\psi]]$, where ϕ and ψ are stative sentences (i.e. of the form $\pi_n\ (\alpha_1, \ldots, \alpha_n)$, as in *The door's opening causes the lamp to fall down*), or are more complex sentences. (*The beginning of the construction of a new highway causes the interruption of many residents' remodeling projects.*)
2. (Non-Intentional) Agentive Accomplishments: $[[DO(\alpha_1, [\pi_n(\alpha_1, \ldots, \alpha_n)])]$CAUSE$[$BECOME$[\rho_m(\beta_1, \ldots, \beta_m)]]]$. (*John broke the window.*)
3. Agentive Accomplishments with Secondary Agent: $[[DO(\alpha_1, [\pi_n\ (\alpha_1, \ldots, \alpha_n)])]$ CAUSE $[DO(\beta_1, [\rho_m(\beta_1, \ldots, \beta_m)])]]$. (*John forced Bill to speak*;[25] This is the class Talmy (1976: 112) calls *caused agency*. Also, the result clause can be an accomplishment: *John forced Bill to build a house.*)
4. Intentional Agentive Accomplishments (?): $DO(\alpha_1, [DO(\alpha_1, \pi_n\ (\alpha_1, \ldots, \alpha_n))$CAUSE $\phi])$, where ϕ may be any non-stative sentence (*John murdered Bill*).

A possible logical structure that does not fit exactly into any of Vendler's four categories is $DO(\alpha_1, BECOME[\pi_n(\alpha_1, \ldots, \alpha_n)])$; these would be *basic actions*, events under the unmediated control of an agent that are not brought about by any subsidiary activity. Plausible candidates would be *John opened his eyes* and *John raised his arm*, where no conscious causal activity is apparent. The only linguistic evidence I know of that pertains to such cases is that *John tried to open his eyes but wasn't able to do it* seems to entail that John somehow did something that he hoped would bring his eyes to open, perhaps he performed an unobservable "act of the will". This might be taken to indicate that these examples are not basic actions. Perhaps then the only basic actions are acts of the will. But this is scanty evidence with which to try to decide issues that have been the subject of philosophical controversy since Descartes.

Of course, more complex formulas than these would certain underlie many complex English sentences, but I believe that the above table covers most if not all the cases that can be claimed to lexicalize as single verbs in English.

2.4. THE ASPECT CALCULUS AS RESTRICTING POSSIBLE WORD MEANINGS

Though I have suggested that the aspect calculus embodies a hypothesis about possible versus impossible word meanings of English, it is still in a certain sense a vacuous hypothesis within the framework of model-theoretic semantics. The reason for this is that we have not yet put any limitations on the interpretations of stative predicates. Until we do so, the intension of a primitive (stative) one-place predicate can be any function in $(\{0, 1\}^{D_e})^{I \times J}$ whatsoever, and the interpretation is similarly general for two and n-place predicates. To then say that a possible sentence meaning is any proposition expressible by a sentence formed out of stative predicates plus aspectual operators CAUSE, BECOME, DO, etc. is not really to exclude any proposition (set of indices) as impossible, nor is it to exclude any function

in $(\{0,1\}^{D_e})^{I \times J}$ as an impossible intransitive-verb meaning, etc. For that matter, even without the aspectual operators no real limitation is being made by such a language as long as we do not limit the interpretation of the primitive (stative) predicates.

The intuition behind the aspect calculus is of course that stative predicates are somehow simpler or more limited in their interpretation than other kinds of verbs, hence it is an interesting enterprise to try to figure out how non-statives can be constructed out of statives in a tightly-constrained way. The problem is to come up with some initial narrow constraint on the interpretation of statives that makes this a non-vacuous undertaking.

My suggestion as to how to approach this problem is tentative and programmatic, but I hope it will suggest promising ways of proceeding. The meanings of many or perhaps most stative predicates are tied to physical properties of some sort – location in space, size, weight, texture, physical composition, color, etc. The suggestion is to add enough physical structure to the definition of a model to make stative predicates (or at least an interestingly large subclass of them) directly definable in terms of this physical structure.

As an example of the way that increasing the "structure" of a model leads to interesting analyses of word meaning, see the model-theoretic interpretations of various senses of English spatial prepositions in Cresswell (1978) where not only location in space but also the "path" of an object moving through space over time is set-theoretically defined. (The account of locative and change-of-location prepositions given in Chapter 4 differs from Cresswell's in interesting ways in semantics and especially in syntax.)

To carry out this plan I will employ van Fraassen's notion of *logical space* (an idea whose use in this context was suggested to me by Thomason's (1974b) semantic treatment of some English sentences about weight and location). There will be as many axes of logical space as there are kinds of measurement; if the measurables were only weight, color and hardness, for example, a point in logical space would be a triple representing a possible outcome of measurements of weight, color and hardness respectively. Each axis might have a different mathematical structure according to the discriminations that can appropriately be made in each case. For example, tests for hardness give only a linear ordering – we can say that one thing is harder than another but not twice as hard – but in the case of weight, we can say that one thing weighs twice as much as another. Values on the space-axis would represent places, which would themselves be regions in Euclidian or some other sort of space. It is not necessary at this stage to commit ourselves

as to just what axes are to be included in logical space nor just what the mathematical structure of each axis is to be, as long as there are only a finite number of axes. A model for a language is then to include – in addition to a set of individuals, a set of worlds and a set of times – a function assigning to each individual at each index a value in logical space. Of course, certain individuals may lack values for certain axes at certain indices – for example, some things are colorless – and this situation might best be handled by including a "null position" on various axes.

We than constrain the interpretation of (physical) stative predicates by requiring that *for each stative predicate there is a region of logical space such that at each index, an individual is in the extension of that predicate at the index if and only if the individual is assigned to a point within that region of space*.

Perhaps other limitations might be added. Most stative predicates seem to depend on only one axis of logical space (color, weight, etc.), so these predicates have as their determining region a "slice" of logical space not varying along the other axes. Also, many if not most predicates correspond to a continuous rather than a discontinuous region of values along their appropriate axis. Basic color terms, for example, denote objects reflecting light within certain continuous segments of the spectrum but not, apparently, disjoint parts of the spectrum (though there are counterexamples like *mottled*).[26] Pursuit of such constraints would quickly lead us into very specific and detailed questions of lexicography that might or might not turn out to have any general interest for theoretical semantics at this point, but we can ignore these questions here. Even with the very general constraint given above, it is now possible to see that certain interpretations of stative predicates are ruled out, relative to a given logical-space assignment. This is because the logical-space conditions for predicates, whatever their complexity may have to be, are required to be the same for all moments of time in the model. (Of course, individuals do change their logical-space values over times, so this requirement by no means entails that the denotations of stative predicates are constant over time, only that the logical-space conditions for whether or not an individual is in the denotation remain constant.)

What kinds of interpretations are ruled out by this condition? One "impossible" word would be Nelson Goodman's famous hypothetical adjective *grue*. An object is *grue*, according to Goodman (1955), just in case it is green up to a given time t and blue thereafter. I think this is a correct result for a theory of word meaning in natural language. Though one can intelligibly define such a special invented predicate, this seems to me to be just the kind of predicate that does not occur naturally in human languages.

With this restriction, the effect of the aspect calculus becomes non-trivial. With its help, we can construct from stative predicates like *green* and *blue* possible verbs meaning "become green", "cease to be green", "cause to become green," even "change from green to blue" (i.e. become not-green and at the same time become blue), etc. but never, as far as I can see, anything like Nelson's *grue*. (It is important to note that subformulas of the form AT(t, ϕ) must be excluded from the class of formulas claimed to underlie single verbs, else *grue* could be constructed.) In general then, the effect of the constraints on the aspect calculus is to exclude predicates whose interpretation depends on the state of the world at more than one time (or in more than one possible world) in any way other than in the ways explicitly allowed for by the tense and modal operators of the calculus. I expect that a good deal of work would be required to show formally just what class of word meanings is excluded by this condition for some specific version of an aspect calculus, but I hope the idea is clear enough. Though formulas of great complexity could be constructed in the aspect calculus which almost surely do not correspond to any verb of a natural language, it seems safe to suggest that the likelihood of occurrence of a verb with the meaning of a very complex formula would be inversely proportional to the length of the formula, so that formulas with more than a small number of connectives and operators (say, eight) could be excluded as candidates for single word meanings altogether. But all *short* formulas of the aspect calculus now seem to be acceptable candidates for possible word meanings.

It is perhaps doubtful whether this method can be extended to *all* stative predicates. Are there really physical criteria for "subjective" stative predicates like *beautiful* or *pleasant*? Even more questionable than these are relations among sentient individuals, as in *x likes y, y knows z*. An extreme materialist would of course readily assent to the position that such predicates must have truth conditions definable ultimately in physical terms, insofar are there any really consistent truth conditions for them at all. But regardless of what metaphysical position one wants to adopt for external reasons it seems that a semantic theory should not presuppose any particular metaphysics of this sort.

Even if it turns out that some natural language words can neither be given a physical criterion nor defined with the aid of novel modal operators in terms of predicates having physical criteria, it may nonetheless be of interest to show how hypotheses of possible and impossible word meanings can be formulated which apply to some large subclass of words. It is interesting in this connection to note that the class of words, as isolated by various syntactic tests, that Carlson (1977) believes to be predicates of "stages" of

individuals (rather than predicates of individuals or of kinds) are those for which physical criteria seem suitable (e.g. adjectives *alive, drunk*, etc., verbs *hit, find*), while those he believes to be predicates of individuals or of kinds (e.g. *intelligent, fear, hate, admire*) are those for which physical criteria are inappropriate. Perhaps further investigations of Carlson's hypothesis would lead to a more motivated account of a "physical" subclass of stative predicates.

NOTES

[1] As Cresswell points out (1977), this implicit use of negation and conjunction in the 'language' of semantic markerese amounts to the distinction between logical words (the sentential connectives) and non-logical words (the predicates represented by the semantic features) as it is usually drawn in the formal languages of logicians. That is, the analysis of analytic sentences such as *Every bachelor is unmarried* by decomposition with semantic markers implicitly appeals to the logical properties of conjunction and negation, whether or not logical connectives are explicitly mentioned. Cresswell notes that this is somewhat paradoxical in Katz' theory, since Katz claims to reject the distinction between logical and non-logical words (Katz, 1972, pp. xix, 106).

[2] Though Lakoff's analysis of these sentences in his dissertation (Lakoff, 1965) may be cited as the source of the hypothetical causative and inchoative analysis which most influenced the subsequent development of generative semantics, it is difficult to determine the original source of this idea since it is also discussed in both Hall (1965, pp. 26-28) and Chomsky (1965, pp. 189-190), though the last two authors are inclined to reject the analysis.

[3] Heringer (1976) suggests that the distinction between manipulative causation on the one hand and directive causation or causation for conventionalized purpose on the other can be used to predict which *come*-idioms have *bring*-counterparts and which do not: *come*-idioms whose meaning involves manipulative or directive causation for a conventionalized purpose are claimed to allow corresponding *bring*-idioms, *come*-idioms whose meaning involves non-conventionalized directive causation or indirect causation are claimed not to allow *bring*-idioms. Whether or not this is correct (and I find the facts hard to judge), other problems for the relexicalization analysis do not lend themselves to this solution, cf. the *harden* example below and note 4.

[4] A few of the other such cases I have noticed among causatives derived (possibly by way of inchoatives) from adjectives are *toughen* (loses the meaning "difficult" – *toughen* can mean only "make resistent to tearing", not "make difficult"), *dirty* loses the meaning "obscene", cf. **He dirtied his jokes when the hostess left*), *straighten* (loses the meanings "socially conforming", "heterosexual"), *dry* (loses meaning "boring"). From these examples, it might seem that figurative or slang meanings never carry over to derived causatives while literal meanings do. This is not always the case, since *deaden* has the figurative meanings of its adjective root ("not capable of perceiving sensation", etc.) but lacks the literal meaning completely ("not alive"). Some deadjectival verbs do retain the figurative as well as the literal meaning of the adjective, cf. *That soured his mood, This muddies the issue*. For further proposals about the manner and point at which lexical insertion takes places in a GS derivation, see McCawley (1971) and Newmeyer (1974).

[5] Kenny thought Ryle's achievements fell into all three of his categories (Kenny, 1963, p. 185). I find this inconsistent and think the disagreement hinges only on the misclassification of one or two borderline examples by Ryle.

[6] In addition to verbs, adjectives and nouns also split into stative and non-stative categories, according to whether the progressive can be used when they appear as predicate adjectives and predicate nominals. Cf. *John is being careful* vs. **John is being tall*, *John is being a hero* vs. **John is being a grandfather*. Non-stative adjectives are first discussed in 2.3.8 below.

[7] Achievements are like statives according to some stativity tests (**John persuaded Bill to notice a stranger in the room*) but not others (cf. note 8): this difference can be accounted for in part by postulating agentive achievements (or *basic actions*, cf. 2.3.11) as well as non-agentive achievements and in part by the revised verb classification suggested in Chapter 3 within an interval-based temporal semantics.

[8] The "does not apply" indication appears here because the (present) progressive tense is somewhat strange with most examples of achievements. That is, ?(*At this moment*) *John is noticing a stranger in the room* is presumably strange for the same reason as ?*John noticed a stranger in the room for a few minutes* – achievements like *noticing* do not in Vendler's view take up time but happen virtually instantly, and the progressive, like durative time adverbials, suggests duration. But in fact, the progressive does not really sound so bad with many achievements (cf. *John is dying, John is arriving*), and this is one of the observations that will lead us to a revision of the aspect analysis in Chapter 3.

[9] The same kind of observations (for English, this time) were made independently by Mittwoch (1971).

[10] It occurred to me at one time (and independently to Carlson (1973)) that one might account for this scope restriction on indefinite plurals by treating them as free variables in logical structure, but this idea had to be abandoned for want of a satisfactory semantic account of how the free variable would be interpreted. On the standard Tarski definitions of truth and satisfaction, a formula with a free variable counts as true just in case the universal closure of the formula is true, but this is of course the wrong result for indefinite plurals.

[11] I have here represented the translations of bare plurals as individuals constants – *goats* translates into g, etc. – but in English such bare plurals are obviously derived from singular common nouns. Carlson initially uses this same method for expository purposes, but also shows (Carlson, 1977, pp. 213-219) the syntactic and semantic method for deriving kind-denoting term phrases ("bare plurals") from plural, "ordinary" common nouns (e.g., *goats* as in *I saw two goats*), which are in turn derived from singular "ordinary" common nouns.

[12] McCawley also considered both the possibility that the subject of CAUSE is an agent and that it is an event; cf. McCawley (1973, pp. 34ff).

[13] The usual GS assumption about the analysis of such verbs as *assassinate* whose meaning involves a particular motivation or kind of intention is that this aspect of the meaning comes from a higher adverbial clause in logical structure; cf. McCawley (1973, p. 24).

[14] For convenience I have used a slightly simpler example, (111), than the one McCawley was actually discussing in this context (which was *John hammered the dent out of the fender*), but I believe the comments I have quoted here apply to (111) in exactly the same way.

[15] As is reflected in an observation by Kim (1973), we must be careful to get the right descriptions of the events involved if we analyze *by*-phrases in terms of causation: he notes that if I open the window by turning the knob, "my turning the knob does not cause my opening the window (though it does cause the window's being open)"; see 4.9 for a treatment of this problem.

[16] I use the symbol "$\Box\!\!\rightarrow$" throughout my discussion of conditional (or counterfactual) logic, though Stalnaker used ">" instead of (Lewis') "$\Box\!\!\rightarrow$".

[17] In other words, causative verbs are invariably *If-verbs* in the sense of Karttunen (1970), complement-taking verbs for which the following pattern of inferences holds: "*x Vs S*" entails *S*, and "It is not the case that *x Vs S*" entails neither *S* nor not-*S*. It seems to me in fact that all *if*-verbs are causatives.

[18] A "conjunctive" causal statement of the form $[[O(c_1) \wedge O(c_2)]$ CAUSE $O(e)]$ does not help in this situation, because the counterfactual associated with this is $\neg[O(c_1) \wedge O(c_2)] \Box\!\!\rightarrow \neg O(e)$, and this in turn is equivalent to $[\neg O(c_1) \vee \neg O(c_2)] \Box\!\!\rightarrow \neg O(e)$, i.e. nearest worlds in which e occurs but either c_1 does not occur or in which c_2 does not occur are closer than nearest worlds in which e does not occur. This is false in a situation of causal overdetermination. On the other hand, the "disjunctive" causal statement $[O(c_1) \vee O(c_2)]$ would seem to correctly describe this situation since its counterfactual is equivalent to $[\neg O(c_1) \wedge \neg O(c_2)] \Box\!\!\rightarrow \neg O(e)$. This is true in the causal overdetermination situation in Figure 2 below.

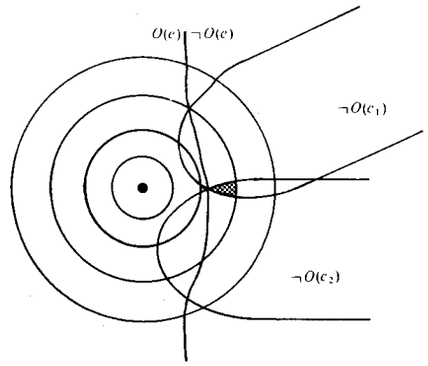


Fig. 2.

However, all obvious ways of rendering such a disjunctive causal statement in ordinary English – such as *Either the electrical short or the cigarette ash caused the destruction of the house* – sound wrong; we take them as $[O(c_1)$ CAUSE $O(e)] \vee [O(c_2)$ CAUSE $O(e)]$ instead, and this last formula has the wrong truth conditions. Philosophers would apparently prefer to shun "disjunctive events" altogether – cf. Loeb's (1974, p. 531) discussion of J. L. Mackie's "trilemma" of causal overdetermination. In any case, the relationship between a "disjunctive event" and the disjunction of two sentences asserting that events occur is obscure to me.

[19] Other verbs which would appear to be achievements by some tests do occur in agentive contexts; these will be treated in Chapter 3.

[20] Like other stative verbs (cf. note 5), *see, hear* and *feel* have an inchoative reading which is really as common as the stative reading.

The distinction between the inchoative and stative readings of these verbs explains (as Vendler noted) Aristotle's puzzlement that one can say *I have seen it* as soon as one can say *I see it*. The *see* in *I have seen it* is inchoative (an achievement), while the *see* in *I see it* is stative. Ryle noticed the strange fact that for the physical perception verbs, the stative reading of *see* etc. (but not the inchoative) is equivalently expressed by *can see*, etc.

[21] See Rogers (1971) for a discussion of some unsystematic differences in this paradigm. There seem to be two apparently distinct senses of *watch* and *look*. If *look* means "see on purpose", *look* entails *see*. (This is the sense under discussion in the text.) But sometimes *look* is paraphrasable as "direct one's eyes toward." In this sense, blind men can look at things and one can "look right at it but not see it." The fact that this second sense does not extend to the other members of the physical perception paradigm (*listen, feel*, etc.) Rogers attributes – correctly, I believe – to the fact that man's organs of sight are directional in a way that his other sensory organs are not.

[22] The phrase *controllability* has sometimes appeared in the literature to describe agentive contexts (e.g. Berman (ms), Givón (1975)), but I do not believe the distinction between controllability and intentionality has been clearly drawn.

[23] Though as far as I know there has been little study of the cross-linguistic evidence for DO, the results from Japanese (Inoue, 1973) are not wholly encouraging. Though there is evidence in Japanese quite parallel to Ross' evidence for DO, Inoue shows that the semantic properties of such a Japanese DO would have to be somewhat different from those attributed to DO in English.

[24] Though I mentioned END and REMAIN earlier as operators, these are really unnecessary as they are definable in terms of BECOME and negation: END ϕ is defined as BECOME $\neg\phi$, and REMAIN ϕ as $\neg$BECOME $\neg\phi$. Similarly, the logical structure underlying the verb *prevent* will involve formulas of the form [ϕ CAUSE$\neg$BECOME ψ] and (at least one sense of) *allow* as $\neg$[ϕ CAUSE $\neg$BECOME ψ].

[25] The verb *force* which occurs with an adjective complement and means "bring about by physical effort exertion against resistance", as in *force the door open*, should not be confused with the *force* that takes an infinitive complement and means "compel to do", which is the verb cited in this example. It is only the latter which is "subcategorized" for a secondary agent – note that **John forced the door to open* is anomalous.

[26] The treatment of vague predicates discussed earlier (section 2.3.5) can also be accommodated here. In fact, the logical-space restriction might form a basis for some of the "semantical principles" mentioned by Kamp that determine how "legal" resolutions of vague predicates can be made. For example, the vague predicate *heavy* can be resolved in any way as long as we assign to it *all* individuals whose value on the weight axis lies above some particular point; no "discontinuous" portion of the weight axis may correspond to the extension of *heavy*.

CHAPTER 3

INTERVAL SEMANTICS AND THE PROGRESSIVE TENSE

3.1. THE IMPERFECTIVE PARADOX

One of the tests used to distinguish activities from accomplishments in 2.2 was the test of entailment from a sentence in a progressive tense to the same sentence in a simple tense. Thus *draw a circle* counts as an accomplishment verb phrase because (1) does not entail (2), while *push a cart* counts as an activity because (3) does seem to entail (4):

(1) John was drawing a circle.

(2) John drew a circle.

(3) John was pushing a cart.

(4) John pushed a cart.

In this chapter I turn to the task of constructing an analysis of the progressive that will complete the account of the semantics of (1)–(4). As we observed, following Kenny (1963), the meaning of an accomplishment verb phrase invariably involves the coming about of a particular state of affairs. For example, *drawing a circle* involves the coming into existence of a circle (or in any case, a *representation* of a circle, cf. *draw a unicorn*), *kicking the door open* involves the door's coming to be open, and *driving the car into the garage* involves the car's coming to be in the garage. The analysis of accomplishments in terms of BECOME-sentences was motivated (on the semantic side) by the need to capture such entailments. Yet it is just this entailment that such a result-state comes about that fails when the accomplishment verb phrase appears in a progressive tense. In other words, the problem is to give an account of how (1) entails that John was engaged in a bringing-a-circle-into-existence activity but does not entail that he brought a circle into existence. This is the 'imperfective paradox'. Notice, furthermore, that to say that John was drawing a circle is not the same as saying that John was drawing a triangle, the difference between the two activities obviously having to do with the difference between a circle and a triangle. Yet if neither activity necessarily involves the existence of such a figure, just how are the two to be distinguished?