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On verbs and time.

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ON VERBS AND TIME

A Dissertation Presented

By

DORIT ABUSCH

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ABSTRACT

On Verbs and Time

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This work is intended to contribute to the study of aspect. It is claimed that, just as change and causation can be viewed conceptually as either instantaneous or continuous, inchoatives and process verbs, whose meaning involve such notions, appear in natural language as either event or process type verbs.

We adopts Dowty's hypothesis that the difference between classes of aspectual verbs may be captured by the presence of abstract operator such as Become, CAUSE and DO in the logical structure of verbs, where these notions from generative semantics are formalized in a Montague Grammar. We argue that the presence of the abstract operators does not always yield the classification of aspectual verbs predicted by Dowty, due to the interaction of the meaning of these operators with other factors. While achievement and accomplishment verbs, which are analyzed as including Become and CAUSE respectively in their meaning, are event type verbs for Dowty, inchoative and causative verbs which are process verbs may be found in natural language. Their semantic analysis involves notions such as comparison, scope

relations, conditions on the relationship between the time at which the two sentences underlying a causative sentence are true and the time adverbial modifying it, as well as other relatied topics concerning the interaction of the properties of partitivity and additivity and process causative verbs, and the gap problem in the case of process verbs vs. that in the case of process inchoative verbs.

It is shown that Hebrew verb morphology system called "binyanim" reflects some of the subtler distinctions among verbs involving change and causation. The relations between the aspectual property of being an inchoative and change and that between being an accomplishment and causation is examined via the Hebrew binyanim, which are traditionally claimed to carry the semantic features of inchoation and causation.

Several issues concerning the semantics of the English progressive, which is an overt aspectual marker, are discussed. Following Dowty and Kratzer a proposal is given analyzing it as an expression of necessity whose meaning contains a free variable over sets of worlds, which is fixed by the context of utterance.

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1. Introduction

1.1. The Classification of Aspectual Verbs

In English and in many other languages it is the verb which carries the tense system discriminations of past, present and future. The role of what is called in grammar "tense" is to relate the time of the situation described in the sentence to the time of speaking. A situation described in the past tense is located prior to the moment of speaking and a situation described in the present tense is located temporally as simultaneous with the moment of speaking. It was observed long ago that verbs carry other discriminations involving the notion of time, for example, whether the event referred to by the verb begins, ends or is still occurring, whether it is complete or incomplete, single or iterative, protracted or momentaneous. Temporal discriminations of this kind are known in the literature as aspectual ones and the phenomenon is called "aspect".

Aristotle is often referred to as the first to mention in his writing certain aspectual differences among group of

verbs, although he did not employ the term "aspect". He discussed the subject within the framework of his metaphysical system, which we will not discuss here.[1] The philosophers Ryle (1947), Kenny (1963) and Vendler (1967) were the first to discuss at length the different properties of classes of verbs. Ryle described as "achievement verbs" resultative verbs which express the success or failure of the activity denoted by them (win, prove, find) and distinguished them from irresultative activities (run, swim) making further refined distinctions within the class of achievements. Kenny provided strict grammatical and logical criteria to sort different classes of verbs and Vendler extended those criteria ("time schemata" in his terminology) to yield four different categories of verbs: states, activities, accomplishments and achievements.[2] Vendler's verb classification and the tests which determine it were widely adopted by linguists and philosophers interested in the theory of aspect.

The major criteria considered for the classification of aspectual verbs may be divided into three categories:

(a) tenses.

(b) logical entailments.

(c) time adverbials.

We will give one example to illustrate the way each of the

three categories interacts with inherent properties of verbs and how it affects their classification. A complete table of classifying criteria accompanied by examples is given in the end of this section.

Stative verbs (love, know, live in Northampton) may be used in the simple present tense to report certain situations. Consider:

(1) John loves Mary.

(2) Alison lives in Northampton.

Activities, accomplishments and achievements in the simple present tense can not be used as reportive and have only the habitual reading:

(3) John runs.

(4) Mary plays the piano.

(5) John catches butterflies.

Sentences (3)-(5) can be used to report a happening only in restricted contexts, as when uttered by an actor on a stage or a radio announcer. The occurence in the simple present tense with a non-habitual reading distinguishes stative verbs from other kind of verbs. This is an example where the use of tenses interacts with the inherent temporal features of verbs to yield different readings.

A second kind of test suggested for classifying verbs is that of logical entailments. Kenny noticed that entailments from the progressive to the non-progressive distinguish activities from accomplishments. If ϕ is an activity verb, then x is (now) ϕ-ing entails that x has ϕ-ed but if ϕ is an accomplishment verb, then x is now (ϕ-ing) entails that x has not (yet) ϕ-ed. The following example illustrates this principle (where $\longrightarrow$ stands for the entailment relation):

(6) John is running $\longrightarrow$ John has run.

(7) John is drawing a circle $\longrightarrow$ John has not drawn that circle.

The third test is that of time adverbials which occur with certain kinds of verbs but not with others. Accomplishments take <u>in</u>-phrase time adverbs (and in marginal cases take <u>for</u>-phrases) and activity verbs allow only <u>for</u>- phrases time adverbials. Consider[3]:

(8) ?John wrote this poem for an hour.

(9) John wrote this poem in an hour.

(10) John ran for an hour.

(11) *John ran in an hour.

Other classifying criteria have been suggested in the literature in addition to tenses, logical entailments and time adverbials. It has been observed that some verbs but

not others may appear as complements of certain verbs, that some adverbs can not occur with all verbs and that certain verbs can not take the progressive.

The classifying criteria set up by philosophers and linguists were not picked up arbitrarily- all of them involve certain assumptions or entailments about temporal properties which verbs in natural languages maintain or lack. Since the criteria chosen were meant to reveal the inherent temporal properties of kind of verbs, and assuming some claims about language universals are true, we expect some criteria to be similar in different languages. When two languages react differently toward the classifying criteria, their verb classification must be affected by it. Certain criteria used to detect aspectual features of English verbs may be absent in other languages, i.e the grammar may fail to express them (Hebrew, for example, lacks the progressive, which in English can not occur with stative verbs and serves to distinguish them from activities and accomplishments), but we expect grammars of all languages to exhibit some criteria (not necessarily the same for all languages) in common.

The number of chosen criteria and the importance assigned to some of them but not to others will affect the refinement of the classification. Categories others than these suggested by Vendler can be found in the literature.

L. Carlson (1981), for instance, adds two additional categories to these suggested by Vendler- that of momentaneous verbs and that of dynamic verbs. He distinguishes between achievements which take the progressive and those which do not, and calls the latter momentaneous verbs. The verbs hit, notice, and blink are momentaneous while win, attack, and take off are achievements. Dynamic verbs are placed between Vendler's class of stative and that of activities and they share properties with both. The difference between activity and dynamic verbs is that the latter take momentaneous adverbs while the former do not. Carlson gives the following example of a dynamic verb with a momentaneous time adverbials:

(12) At seven o'clock the caravan was standing in its old place.

Bach's (1983) verb classification also differs slightly from that of Vendler's. He distinguishes between states, processes (non-states) and events, where the latter are sub-divided into momentaneous and protracted events (accomplishments in Vendler's terminology). He sub-divides states into dynamic (sit, stand) and static (love x, be drunk) and momentaneous events into happenings (recognize, notice) and culminations (die, reach the top).

Other verb classifications have been suggested in the literature, all of them more or less based on that of Vendler and differing only in the degree of refinement of the chosen criteria which determines how subtle the classification will be. In this work we will adopt Vendler's classical classification and, like him, distinguish among statives, process, achievement and accomplishment verbs. Our terminology differs slightly from his. We will replace the term "activity verb" with "process verb", since the former denotes actions in general instead of temporal properties, which are relevant for the classification of this class of verbs.

Linguists have observed (Dowty 1979; L.Carlson 1981) that the choice of subject and certain other NP-complements affects the aspect of the verb. Consider:

(13) John ate the bag of popcorn in an hour.

(14) *John ate popcorn in an hour.

(15) John ate a chicken.

(16) John ate chickens.

(17) All guests arrived.

(18) Guests arrived.

The verb <u>eat</u> is an accomplishment but when it takes the indefinite plural direct object (as in (16)) or a mass noun (as in (14)) it turns into a process verb. <u>Eating chickens</u>

denotes a process while eat a chicken denotes an event. Sentence (14) is ungrammatical since eat popcorn is a process verb and as such can not take the in- phrase time adverb. Sentence (18) has an accomplishment verb arrive but when its subject is an indefinite plural it turns into a process.

Process verbs describing movement which occur with a specified destination or with an indefinite NP behave like accomplishments. Consider:

(19) John walked to the park.

(20) John ran a mile.

Dowty (1979) observed that almost all process verbs can have an accomplishment sense when a proper context is provided: if we know that John is in the habit of swimming a mile every day we can say that in the previous day John swam in an hour or that he finished swimming.

All those facts raise a serious difficulty for Vendler's classification which applies to surface verbs only. The example given suggests that VP's and whole sentences are involved in determining the aspectual properties of verbs.

David Dowty (1979) adopted Vendler's verb classification in his attempt to show that the difference among Vendler's aspectual classes can be explained, to a

remarkable degree, by the appearance of abstract operators like Become, CAUSE in the logical structure, of verbs of each class. All verbs which belong to one aspectual class share the same logical structure, which differs from that of verbs of other classes. Dowty presents a lexical decomposition analysis of classes of verbs in English which is based on word meaning analysis in generative semantics. His decomposition analysis is treated as fragment of a "natural logic", for which an explicit model theoretic interpretation is given. The detail of this theory will be discussed at length in the following chapters.

Dowty's main idea is that different aspectual properties of verbs can be explained by introducing a class of predicates which he calls stative predicates in addition to a few sentential operators and connectives. The aspectual operators and connectives are treated as logical constants and the stative predicates as non-logical constants. Statives, which Dowty assumes to be understood clearly, hold or do not hold of an individual by reference to a state of the world in a single moment. Dowty refers to events and processes in his exposition, but these plays no formal role in his theory. The only notion his theory employs is that of truth with respect to an interval of time (see the discussion of this in chapter III). The notion of an interval is taken as basic in his semantics.

Truth-conditions of accomplishment, process and achievement sentences are derived from the semantics of the aspectual operators and the stative predicates.

Bach and Kamp take an opposite approach. Bach (1977; 1980; 1981) has introduced the generic term "eventualities" which stands for events, process and states. Unlike Dowty, he does not take the notion of interval or that of moments of time as primitive, but goes in the other direction and analyzes the notion of time in terms of eventualities and the relation of precedence and overlap between them. Processes, events and states are analyzed as primitive in the model and unlike in Dowty's analysis, they have a role in the formal theory. Dowty does not adress the status of events, processes and states in the world, but only provides truth conditions for event sentences, process sentences, etc. Bach introduces the notion of a possible history which consists of a set of individuals , a set of eventualities and their relations. He uses the English words before and while as technical terms which refer to the relations of strict precedence and overlapping, and he defines other relations between eventualities- as, for example, that of simultaneity.[4] Meaning postulates guarantee that different verbs receive their appropriate aspectual meaning.[5]

Kamp (1981b) has also argued for taking eventualities rather than moments of time as basic and has shown how

moments and intervals can be constructed from them by a technique that traces back to Russell and Wiener. Various linguists and philosophers dealing with aspect have adopted the framework that takes eventualities as basic (Parsons 1983; Hinrichs 1981; Partee 1984). We would like to keep in mind the difference between Dowty's and Bach's approaches.

There follows the classifying table of aspectual verbs taken from Dowty. The application of each of the criteria is demonstrated by an example given below. The notation + and - indicate that the class of verbs satisfies or fails to satisfy the given criterion. The notation 0 indicates that the criterion does not apply to verbs of this class. The words "o.k" and "bad" specify correspondingly whether the sentence is grammatical and semantically normal, or not.

Table 1. Criteria for Verbs Classification

Criterion	states	processes	accomplishments	achievements
1. Meets non-stative tests.	-	+	+	??[6]
2. Reportive reading in the simple present tense.	+	-	-	-
3. x is ∅-ing entails x has ∅-ed.	0	+	-	0
4. x ∅ for an hour entails x at all times in the hour.	+	+	0	0
5. x ∅-ed in an hour entails x was ∅-ing during that hour.	0	0	+	-
6. ∅ for an hour	o.k	o.k	bad	bad
7. ∅ in an hour	bad	bad	o.k	o.k
8. complement of stop	o.k	o.k	o.k	bad
9. complement of finish	bad	bad	o.k	bad
10. occurs with <u>studiously</u>, <u>carefully</u>, etc	bad	o.k	o.k	bad
11. ambiguity with <u>almost</u>	-	-	+	-

The following examples demonstrate the application of each criterion to different classes of verbs and the results they yield:

The first criterion combines different non-stative tests. Stative can not occur in the progressive (example 21), in pseudo-cleft constructions (example 23), they can not take the imperative (example 22), they can not appear with adverbs such as deliberately or carefully (example 24). They also can not occur as complements of force and persuade (example 25). These restrictions do not hold in the case of other aspectual verbs. The sentences below show that statives fail to occur in these constructions:

(21) a. *John is loving Mary.
b. John is running.

(22) a. *Love Mary!
b. Draw a circle!

(23) a. *What John did was live in Boston.
b. What John did was win the race.

(24) a. *John deliberately loved Mary.
b. John deliberately built a cabin.

(25) a. *John forced Bill to know French.
b. John forced Bill to learn French.

The criteria listed above differ from Dowty's only in the results of the Ø for an hour test (criterion 6). In Dowty's table accomplishments take for adverbials. However, in chapter II of his book he provides contradictory judgements with respect to this point. At one point (pg. 56) he maintains that accomplishments only very marginally take for-phrases, while at another point (pg. 58) accomplishments are said to allow both for-phrases and in-phrases. English

native speakers have informed me that accomplishments with for adverbs are generally bad. Given their judgements, in addition to Dowty's contradictory judgements on that point, I have changed the results of criterion (6) in Dowty's table so that accomplishments do not take for adverbials, and as a consequence criterion (4) is no longer applicable to accomplishment verbs. Only process and stative verbs now satisfy criterion (4). If ϕ is a process verb like walk then John walked for an hour entails that at any time during that hour John walked is true.

We have already given examples of the application of the second and third criteria. The fifth criterion distinguishes accomplishments from achievements: if John wrote a sonata in a month it is true that he wrote the sonata during that month but if he discovered a treasure in a week it is not true that he discovered the treasure throughout a period one week in length.

Criteria (8) and (9) distinguish achievements from accomplishments. Unlike accomplishments, achievements are unacceptable as complements of finish, and also unlike accomplishments and processes, they can not occur as complements of stop. Consider:

(26) *John finished discovering the treasure.

(27) John finished building the cabin.

(28) *John stopped reaching the top of the mountain.

(29) John stopped building a house.

(30) John stopped running.

The tenth criterion was observed by Ryle (1947), who suggested that certain adverbs are anomalous with achievements:

(31) ?John carefully recognized his mother.
attentively reached the top of the hill.
conscientiously discovered the treasure,
etc.

Others adverbs which belong to this class are studiously, vigilantly and obediently.

The last criterion which Dowty gives is that of the effect of the adverb almost on different verbs. Consider:

(32) John almost drew a circle.

(33) John almost ran.

Sentences (33) entails that John did not run while (32) has two "readings": that in which John intended to draw a circle but did not do so and that in which John began to draw a circle but did not finish it. Process verbs lack the second reading when used with almost.

Later in the book Dowty revised his verb classification and made further distinctions relevant to the various topics he discussed: as, for instance, interval semantics, subinterval predicates, agentivity etc. We will stick to

Dowty's "classical" verb classification described in table 1 and will discuss later in our work some of the issues he raised which may lead to a subtler aspectual verb classification.

1.2. Analogies between Temporal and Nominal Reference

In various places in the literature (Taylor 1977; Mourelatos 1978; L. Carlson 1981; Bach (to appear)) claims have been made about certain correlations and analogies between reference in the object and temporal domains. L. Carlson (1981) mentions the property of partitivity (discussed by Quine and the Swedish grammarian Adolf Noreen) which in nominal reference constitutes the semantic distinction corresponding to the syntactic distinction of countability. Informally, partitivity is a notion connected with divisibility. A portion of some substance like gold can be further divided into parts each of which is also gold. (This condition is too strong since there are parts of gold too small to count as gold.) The inverse property of partitivity, i.e additivity, seems to hold unconditionally of mass terms- the sum of a number of portions of gold is always gold. Additivity and a weaker version of partitivity do not hold in case of count terms. An individual in the extension of a count term such as "chair" is not divisible into further members in the

extension of "chair". Reference in the temporal domain is similar. Additivity and a weaker partitivity hold of process verbs like push a cart, run and walk. This has led to their characterization as subinterval verbs: if a sentence with a process verb is true of some interval of time I, then the sentence is true of every subinterval of I including every moment of time in I.[7] Event type verbs (accomplishments and achievements) like recognize and build a cabin don't exhibit this property.

One of the contrasts between count and non-count nouns is in their quantifying systems. Numerals, singular quantifiers, words like a, each, every come only with count nouns while only mass nouns and plurals come with measure phrases.

Mourelatos (1978) observed that there is a nominalization equivalent to an event predication in which the original verb appears as a gerund or deverbal noun with suffixes like -ion, -ment, -al, -ure. The nominalization appears with numerals, indefinite articles and other count features as in the following example: there were three eruptions of Vesuvius. The nominalization equivalent to a process predication never appears with an indefinite article or cardinal numbers.

Taylor (1977) made a distinction between process verbs (E-verbs in his terminology) and event verbs (K-verbs) which

can be either instantaneous or protracted, and drew analogies with spatial dimensions. He observed that E-verbs are homogeneous while K-verbs are heterogeneous. Fall is an example of an homogeneous E-verb since every period within a period of falling is itself a period of falling. Stab is a heterogeneous verb since no period within a period of stabbing is itself such a period. He draws analogies with spatial dimensions: every three-dimensional area within a homogeneous stuff, like a lump of gold, is occupied by a lump of gold but no space within a table (which is heterogeneous) is occupied by a table. Later on in this chapter I will return to the observations made by Taylor and Mourelatos.

Bach (to appear), following Carlson, dealt with the aspectual shift of verbs from one class to another. He adopted Link's analysis (1983) of nominals and extended it to the temporal domain. His treatment reflects a similar asymmetry in the relation between count and non-count meaning that runs in the same direction in the nominal and temporal domain. Link has adopted models with a richer structure than those found in Montague by giving more structure to the domain of individuals. In Link's semantics there are plural individuals like the children and John and Mary and also quantities of 'stuff' or matter that correspond to individuals of both kinds. There is stuff

that makes up the plural individual John and Mary and the stuff that makes up the plural individual children.

One starts with a set of individuals A_i and extends this domain by a join operation to define a superset E_i ($A_i \subseteq E_i$ where every i-join of individuals exists). A partial ordering is then defined on the members of E_i such that α is "less than or equal to" β just in case the i-join of α and β is α itself. Among the elements of A_i there is a subset D_i which forms a special subsystem. Each of its members is the "stuff" which makes up some individual. This subsystem has its own join and partial ordering. What are the relationships between the system D_i and the rest of the domain? There is a mapping h_i from individuals (atomic or plural) to the stuff which composes them. The ordering among individuals is preserved in the ordering among the quantities in the mapping (h_i is an homomorphism). The same quantity of stuff may correspond to many different individuals. The same individual may be both in the extension of man and the extension of cells since the value of h_i, given the two arguments, is identical.

Bach shows how one may extend the structure of the model just described to the domain of events and processes, which are new kinds of elements. The analogies are between events and singular/plural individuals, on the one hand, and bits of process or portions of matter which compose events

and individuals on the other hand. As before, one starts with a set of events A_c and extends this domain to E_e by means of join-operation and partial ordering. D_e is a subset of E_e and its elements are bits of process of which the events are composed. This subsystem has its own join and partial ordering. The homomorphism h delivers the bounded bits of process corresponding to instances of each of these event types.

Bach claims that any count term can be used as a mass term and vice versa. As an example he gives the sentence there was dog splattered all over the road and the expressions portions of ice cream and kinds of mud. The same phenomenon occurs in the domain of verbs. Process verbs can be used as events and events as processes. Bach mentions Dowty's example I finished looking for a book, uttered in the context of a library with a well defined search procedure.

Bach noticed an asymmetry in the relation count/non-count in the nominal and temporal domain. When one starts with a count meaning and derives the non-count meaning, a particular meaning seems to be involved. The mass noun apple seems to mean the stuff such that there is at least one apple that is constituted from that stuff. (He argues later that a more indirect relation between the denotation of a mass predicative term and the corresponding

count predicate is in need). But in the other direction, it is not clear how the meaning of a count noun is to be constituted from that of a mass noun. A beer may be a serving of beer or a kind of beer. The same asymmetry holds in the verbal domain. When we use a process expression in the count meaning in a certain context we must come up with some kind of corresponding event, but it is not determined what event it is- the beginning of the process in question, some bounded portion of it or its end. Bach argues that this asymmetry is predicted by the many to one function from the count elements to the non-count ones (as illustrated before with the NP's cells and man which correspond to the same stuff).

1.3 Von Wright's Logic of Change and Inchoatives

Achievement verbs like cool, reach and die denote a change from one state to another. This observation may be found in various places in the literature. Von Wright (1963) developed a formal calculus to represent change. An event is a change of state where one state is the negation of the other. His calculus of change of state consists of classic propositional logic plus an operator T ("And Next") by which four basic types of formulas can be represented:

$\sim pTp$ - the state p comes about.

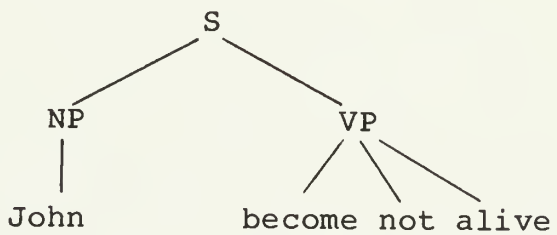
$pT\sim p$- the state p ends.

pTp - the state p remains.

~pT~p- the state ~p remains.

Generative semanticists suggested that an operator such as Become is involved in the underlying representation of sentences like John died. Various proposals were made about the stages of lexical insertion and the syntactic nodes which govern different constituents. I will ignore these questions here and represent John died by the general tree:

(34)



Dowty (1979) analyzed sentences involving the operator Become in terms of Von Wright's logic of change. His analysis can represent the beginning and the ending of states and activities as in John got drunk and John stopped running. He suggested that one regard Become as a sentence operator, and define its truth condition with respect to a model.

Dowty's claim that all achievements have a logical structure consisting of Become plus an embedded clause leads him to distinguish between three types of achievement verbs which he represents by different formulas. He uses a

convention whereby α stands for arbitrary predicates and ϕ for arbitrary formulas either atomic or complex.

The first type are simple achievements represented by $\lambda x(\text{Become}[\alpha'(x)])$. Simple achievements are sub-categorized into several groups: locatives like reach, leave which are transitive, and also two place predicate like arrive at; absolute changes of physical state like freeze, melt, die which are intransitive, and one-place predicates like become-adj-er; aspectual complement verbs like begin, start, verbs of possession change like lose, acquire; cognitive verbs like notice, see; and change of state of consciousness like awaken.

The second type of verbs of change are those which indicate inchoation of activity. Sentences embedded under Become do not always contain a stative predicate, and may instead contain an activity. The only English lexical example Dowty provided is germinate (Become plus grow). Complex sentences like John begin to walk also fall under this category. Dowty represents inchoation of activity as follows, where α stands for arbitrary individuals terms, π for n-place stative predicates and DO is a semantic operator which changes statives into activities:

(35) $\text{Become}[\text{DO}(\alpha_i[\pi(\alpha_i, \ldots \alpha_n)])]$.

The third type of verb is that of an inchoation of

accomplishment. Where ϕ is an accomplishment sentence, Become ϕ represents this group.

The linguistic tests which single out achievements were discussed in 1.1. Achievements are event type verbs. There are many cases in which they represent an absolute change of state. Consider:

(36) The cube of ice melted at midnight.

(37) The puddle of water froze at three o'clock.

(38) John reached the top of the mountain at one O'clock in the afternoon.

There are physical states which determine the time at which the subject entered the absolute states implied by sentences (36)-(38). While the adjectives frozen, melted desribe these absolute states there is no English adjective which describes the absolute state of being on the top of the mountain or being a winner of a race. Since stative predicates underlying VP's like win the race and reach the top of the mountain do not exist in English, Dowty suggests giving these VP's a more complex representation.

Inchoative verbs form a sub-class of achievements and usually denote a change of physical state, melt, freeze, die, for example. In English there are inchoatives morphologically related to adjectives which denote the state which undergoes the transformation described by the verb. Cool_{V} is morphologically related to cool_{adj} as redden_{V} is

related to $\underline{red}_{adj}$. English has a quite productive lexical rule for deriving inchoatives by adding the suffix en to the corresponding adjective. In Chapter IV we will discuss lexical rules in general and the deriviation of inchoatives in Hebrew, which is more productive than in English.

Dowty offers the following syntactic and semantic lexical rule for deriving inchoatives:

S_1: If $\alpha \in P_{adj}$, then $F_{w2}(\alpha) \in P_{IV}$, where
$F_{w2}(\alpha) = \alpha$ + en if α ends in a non-nasal obstruent,
α otherwise.

T_1: $F_{w2}(\alpha)$ translates into: $\lambda x[\text{Become } \alpha'(x)]$

The clay hardened is represented in the intensional logic as (I ignore the past tense in the representation and represent clay' by c):

(39) a. $\lambda x[\text{Become hard}'(x)]$ (c)

b. Become hard' (c) by λ-conversion

The above translation rule seems to capture our intuition about absolute change of states. Let us call inchoatives which denote an absolute change of states simple inchoatives. It seems that the above rule involves an instantaneous change usually associated with event type verbs. Any discussion of the kind of change involved here is directly related to the semantics proposed for the Become

operator introduced in the translation rule. This issue will be postponed to a later section.

2. Comparison Classes and Change

2.1. On Adjectives and Comparatives

One class of verbs occurs with durative adverbs and usually does not allow the punctual time adverbial at t. Consider:

(40) The soup warmed for three hours.

(41) The tree grew for three years.

(42) The face reddened for two minutes.

The verbs in (40)-(42), which denote change, share some properties with process verbs. Like run, they extend through a period of time and possess the sub-interval property characteristic of process verbs- when the soup warms for three hours it warms at each sub-interval within the three hours. Unlike run, which denotes a process, the verbs in (40)-(42) contain a sense of completion which processes lack. They may occur with time adverbials like in an hour or It took x y time, which process verbs can not take:

(43) The soup warmed in two hours.

(44) It took the soup two hours to warm.

(45) The tree grew in three years.

(46) It took the tree three years to grow.

(47) His face reddened in two minutes.

(48) It took his face two minutes to redden.

Inchoatives like cool, redden and warm are related to adjectives whose extension is hard to determine since it is relative to a comparison scale, or context. Linguists and philosophers have pointed out that vague adjectives can form the comparative with no semantic anomaly. Adjectives like cool, warm, red can be used for comparison as follows:

(49) X is $\left\{\begin{matrix}\text{cooler}\\ \text{warmer}\\ \text{redder}\end{matrix}\right\}$ than Y.

Adjectives like dead related to verbs like die which involve instantaneous change can not be used for comparison:

(50) *John is deader than Bill.

Kamp (1975) and Klein (1980) have made suggestions regarding the interaction of positives and comparatives. Hoepelmann's (1982) theory of comparison and change is an extension of these works- his semantics for verbs of change is related to Klein's and Åqvist's. I will discuss briefly the approaches they have taken. Kamp deals with the problem of vagueness and contextual disambiguation. He treats positive adjectives as one place predicates and claims that

comparative forms which are two place relations are derived semantically as well as morphologically from the positives. To show the primacy of positives over comparative adjectives he evaluates predicates in a multi-valued model theory. In a two valued logic a predicate can be identified with a characteristic function which is a function from a set onto the set 0,1 . The extension of the predicate man is defined as the set of elements in the universe which give the truth value 1 when the characteristic function is applied to them. Tall is a vague predicate since its extension varies from context to context. For any group of men some of them are definitely tall, some definitely not tall and for some of them it is not determined whether they are tall or not.

Before proceeding with our exposition we will mention some distinctions made by Kamp (1975) and others to single out different dimensions involved in determining the extension of an adjective. Some adjectives are vague but linear, i.e there is a single relevant scale which determines their extension when the context is given. Tall, old, wide, long, belong to this category. These adjectives are also partial functions, i.e they are not defined for all the individuals in the universe of the model. Another group of adjectives are those which are vague and nonlinear (Klein's terminology for these adjectives), i.e there is more than one relevant "dimension" or "scale" which

determines their extension. Big is a non linear vague adjective whose relevant extension can either be its volume, height, surface area etc. A can be bigger than B in a certain context where the scale is A's and B's heights, and B can be bigger than A in a different context where the scale is their volumes. An adjective like prime, on the other hand, is not vague but a partial function. The tomato is prime is nothing but a case of sortal incorrectness- prime is not defined for tomatoes.

Kamp argued that to deal with the vagueness of tall one can let the characteristic function F_{tall} be a partial function on the set of men rather than a total one. For some men the function will give the value 1, for others 0, and for some it will be undefined. John is tall and John is not tall may lack truth values, as may tautologies and contradictions of classical logic. The positive extension of a predicate in a context c is a set of things of which it is definitely true, its negative extension is the set of things of which it is definitely false, and individuals who fail to belong either to the positive or negative extension are said to belong to an extension gap. Kamp introduced a set of new valuations which close up the extension gap in a consistent way. This is done by a completion of the partial model determined by partial characteristic functions. Each complete characteristic function that extends the first one

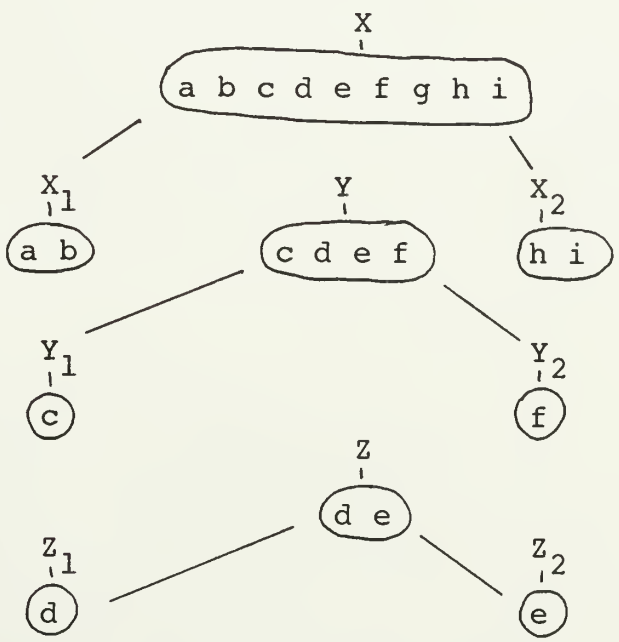
in a consistent way assigns the truth value 1 to tautologies and 0 to contradictions. Given a context c and a predicate A we can define the set of consistent c+ (set of new contexts) which include a consistent total extension of the meaning of A in c, i.e the set of all c+ such that $Ac \subseteq Ac+$ and Ac+ is total. This is the supervaluation idea of Van Fraassen (1969) . Suppose we have a partial model where some tautologies are undefined. We can make them true by introducing supervaluations: something is true if it is true in all the total extensions.

Kamp's analysis allows the comparative to be defined in terms of the positives- if A is in the positive extension and B is in the extension gap, then A is taller than B is true if there is a completion F'_{tall} of the original function F_{tall} such that $F'_{tall}(A)=1$ and $F'_{tall}(B)=0$. For the case where both are in the extension gap, supervaluations are not enough. The reason is that if A and B are both in the extension gap, there will be some consistent total extensions in which A is tall, and some consistent total extensions in which B is tall and A not tall.

Klein introduced the notion of a comparison class. A comparison class is a subset of the universe of discourse which is established by a context of use. When Mary and John are both in the positive extension of tall relative to

a universe, a subset of it may serve as a new comparison class on which a new partial or total function can be defined. Klein introduced the following example. One starts with a set X and partitions it by means of the function $F_A(c[x])$ where x is the comparison class for the predicate A in the context c. Y is the extension gap which remains, i.e Y is X- $dom[F_A(c[x])]$. Y is a new comparison class which is partitioned again by means of the function $F_A(c[Y])$. Then again, one takes the remaining extension gap, and partitions it. Klein provides the following figure to illustrate this:

(51)



The comparative is derived from the positive in a similar

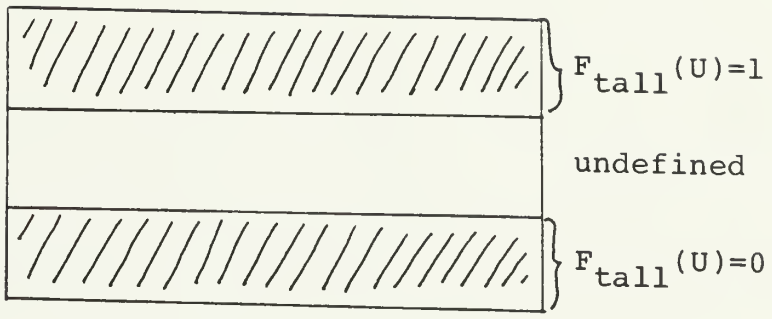
way to that offered by Kamp. Both Kamp and Klein treat adjectives as one place predicates and Klein treats prenominal adjectives as a special case and introduces an ad-hoc device to take care of them.

Hoepelman (1982) presents a semantics for adjectives, comparatives and change in which he treats adjectives as common noun modifiers. His theory is influenced by Åqvist (1981) who tried to account for the relationships between adjectives in order to preserve the validity of arguments in which they occur. For example, Bill is a good violinist, therefore Bill is a violinist and Bill is good is an invalid argument: Aquist would like this to follow from his theory since traditional propositional and predicate logic can not handle such cases.

Hoepelmann claims that an advantage of his theory over Klein's is that it handles all adjectives in a uniform way and is simultaneously able to account for relationships between comparatives and superlatives. He also deals with opposite pairs of degree adjectives like tall-short, big-small, etc.

The area of the really not tall man will be the area of the short man and the area of the really not short man the area of the tall man. He gives the following diagram:

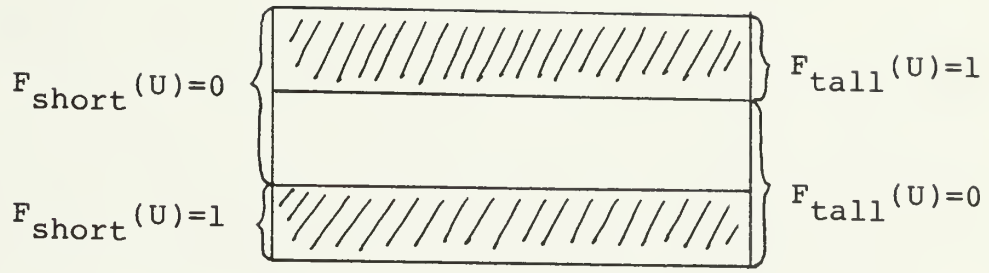
(52)



If Mary is in the undefined area, Mary is tall does not have a truth value and neither does Mary is short. Mary is short and tall and Mary is neither short nor tall are contradictions in classical logic, but do not have a truth value here. However, he claims, we can answer questions like: How tall is Mary? by Mary is neither tall nor short, she is something in between. This is not a contradiction unlike Mary is tall and short. His semantics is intended to reflect this fact.

Hoepelmann presents a theory of polar adjectives by means of comparison classes. He treats common nouns as well as adjectives (except for such adjectives as fourlegged) as a special case. The set of men, for example, is carved up into the set of tall men and the set of short men. Between these two sets there is the set of men which are neither tall nor short.

(53)



The same carving up can be done on this set. The idea is the same as in Klein except that adjectives are common-noun modifiers and contexts are no longer parts of the model. The traditional view of adjectives as function from CN to CN of which Kamp and Montague are representative, is kept here, since degree adjectives like <u>tall</u> are functions taking as arguments subsets of the universe and giving as values subsets of the universe. Hoepelman suggests CN's should be treated in the same way, which may account for their intensionality, i.e with respect to the universe the set of philosophers may be the same as the set of logicians, but the function corresponding to both may be different since $F_{logicians}(F_{logicians}(u)) \neq F_{philosophers}(F_{philosophers}(u))$. Thus when N is an arbitrary CN and A an arbitrary adjective,

$$F(N) \in \left[\wp(N)^{\wp(N)}\right] \text{ and } F(A) \in \left[\wp(N)^{\wp(N)}\right]^{\left[\wp(N)^{\wp(N)}\right]}$$

i.e, adjectives are total or partial functions from possible denotations of CN's to possible denotation of CN's. I will not enter into the details of Hoepelman's semantics or the conditions on the interpretation of adjectives he offers.

2.2. A Certain Case of Ambiguity

Consider the following sentences:

(54) The sky darkened.

(55) The soup warmed.

(56) Bill's face reddened.

In sentences (54)-(56) the meaning of the verbs darken, warm, redden depends on the context and in that sense these verbs are considered to be vague. The vagueness of these inchoatives derives from the vagueness of the adjectives from which they are formed. I assume that the meaning of a vague adjective like cool contains a context parameter c (which I write as a subscript). The lexical rule T_1 will derive the following meaning for the verb cool:

(57) $\lambda x[\text{Become}[\text{cool}'_c(x)]]$

The absolute simple inchoatives can be regarded as a special case: since their meaning does not depend on context, we can suppress the context parameter in their representations.

There is some evidence which suggests that inchoative

verbs are ambiguous between a "become adj" and "become adj-er" reading. Consider the following examples:

(58) a. The Atlantic ocean is wide and is widening.
b. *The Atlantic ocean is wide and becoming wide.
c. The Atlantic ocean is wide and becoming wider.

(59) a. John is tall and is growing.
b. *John is tall and becoming tall.
c. John is tall and becoming taller.

I used the progressive tense in examples (58) and (59) since widen, grow can not appear in the simple present tense. The switch of tenses should not affect my argument. I used the verb grow in example (59), which morphologically is not related to tall, although semantically it is analyzed in terms of the vague inchoative tall. Sentences (58b) and (59b) sound odd since when the Atlantic ocean and John are wide_c and tall_c relative to some fixed context c, they can not become wide_c and tall_c again. Sentences (58c) and (59c) are perfect. The Atlantic ocean can be wide_c and still become wider since in the semantic analysis of the comparative, its width is evaluated with respect to contexts (i.e. comparison classes) distinct from c. In the context c, wide oceans are distinguished from non-wide oceans. In the evaluation of the comparative, the comparison class may be much smaller (for instance, temporal stages of the

Atlantic ocean). One can compare two wide objects which are in the positive extension of a predicate, i.e you can say "a is a wide skirt" and "b is a wide skirt" and "a is wider than b". This suggests that widening in (58a) and (59a) means "becoming wider" and not "becoming wide". Sentences (54)-(56) appear to involve an ambiguity between a vague and a comparative reading. Sentence (54) may imply either that the sky became $\underline{\text{dark}}_C$ or that it became darker.

Partee has suggested (personal communication) the interesting fact that some degree modifiers that comparatives allow are the same as those that go with inchoatives:

(60)

Adjectives	Comparatives	Inchoatives
very cool	*very cooler	*has very cooled
quite cool	*quite cooler	*has cooled quite
so cool	*so cooler	*has so cooled
pretty cool	*pretty cooler	*has pretty cooled
rather cool	*rather cooler	*has rather cooled
*a lot cool	a lot cooler	has cooled a lot
*quite a bit cool	quite a bit cooler	has cooled quite a bit
*ten degrees cool	ten degrees cooler	has cooled ten degrees

On the other hand, absolute modifiers like completely, absolutely (which imply some "absolute" top on a scale) go with adjectives and inchoatives but never with comparatives:

(61)

Adjectives	Comparatives	Inchoatives
completely cool	completely cooler	has cooled completely
absolutely cool	*absolutely cooler	has cooled absolutely

This reinforces the suspicion that the verb cool is ambiguous. Partee has also noticed that we can say:

(62) the weather has finally cooled.

where finally implies an end state $cool_c$ and also,

(63) The weather has cooled considerably.

where considerably implies a degree or comparative reading. How should the reading of inchoatives paraphrased by "become cooler" be represented? In Kamp, x is cooler than y is true iff for all ways of resolving the vagueness of cool by separating the cool from the non-cool, if y counts as cool, then x counts also, but not in the other direction. In line with Kamp, we can say that inchoatives with the "become adj-er" reading, which I will call "comparative inchoatives", are also derived from the positives. To do this we introduce into our lexical rule T_2 an existential quantifier which binds the free variable over contexts:

$$T_2: \lambda x[(\exists c)\text{Become}[\text{cool}'_c](x)]$$

Argumentation for introducing an existential quantifier into

our "comparative inchoative" rule will be given in the next section. Inchoatives derived by T_2, which is a closed expression, are no longer vague, a fact which explains why sentences (58a) and (59a) are fine.

2.3. Inchoatives in Sentences with Durative Time Adverbials

Dowty has given examples of verbs which would seem to be achievements on some semantic and syntactic grounds, but which nevertheless allow durative adverbs which only occur with process verbs. These verbs express a change of state and do not imply that the same change of state occurred over and over. He says that these inchoatives which occur with durative time adverbials are vague.

(64) The soup cooled for three hours.

(65) The sky darkened for half an hour.

(66) The Atlantic ocean widened for three years.

Dowty asserts that (64) should be analyzed as saying that for each time t within the interval of three hours there is some resolution of vagueness of cool by which the the soup is cool is true at t, and false at t-1. One wants different resolutions of vagueness to be used for each time covered by the durative adverb. This is the reason why in the semantic definition one should give "a resolution of vagueness" a narrower scope than that of times. Dowty puts it this way:

(Dowty 1979, pg. 90):"A sentence Become ϕ should be true at t iff there is some resolution of vague predicates that makes ϕ true at t but false at t-1; then $(\forall x: x \in$ an hour$)\ \phi$ must be true iff for all times t' within the interval an hour there is some resolution of vague predicates that makes ϕ true at t'".

How should we represent a sentence like (64) in a way which captures Dowty's suggestion?

To say that the soup cooled for three hours, as in example (64), means that there is some interval I of length three hours, such that for any time t in I, there is a context such that the soup becomes cool (simplifying assumption- the soup' equals s):

(67) $(\exists I)\{$duration of I is three hours &
$(\forall t(t \in I) \longrightarrow (\exists c)[\text{Become cool}'_c(s)(t)])\}$

We have here an existential quantifier over contexts with a narrower scope than that of the durative time adverbial.

Dowty (1972; 1979) has provided examples of achievement verbs with indefinite plurals or mass nouns as subject or object which occur with durative adverbs as in (68):

(68) John discovered fleas on his dog for six weeks.

and noticed that these sentences involve an existential quantifier with a narrower scope than that introduced by the

adverb, but it was Gregory Carlson (1977; 1977a) who accounted for the presence of an existential quantifier in sentences involving bare plurals. Carlson has given examples of sentences with indefinite plurals like dogs, rabbits in constructions of various kinds: VP quantifiers, negation, anaphoric constructions, frame adverbials and aspectual verbs like continue. He has shown that in each case the only possible reading of these sentences is that in which the existential quantifier underlying the indefinite plurals has a narrower scope than the other anaphor. For example:

(69) Harry continued to kill rabbits.

(70) Dogs were everywhere.

Indefinite plurals also seem to have a universal or generic quantifier:

(71) Dogs bark.

(72) Smokers are rude.

Indefinite plurals, referred to by Carlson as bare plurals, are never ambiguous between an existential and generic reading: they are in complementary distribution. Furthermore, anaphoric constructions with bare plurals fail to show the difference between existential and generic NP's: in (73) the NP is generic and since it contains a universal

quantifier, the pronoun they can not be bound, nor deictic or an E-type pronoun.[8] Similarly, in (74) the NP is existential, so again the pronoun can't be bound, deictic or E-Type:

(73) Mary hates raccoons (generic) because they (existential pronoun) stole her sweet-corn.

(74) Raccoons (existential) stole Mary's sweet-corn, so now she hates them. (generic)

The behaviour of the pronouns in (73) and (74) is inconsistent with the assumption that (73) contains a universal quantifier and (74) an existential one. This led Carlson to look for a semantic analysis of bare plurals. He claimed that bare plurals do not contain a quantifier in their NP. The difference between the generic and existential interpretation of indefinite plurals lies in the meaning of the verb they interact with. The indefinite plurals and their pronouns in (73) and (74) share the same meaning, and it is the different verbs hate and steal which determine the interpretations of (73) and (74). Carlson claimed that bare plurals are names of kinds, like chairs, cats and flowers. He introduced a relation R which realizes the kind with an individual. R(a,b) asserts that a thing a realizes the kind or an individual b. Similarly, he distinguished between an

individual and its stages. R(c,d) asserts that the stage c realizes the individual d at a certain time. Certain verbs and adjectives predicate things of individuals and kinds, and others of stages of individuals or kinds at a certain time.

Carlson mentions Milsark (1974) and Siegel (1976) who divided English adjectives into two classes: those which select the indefinite plural existential reading, and those which select the generic reading. Property adjectives like fat, clever, tall are more permanent than adjectives which denote states, such as drunk and happy. Compare:

(75) Dentists were drunk.

(76) Dentists were tall.

Sentence (75) has the existential reading where the subject is an indefinite plural, and (76) has the generic reading. States are predicates of stages of individuals and properties are predicates of individuals.

Hate is a primitive relation between individuals while kick and eat are relations between stages of individuals. A derived translation of eat is a relation between individuals/kinds:

(77) $\lambda xy\, \exists x'\, \exists y'[R(x',x)\ \&\ R(y',y)\ \&\ eat(x',y')]$

The part of (78)

(78) Raccoons were eating sweet-corn.

which is interior to the progressive operator is translated into:

(79) $\exists x' \exists y'[R(x',r) \& R(y',s) \& eat(x',y')]$

Dowty incorporated Carlson's theory into his Become analysis of achievement, and in this way (68) can be represented in a way similar to (64):

(80) $(\forall t:t \in$ six weeks) At(t, Become[John know that $(\exists x[R(x,f) \& x$ is on his dog])])

The existential quantifier in our representation of (64) ranges over contexts and there is no context involved in Carlson's theory. My treatment of comparative inchoatives is an elaboration of a suggestion by Dowty which was influenced by Carlson's treatment of bare plurals. The rule of deriving comparative inchoatives introduces an existential quantifier like that which is implicit in the verb in Carlson's theory of bare plurals.

We will provide an example which illustrates the difference between the two inchoative translation rules T_1 and T_2 repeated below:

(81) Absolute and vague inchoatives:

T_1: $\lambda x[\text{Become } [\alpha'_c(x)]]$

(82) Comparative inchoative:

T_2: $\lambda x[(\exists c)\text{Become } [\alpha'_c(x)]]$

Let's assume that the two contexts of use are Alaska and Egypt. In Alaska anything under 0^0 centigrade is cool and anything which is above 0^0 centigrade is not cool. In Egypt anything under 30^0 centigrade is cool and anything above it is not cool. Suppose a particular glass of lemonade went down from 31^0 to 29^0 centigrade. In this case (83)

(83) The glass of lemonade cooled.

when translated by T_1 and T_2 (see (84) and (85) below) have different truth values with respect to the context of use Alaska and Egypt (where 1 stands for the glass of lemonade):

(84) Become $[\text{cool}'_c(1)]$

(85) $(\exists c)[\text{Become cool}'_c(1)]$

(84) is false with respect to the context Alaska and true with respect to the context Egypt. On the other hand (85) is true with respect to either context, because in each case there exists a context, i.e Egypt, where the glass of lemonade cooled.

3. Inchoative Process Verbs

3.1. The Gap Problem and the Process Meaning of Inchoatives

As we saw in the previous section, a sub-class of the inchoatives take durative time adverbials which usually go with process verbs. Aspectually, these verbs seem to behave like such process verbs as run and push a cart, although morphologically they are derived by the inchoative lexical rule (see chapter IV section 2.1.) and their meaning involves changes of states. We will refer to inchoatives which take durative time adverbials as "inchoative process verbs".

In discussing inchoative process verbs we will deal with two issues:

1. The gap problem which deals with the way of representing the quantifier over times in (67), and the relationship between the length of the intervals at which the activity took place and the gaps in the case of inchoative process and inchoative process verbs.

2. The two possible event and process readings of inchoative process verbs.

In the representation of (64) repeated below:

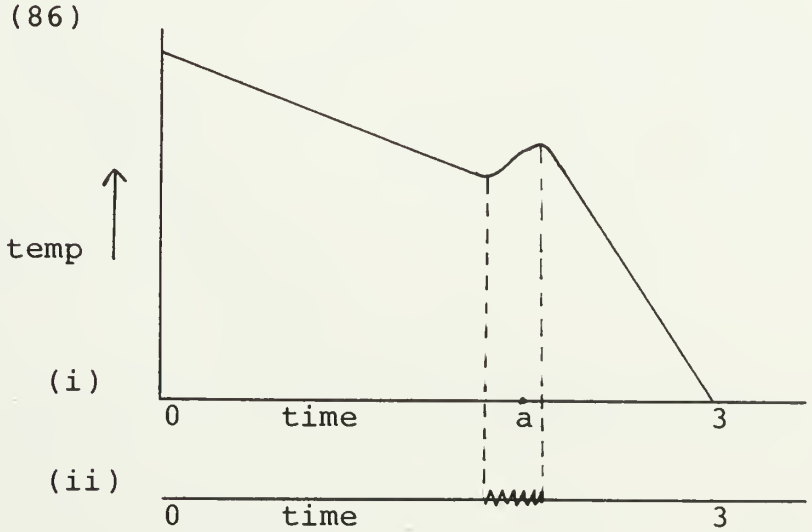
(67) $(\exists I)$[duration of I is three hours &
$\forall t[(t \in I) \rightarrow (\exists c)$[Become cool'$_c$(s)(t)]]]

the context is expected to change for every moment within the interval I of duration three hours such that the soup is not cool at a previous moment and cool at the next one. However, it seems that the universal quantifier in (67) forces us to accept undesired consequences which could be avoided if a weaker quantifier were present. In (86_i) there is no context (resolution of vagueness) with respect to which the soup become cool at moment a, yet, in intuition, sentence (64) repeated below:

(64) The soup cooled for three hours.

is true in the following situation:

(86)



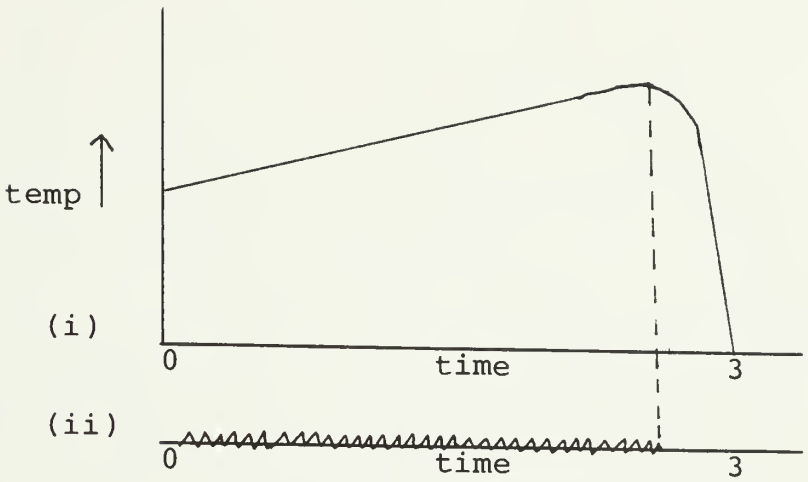
In all the situations described in (86)-(92) I is of duration 3 hours and "∧∧∧∧" represents not running.

The problem of the representation of the durative time adverbials arises not only when they occur with inchoative process verbs but also when they occur with primitive process verbs. For

(87) John ran for three hours.

to be true, John does not have to be occupied in the activity of running at every moment throughout the duration of three hours- he can rest for ten minutes or stop every half an hour for a moment.[9] This situation is described in (86ii) where we have drawn the running and the gaps on a single line. So sentence (64) and (87) are both true in the situation described in (86). Sentence (64) can not be true in the case where for most of the time there was a steady warming rather than a cooling of the soup (see (88i) below) even though by the end of the three hours the soup is definitely more cool than at the first moment. Likewise for primitive process verbs like <u>run</u> in sentence (87). If the running occupies only a small subinterval of the interval of three hours, (87) is not verified. So in case (88), sentences (64) and (87) are both false.

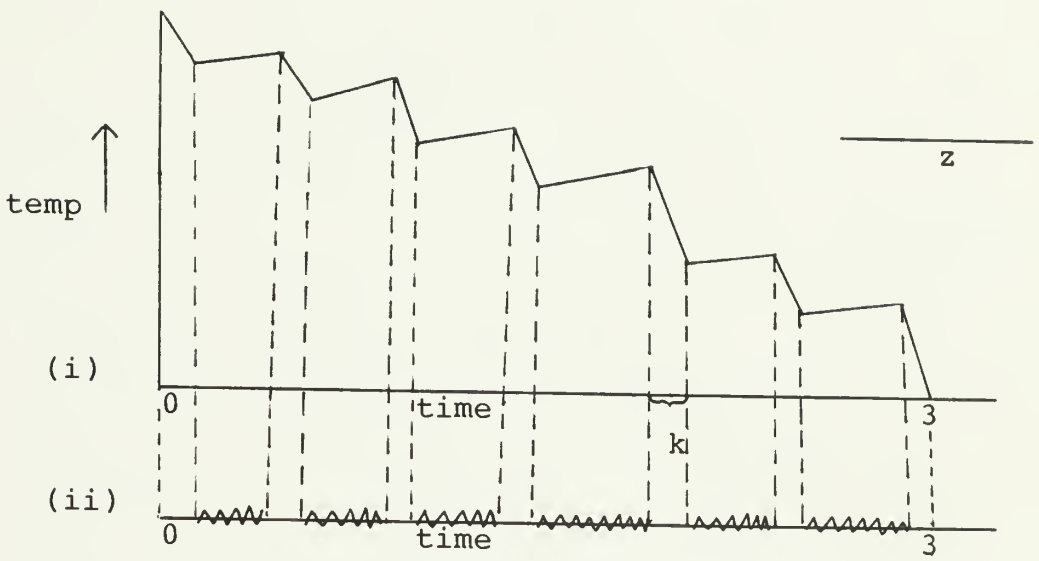
(88)



Some important differences between the length of the intervals at which the activity took place and the gaps show up in the case of process and inchoative process verbs. This seems to follow from the fact that the latter but not the former involve change of states.

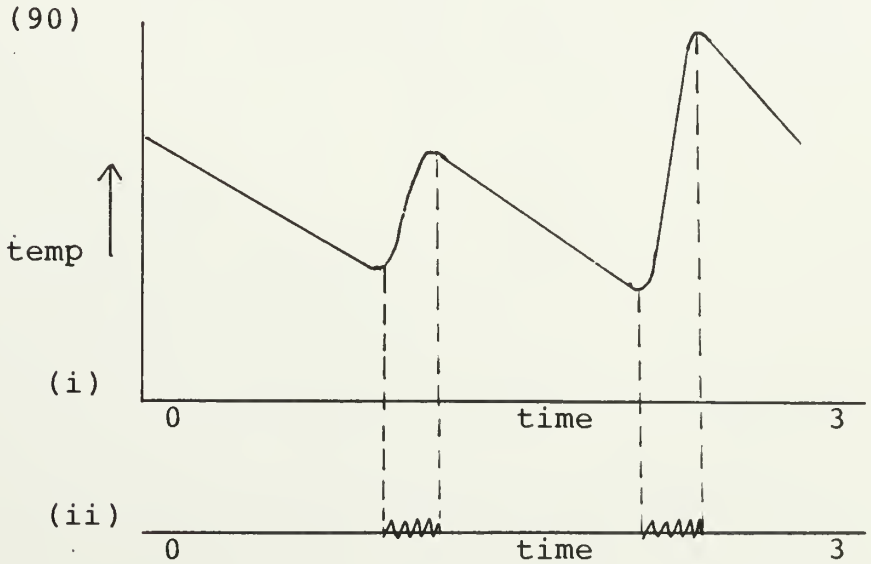
Consider the situation described in (89i). The soup is not actually growing cooler for most of the time but at the end of the three hours it is cooler than at the beginning. Sentence (64) is true in this case. On the other hand, (87) is false where the situation is as described in (89ii) although the periods of acting and rest are the same as in (89i). So, inchoative process verbs seem to behave differently from process verbs in case (89).

(89)



Furthermore, consider the case where the soup cools most of the time but by the end of the three hours its temperature is the same as before, as diagrammed below:

(90)



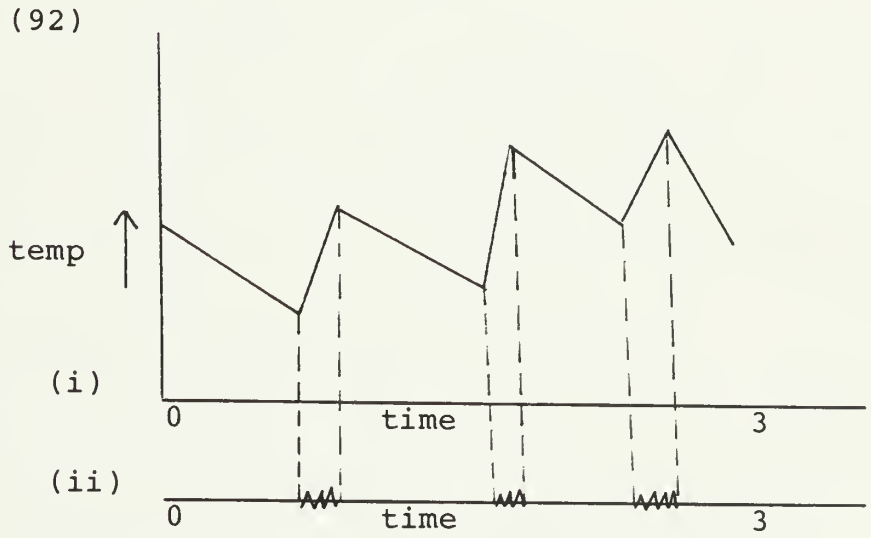
Where the circumstances are as described in (90) we would not say that the soup cooled for three hours, but under the same condition the sentence John ran for three hours is true. This sentence is true whether John ran for three hours circling a building and ended at the starting point, or he ran back and forth along a line, finishing at the point where he started. In running there is no notion of making progress.

The truth of ϕ for n hours depends on the truth of ϕ at subintervals of the verifying interval whose duration is n hours, and some condition on their length must be stipulated.

The idea is that in evaluating the truth of ϕ for n hours we should ignore intervals shorter than some minimum duration z. In the case we have been looking at, and where the sentences were true, the duration of the "gaps" were less than z. This condition is stated more formally in (91) given below. ϕ is true at I iff it is true at all subintervals I' whose length is bigger than z which is an interval whose length is determined by the context (sentence (64) is vague). When ϕ is true at all $I' > z$, then ϕ is true at I.

(91) $[[\phi \text{ for } n]]=1$ iff $(\exists I)[\text{duration}(I)=n \;\&\; (\forall I')[I' \subseteq I \;\&\; \text{duration}(I') > z \rightarrow [[\phi]]_{I'}=1]]$

Sentence (64) is true in case (89i). Since k is not a large enough interval, the temperature increases at k. But for any $I' \subseteq I$, if duration$(I') > z$, then the temperature decreases at I'. This accounts for the truth of (64) in case (89i). But consider case (92):



Sentence (64) is false in case (92i). No matter what z is, as long as I itself has a duration longer than z, there are intervals longer than z where the temperature increases. (I itself is such an interval). This again illustrates the unique feature of inchoative process verbs- it is the degree of cooling which is significant, not just the set of moments where cooling is taking place. Sentence (87) is true in case (92ii) since for all I' bigger than z <u>John ran</u> is true.

What about the cases described in (88i) and (90i)? With regard to (88i), the soup warmed rather than cooled for quite long subintervals of I. Assuming that any reasonable value for z is less than, say, half the duration of I, this explains why sentences (64) and (87) are false. With regard to (90i), note that Become(cool(s)) is false with respect to the interval I itself; recall that we required that a reasonable value for z be less than the duration of I.

Let us turn to the second issue, that of a possible aspectual ambiguity of verbs like warm, redden, widen. These verbs may take a punctual or a durative time adverbial:

(93) The soup warmed at three o'clock.

(94) The soup warmed for three hours.

(95) His face reddened at three o'clock.

(96) His face reddened for three seconds.

Mourelatos has offered offered tests to distinguish event type verbs from process ones as we mentioned in 1.1. He claimed that an event predication has an equivalent nominalization in which the original verb appears as a gerund or deverbal noun. Event predications take cardinal numbers, the existential quantifier and determiners like many, few, while process predications never appear with the indefinite article or cardinal numbers. The corresponding nominalization seems to have the same features:

(97) There were three eruptions of Vesuvius.

(98) For three hours there was pushing of the cart by John.

Verbs like warm, redden, widen seem to have an event as well as a process predication:

(99) a. The earthquake was preceded by a warming of the sea.

b. How much warming will this material tolerate?

(100) a. A widening of the road would facilitate traffic flow.

b. How much widening is appropriate for this expressway?

(101) a. A reddening of the skin is a symptom of measles.

b. How much reddening of the skin will this drug cause?

The progressive tense does not entail the present perfect tense as is the case with event type verbs:

(102) The soup is warming $\not\rightarrow$ the soup has warmed.

(103) The sky is darkening $\not\rightarrow$ the sky has darkened.

but notice the following entailments:

(104) The soup is warming $\rightarrow$ The soup has warmed somewhat.

(105) The sky is darkening $\rightarrow$ The sky has darkened somewhat.

This relates to Kamp's (1979) work on French passé simple and imparfait. Just as we seem to be able to look at change as either gradual or abrupt, we seem to be able to look at time as either continuous or discrete. Kamp discussed the difference between French passé simple and imparfait where the first conveys that the action, event or state reported with its help has come to an end and the second conveys no such termination. The imparfait is used to provide the background to a certain event or sequence of events, whereas the succession of events which unfold against this background is reported by the passé simple. The use of the imparfait places the hearer inside the action and the passé simple keeps him outside it. No one of these observations, Kamp points out, can be captured by truth conditional semantics. He provides the following sentences:

(106) Il y a deux ans la Compagnie acheta un navire de 100,000 tonnes.

"Two years ago the company bought a ship of 100,000 tons".

(107) Il y a deux ans la Compagnie achetait un navire de 100,000 tonnes.

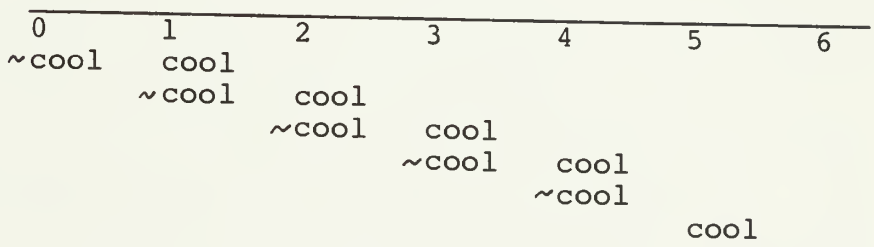
"Two years ago the company had bought a ship of 100,000 tons".

It is not so much features of the event, i.e the time it took to conclude the deal, that determine the use of the appropriate tense but rather the angle from which it is

viewed. According to Kamp, the truth of a piece of discourse should not be equated simply with the truth of its component sentences. Truth conditions can be assigned only to a discourse as a whole and the differences between the imparfait and passé simple can be explicated in terms of their distinctive contribution to the truth conditions of the discourse. The particular order that the discourse conveys depends on where the passé simple is used and where the imparfait. The difference between the two is in how to represent events used to report, or how to represent the information in the discourse. The passé simple, for instance, pushes the action forward since a sentence in the passe simple is understood as reporting an event subsequent to the last event. An imparfait sentence, on the other hand, following a passé simple sentence is understood as stating conditions which obtain at the time of the event e which the passé simple sentence reports. It is not specified whether the state introduced by the imparfait sentence outlasts the event with which it is represented as simultaneous or not. Kamp's theory of discourse representation accounts for such temporal orders. However, what we have attempted to point out here is the analogy between viewing time and change as either punctual or durative.

Let us discuss the process reading of inchoatives. $\underline{cool}_c$ is a vague inchoative which denotes a change from $\underline{cool}_c$ to $\underline{cool}_c$ and the presence of the durative time adverbial suggests a reading with repeated changes from not cool to cool as described below:

(108)



The fact that for every two moments in the three hours the soup turns from $\sim\underline{cool}_c$ to $\underline{cool}_c$ i.e it becomes more and more cool, determines the gradual reading of sentence (64). No comparative component is directly involved in the derivation of inchoatives, but given some facts about the meaning of cool, it can be proved that "become cooler" and $\lambda x((\exists c)$ Become $cool'_c(x))$ are the same thing. The repeated reading of $cool_v$ is not different from the iterative reading involved in sentence (109):

(109) John pinched Bill for three minutes.

where pinch is a regular event type verb. This brings up a difficult issue: should sentences (64) and (109) be analyzed

as process sentences or as event type sentences with an iterative aspect; and is there a real distinction in the world between repeated events and processes?

If an iterative event verb is a kind of process verb then perhaps the aspectual ambiguity in verbs such as cool and redden may be accounted for by the presence of an iterative operator which changes an event type verb into a process one. In this case, (64) should be represented as follows:

(110) Time Adv(Iterative(($\exists$ c)Become cool'$_c$(s)(t)))

event

process

An iterative operator seems to be involved in the morphology of Hebrew where aspectual properties interact with its binyanim system. (The Hebrew binyanim system and its interaction with aspect will be discussed in chapter IV). Some event type verbs in Pa'al, the base form, have an iterative reading when formed in Pi'el. The iterative Pi'el construction (which carries as well other aspectual properties) is more productive in Biblical than in Modern Hebrew. Consider:

(lll)	Pa'al	Pi'el	
	kafac	kipec	'jumped'
	rakad	riked	'danced'
	caxak	cixek	'laughed'

In Hebrew, the verb pattern formed in Pa'al can be used to denote a single event as in kafacti pa'am axat ("I jumped once"), rakadti rikud exad ("I danced a single dance") or caxakti cxok boded ("I laughed a single laugh"), but not when conjugated in Pi'el: *kipacti pa'am axat, *rikadti rikud exad and *cixkakti cxok boded.

Comrie (1976) provides further examples from Slavic languages which reflect iteration morphologically. In these languages habitual forms are often referred to by the term "iterative": pivat', znavat' in Russian are the habitual counterpart of pit' ("drink") and znat' ("know"). Habituality is connected to iterative aspect since any situation that can be iterated a sufficient number of times over a long enough period can be expressed as a habitual. In Hungarian there are several suffixes which serve to mark iterativity like zorren ("knock") and zorog ("knock repeatedly").

The question of whether an iterative event is a process seems to be related to my brief discussion of Taylor's distinction between homogeneous and heterogeneous

processes. In some sense, heterogeneous processes are defined in terms of more primitive accomplishments/achievements- whether there is a verb corresponding to them or not. (Taylor gives the example of chuckling, which can not mean chuckle once). Motion verbs like walk, run, dance involve a complex pattern of change and it is not true that every minimal subinterval of the processes denoted by any of them is also an interval of that process. It is not easy to determine what conditions should be met for x run to be true of a minimal interval, and the fact that such an issue comes up at all casts a shadow on any attempt to distinguish processes from iterative events. It seems that there are few, if any, homogeneous process verbs- fall, rise, move, together with inchoative process verbs may be thought of as constituting this group. But even the processes denoted by these verbs can be viewed as consisting of more primitive events. These are puzzling issues related to metaphysical-conceptual considerations and the answer to the question of whether there is a real distinction between events and processes in the world, and consequently between iterative events and processes, draws heavily on such considerations.

As far as we are concerned, verbs which denote iterative events satisfy the linguistic criteria mentioned before which were set up to single out process verbs.

Notice that iterative events have the subinterval property- if John knocked on the door for half an hour, he knocked on the door at any large enough subinterval of the interval of duration of half an hour.

3.2. Further Issues Concerning the Ambiguity of Inchoative Process Verbs

I suggested that inchoative process verbs and not vague ones incorporate a comparative component. In sentences (112d), (113d) and (114d) the vague inchoatives "become adj", "get adj", "turn adj", "change to adj" paraphrase the inchoative process verbs and all these sentences sound odd:

(112) a. The Atlantic ocean widened at 12 noon May 14 1955.

b. The Atlantic ocean became wide at 12 noon May 14 1955.

c. The Atlantic ocean widened for three years.

d. *The Atlantic ocean became wide for three years.

(113) a. The soup cooled at three o'clock.

b. The soup became cool at three o'clock.

c. The soup cooled for three hours.

d. *The soup became cool for three hours.

Similarly when become is replaced by turn, change to, get:

(114) a. The sky darkened at six o'clock.

b. The sky {turned / changed to / got} dark at three o'clock.

c. The sky darkened for three hours

d. *The sky {turned / changed to / got} dark for three hours.

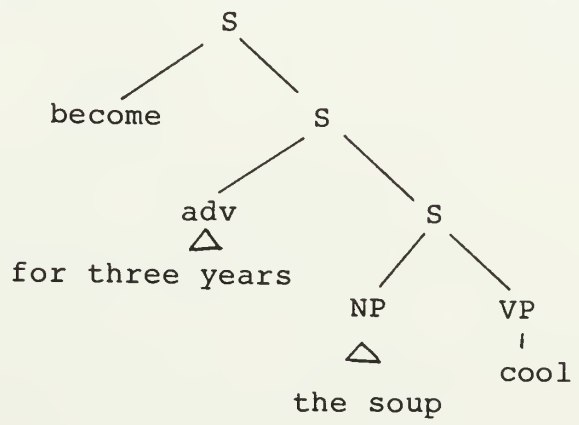
Sentences (112d), (113d) and (114d) sound odd since all of them involve a vague inchoative. Something can not become $wide_c$ repeatedly, where c is fixed. This supports our suggestion that widen, cool and darken in (112c), (113c) and (114c) are derived from comparative inchoatives by something like the iterative operator and not from vague inchoatives.

Notice that sentences (114d) and (113d) may involve a good reading in which the Atlantic ocean remains wide for three years and the soup stays cool for three hours, i.e the time adverbial specifies the duration of the result state. This is not the process reading we are interested in. In (114d) changed to, turned to, but not got give us this good reading. A similar reading where the time adverb specifies the duration of the result state occurs in sentences which involve causatives. Dowty (1979) mentions Binnick, who according to Morgan (1979) and MaCawley (1971; 1973) was the first to notice the following sentence, which is ambiguous between an iterative and a result state reading:

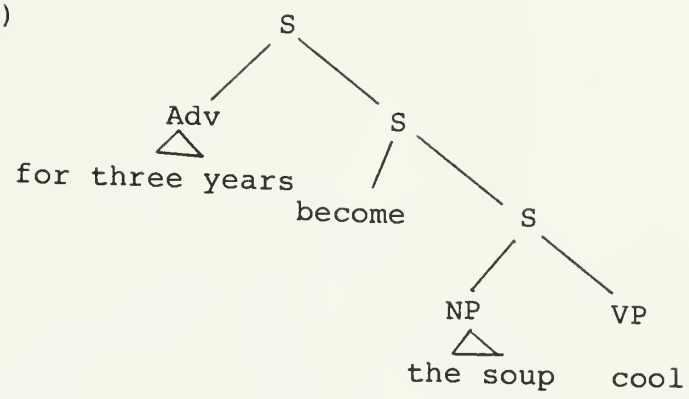
(115) The Sheriff of Nottingham jailed Robin Hood for four years.

In the Generative semantics lexical decomposition analysis of causatives, where jail is analyzed as composed of "cause become x in jail" the iterative reading (in which at various occasions throughout the four years the Sheriff jailed Robin Hood) arises from a structure in which the adverb modifies the highest S, while the result state reading arises from a structure where it modifies a lower S. In the first case the duration of the activity described by the VP cause become x in jail is specified, while in the second case it is that of the state be in jail. The following structures (116) and (117) represent correspondingly the result state and the iterative reading of (112d), (113d) and (114d):

(116)



(117)



Since the meaning of the inchoative process verb cool is different from that of a vague inchoative which is represented in structure (117), it is not surprising that (114d) is bad. On the other hand, when the verb is an event type verb like that in sentences (112a), (113a) and (114a) it can be paraphrased (under one reading) by a vague inchoative verb as in (112b), (113b) and (114b).

We could expect sentences with "become cooler" and durative time adverbials to be perfect, since the meaning of inchoative process verb incorporates that of a comparative inchoative. Consider:

(118) a. The Atlantic ocean widened for three years.

b. The Atlantic ocean became wider for three years.

(119) a. The soup cooled for three hours.

b. The soup became cooler for three hours.

Surprisingly, when read in the iterative sense, the

following sentences sound a bit odd:

(120) ?The Atlantic ocean became more wide for three years.

(121) ?The soup became more cool for three hours.

(122) ?He began to earn more money for three years

When replacing "become more adj" by "become more and more adj" these sentences are good:

(123) The Atlantic ocean became more and more wide for three years.

(124) The soup became more and more cool for three hours.

(125) He began to earn more and more money for three years.

The iterative reading of inchoative process verbs is explained by the existential quantifier over contexts which change throughout the interval. The paraphrase "become more and more wide" implies that such an iterative reading is incorporated in widen. Still, it remains a puzzle why (120)-(122) sound worse than (118)-(119) and (123)-(125) since $\lambda x[(\exists c)\text{Become cool}'_c(x)]$ means become cooler and the interaction of the comparative inchoative with the durative adverb should have implied the process-iterative reading.

Partee has mentioned (personal communication) that it is possible that (120)-(122) are odd due to morphological suppletion facts. Since the verbs wide and cool, when used

for comparison, have the specific adj+er forms wider and cooler, the latter should be used with become rather than the form more+adj. In the case where the adj+er form does not exist in English, as for example *beautifier, the more+adj form can be used with become:

(126) Mary became more beautiful for three years.

Sentences (127),(128) exhibit a similar difficulty:

(127) a. This flower darkened more than that flower.

b. *This flower became dark more than that flower.

c. *This flower became darker more than that flower.

(128) a. This boy grew more than that boy.

b. *This boy became tall more than that boy.

c. *This boy became taller more than that boy.

The oddness of (127b) and (128b) is predicted since once the context of dark'$_c$ is fixed, one flower can not become dark'$_c$ more than the other. The verb in (127c) is an inchoative process verb, and the comparison in these sentences is between the two processes of darkening, not between the two result states. We may say that between the age of twelve and fifteen Dan grew more than between the age of twenty and twenty-three, although when twenty-three years old Dan was

taller than when he was fifteen. Sentences (127c) and (128c) do not imply the reading in which two processes are compared, and as in (120)-(122), they present a difficulty for the analysis of inchoative process verbs in terms of inchoative comparatives.

Partee has also mentioned that increasingly wide, which hardly seems like a predicate of any sort (*The Atlantic Ocean is increasingly wide), inherently has to be linked to gradual change. Sentence (129) seems to have the same meaning as (130) and (131):

(129) The Atlantic Ocean became increasingly wide for three years.

(130) The Atlantic Ocean became wider and wider for three years.

(131) The Atlantic Ocean became more and more wide for three years.

Another issue worth mentioning is the difference between two kinds of inchoative verbs. One of my examples illustrating the possible ambiguity of inchoatives between the vague and the comparative meaning was sentences (58a), (59a) paraphrased by (58c) and (59c). When we replace widen and grow by warm and darken sentences (132a) and (133a) are less good:

(132) a. *The soup was warm and was warming.

b. *The soup was warm and becoming warm.

c. The soup was warm and becoming warmer.

(133) a. *The sky was dark and was darkening.

b. *The sky was dark and becoming dark.

c. The sky was dark and becoming darker.

The oddity of (132b) and (133b) is predicted as is the case in (58b) and (59b), since once the sky is dark'$_c$ relative to some fixed context, it can not become dark'$_c$ again. Sentences (132a) and (133a) which were assumed to be paraphrased by sentences (132c) and (133c) are bad. This is puzzling.

There seems to be a difference between verbs like widen, grow, fatten and verbs like warm, darken and redden. There is no upper bound to the degree of tallness or width of an object relative to a comparison class- any tall object may become taller, but this is not true of predicates like redden, darken. To get the difference one may ask whether a red object may become redder, i.e is there a degree of redness such that an object red to that degree can not become any redder? Intuitively the answer is yes for red and dark and no for wide and grow. At the same time we count something as red in a context even when it has not reached the maximal value of red in that context. Perhaps the fact that something can be red without reaching the maximal value accounts for the good reading of (132c) and (133c). I mentioned previously that we can say that a is a red cloth,

b is a red cloth and a is redder than b. In this case, the comparison class is the set of cloths and one compares between two members in the positive extension of red.

Adding the degree adjective quite makes a difference in the grammaticality of (132a) and (133a), since it implies that the property has not yet reached its upper bound, so the process may still go on.

(134) a. The sky was quite dark and was (still) darkening.

b. *The sky was quite dark and (still) becoming dark.

c. The sky was quite dark and (still) becoming darker.

There are other suggestions in the literature for treating change. In a first attempt Hoepelman (1981) adopted the framework of fuzzy logic to analyze gradual change. He talks of a sentence describing a state of affairs as becoming more and more true. Roughly speaking, a sentence like the door closes is given the anaysis "It becomes more and more true and finally is true that the door closes". Hoepelman later replaced the framework of fuzzy logic with a new one, which analyzed change in terms of comparison (1982). The notion of becoming is defined in terms of MORE and LESS. If something changes it has a certain property to a greater or lesser degree than it had before. To evaluate John grew, different stages of John must be compared, and

this is where Hoepelman introduces individual concepts into his semantics.

In treating process verbs our intuition was similar to that of Hoepelman, however we further extended the discussion and provided an analysis of inchoatives in general. We have pointed to a general ambiguity in the case of inchoatives which has to do with the way we view change, and provided plenty of evidence to support it. We have also shown how the notion of change incorporated in the meaning of inchoative process verbs distinguishes them from process verbs, whose meaning does not involve change, and how the gap problem interferes with that difference. In the next chapter we will see that time and change are not the only aspectual notions which can be looked at as either punctual or gradual in metaphysics and language.

4. Conceptual Puzzles

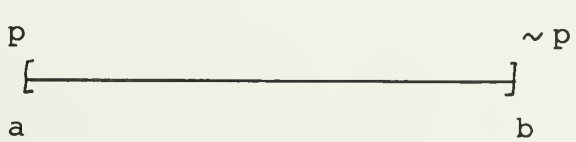
4.1. On Change and Time

The Become operator was introduced in our two lexical rules which derive absolute/vague inchoatives and comparative inchoatives and its semantics has not been discussed yet. Now that we are familiar with different kinds of inchoatives whose meaning, we said, involve abrupt and gradual changes of state, we can turn to the more general issue which seems to underly any talk of change.

There is an old argument for the contradictoriness of change taking place in time (see discussion of it in Van Benthem (1983) and Kamp (1980). Whenever there is a change there is a succession of incompatible events and where there is a succession of incompatible events there is change. It is argued that when a state p is followed by an incompatible state q, which is $\sim p$, then a change occurs. The question is about the time of its occurence. It could not be before p has ended and not after q has come about. Two principles seem to be in conflict when dealing with the time of change from p to $\sim p$: that of bivalence which states that at any time t either p obtains or $\sim p$ obtains and that of incompatability which asserts that at the time of change from p to q neither p nor q obtain. These two principles exclude the possibility of change occuring at any time since the first requires that either p or $\sim p$ should hold at such a time and the second requires that neither of them should hold.

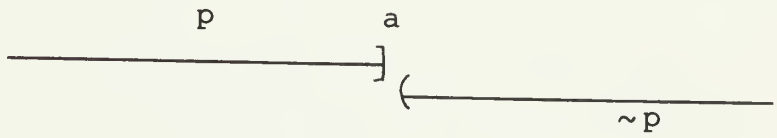
When time is discrete such a problem does not arise since if a is the last point where p holds, and b is the first point where $\sim p$ holds, there is no point between a and b and the question about the time of change does not arise.

(135)



In this case change is instantaneous and the borderline between predicates denoting states is sharp. When time is dense it seems more problematic. However, there is a way to attack the puzzle. In (136)

(136)



there is no point between the last point where p holds and the first point where ~p holds, for there is no first point where ~p holds. Things are similar when we take the notion of truth at an interval rather than at moments as basic. If ϕ is bivalent and time is discrete the minimal interval where change occurs will contain only two moments. In chapter III, which deals with the progressive, we will discuss the advantages of interval semantics over point semantics.

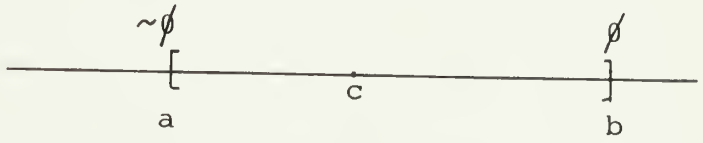
Dowty's (1979) truth condition for [Become ϕ] given below involves the notion of an interval.

(137) [Become ϕ] is true at I iff (1) there is an interval j containing the initial bound of I such that ~ϕ is true at J, (2) there is an interval K containing the final bound of I such that ϕ is true at K, and (3) there is no non-empty interval I' such that I' $\subset$ I and conditions (1) and (2) hold for I' as well as I.

Dowty introduces the third condition to prevent sentences like the door closed from being true of any interval whatever as long as the interval contains the first moment at which the door was closed. One wants to limit the truth of the door closes to the smallest interval over which the change occured. Dowty suggests that perhaps the third condition should not be part of the definition of [Become ϕ] but rather understood as a felicity condition on the assertion which follows from Grice's conversation maxims.[10]

Let's consider the case where ϕ is bivalent and

(138)



at a $\sim\phi$ holds. Suppose $c \neq a$, $c \neq b$, $c \in [a,b]$. Since ϕ is bivalent, either ϕ at c or $\sim\phi$ at c. If ϕ at c then [a,b] does not satisfy (137), since [a,c] is a smaller interval which satisfies (137). If $\sim\phi$ at c then [a,b] does not satisfy (137) since [c,b] is a smaller interval satisfying (137). But when ϕ is not bivalent (and time is discrete) there may be other moments contained in [a,b] for which ϕ is undefined. According to (137) the sentence It turned red is true with respect to an interval [a,b] where at a it is red is false (let us assume it is orange) and at b it is true.

(137) does not specify what must occur at the times between a and b. Also, that a change from orange to red can be defined with respect to a minimal interval [a,b], as is required by (137), is not so obvious. It is not clear what is the minimal interval at which sentences containing fuzzy predicates, like the inchoatives, are true. Inchoatives may be used in the present progressive, for example, It is fading, the soup is cooling, John is dying. In all these cases there is a transition from a state p to an incompatible state q, separated by intermediate states which also begin and end and thus also involve the question of the time of change. When the color of the sun changes from orange to red it is difficult to determine at what time it ceases to be orange and becomes red since the borderline between orange and red is fuzzy. Kamp (1979), (1980) discussed at length these issues, which directly lead to questions about the nature of time. Kamp mentions two views on time- one taking time as the totality of temporal relations between events and processes which constitute the history of the world, and the other taking statements about time to be in last analysis complex claims about our experiences. What is common to both views is that they take as primary certain entities (physical events or mental experiences) of finite duration, i.e events. According to Kamp, Wiener has shown how from events of finite duration,

and the temporal relations by which they are recognized, one can construct a linear order of instants.

Given the meaning of the precedence and overlap relations Kamp quotes seven postulates. However, there are some difficulties with the last one:

(139) $(\forall x)(\forall y)(x \prec y \vee xOy \vee y \prec x)$

(where x and y are individual variables over events and $\prec$,O are correspondently the relations of complete precedence and temporal overlap). Kamp gives examples which illustrate the indeterminancy of the relations of temporal overlap and precedence involved in (139). This is because of the vagueness of the concept used to individuate events, so the structure of time can not be determined by events with fixed relations. (139) can be satisfied only when the vagueness of event individuation disappears.

So far we have discussed the problem of the minimal interval of change when fuzzy predicates are involved. Since some of the inchoatives we discussed are vague and others are not, we would like to see how change interferes with each kind of inchoative and summarize what we have said so far.

In the case of absolute inchoatives, where time is discrete, there is a first moment b such that at any time before b $\sim\phi$, and at b ϕ. In this case ϕ is bivalent and

change is instantaneous. When time is dense, such a minimal interval does not exist. Let us assume there is a single moment b where ϕ is true and [a,b] is the minimal interval where change occurs. By hypothesis, for any a before b $\sim\phi$ holds. Since time is dense, there is an a' between a and b and by hypothesis $\sim\phi$ is true at a' which precedes b. Therefore, [a,b] is not the minimal interval where change occurs. This shows that Dowty's definition of [Become ϕ] is too strong since it works only when time is discrete. When time is dense one would like to get rid of the minimal interval condition.

In the case of vague inchoatives, if the vagueness of the adjective is resolved by the context, then there is a minimal interval where the instantaneous change from $\sim\phi$ to ϕ occurs, as was the case with absolute inchoatives. Whenever the vagueness of the adjective is resolved but ϕ is not bivalent, i.e there is a truth value gap, the minimal interval depends on the context picked up.

What about comparative inchoatives? There is no minimal interval where the soup became warmer is true. The soup became warmer is consistent with a situation where the soup reached the maximal value of warm for soups and also where it has warmed by one degree only or anything between the two.

4.2. The Logical Form of Verbs of Change

Do all events involve a change of states? This is not implied by definition (137), where ϕ can be of any aspectual kind. Some achievements seem to involve a change from a state to a process, like the Hebrew verb parax, which means "began to fly"; "took off (bird, insect)". Von Wright (1963) mentioned that events may be transitions from a state to a process, from a process to a state, from a process to another process or from a state of a process to another state of the same process, for example, from quicker to slower or from louder to weaker. The four possibilities of transitions among states and processes are given below:

	Verb
1. state to state	cool
2. state to process	began to fly ("parax" in Hebrew)
3. process to state	–
4. process to process	–

There is no English verb to my knowledge, which denotes a change from a process to a process. As I mentioned in I.3., Dowty holds that achievements may stand for "an inchoation of an activity", with germinate ("become plus grow") as an example. One should not confuse an inchoation of a process with a process consisting of inchoation, as in the case of inchoative process verbs. The complex VPs begin running, begin moving also constitute examples of verbs of class (2).

John stopped walking and began running exemplifies a change from one process to another. I am unaware of any example of a simple Hebrew verb which denotes this kind of complex change.

The verbs stop, end may be examples of a change from a process to a state although stop seems to imply doing something. It is hard to determine whether the fact that stop follows a process of walking or running is part of its meaning or a presupposition. There are few examples of verbs of category (2) and (3) and these verbs are not derived from adjectives.

Dealing with verbs of class (2) and (3), we must not confuse our linguistic and conceptual intuitions. The assumption that there are states of which begin flying or begin growing are the negation is a purely conceptual one. Since our decision about the kind of change expressed by the verbs in category (2) and (3) is often based on conceptual intuitions rather than linguistic ones (binary adjectives like small and tall can be considered as linguistic aspectual evidence), indeterminancy may arise in many cases. To give an example, is begin running a transition from a state to a process or from a process to a process? Stop running can be argued to be a transition from a process to a state since the verb run is a process.

Questions may be raised about a verb like die. Because

of the existence of the adjective alive, it is tempting to derive die by

(140) $\lambda x[\text{Become}[\text{not}(\text{alive}'(x))]]$.

and regard it as a transition of states. The following argument, however, may be given against it: die has the same meaning as stop living and as stop being alive. The first expression demonstrates linguistically and conceptually a transition from a process to a state, while the second one demonstrates a transition of states. Since stop living and stop being alive have the same meaning, they should also be of the same aspectual type- that of statives. We see that in the case of some verbs, there is no way to determine what kind of transitions underlie their meanings.

In our two lexical rules deriving inchoatives, only the output state denoted by an adjective translation α is given. α may denote a certain state or its negation and the inchoatives formed from them are "opposite". There are many such examples in Hebrew: katan "became small" vs. gadal "became tall"; hitraxev "became wide" vs. hitkacer "became narrow"; hismin "became fat" vs. hirza "became thin". Definition (137) specifies a change from $\sim\phi$ to ϕ (and no restriction on ϕ's aspectual type is given). I have said that $\sim\phi$ may be of a different aspectual type than ϕ, although it is difficult to prove it (in the same way it is

difficult to prove that they are of the same aspectual type). When α is an adjective, the state it denotes may be either the output of the transition from a process to a state, or an output of a transition of states.

FOOTNOTES

[1]Kenny (1963:173-183) provides references to and an exegesis of Aristotle's discussion of different classes of verbs.

[2]Vendler's accomplishments are Kenny's performatives and Ryle's achievements with an associated task. Kenny discriminated between achievements with an associated task and purely lucky achievements.

[3]In this work * indicates that the sentence marked by it is ungrammatical. ? indicates that speakers differ in their acceptability judgements of the sentence and ?? means less grammatical than ?.

[4]Here is one definition he provides: $Sim(e,e') =_{def}$ for all eventualities e'', (while(e'',e) iff while (e'',e')) and (while(e,e'') iff while(e',e'')).

[5]This and other details of his theory are given in his 1977 manuscript.

[6]Achievements satisfy some stative tests and fail to satisfy others.

[7]For a discussion of interval semantics see chapter III, section 1.

[8]An E-type pronoun is a plural pronoun referring back to a group of individuals. Gareth Evans introduced this term and discussed the issue in "Pronouns", Linguistic Inquiry 11.2:337-362.

[9]The problem of the possible length of the gaps in the interval at which a sentence is true is different from that of the "relevant moments" mentioned by Dowty. We say of John that he worked in the factory for the last year and do not imply by it that he worked at weekends, holidays or during the nights. If the universal quantifier stands for the durative time adverb, then the relevant moments it quantifies over are the standard work hours in John's factory. According to Dowty, if we are to use the universal quantifier to represent durative adverbs, then the moments it quantifies over are relevant moments which are vaguely specified and contextually determined. After the relevant moments are determined by the context we can still inquire about the possible length of the gaps in the interval which consists of the relevant moments: if John stayed in the hospital for eight months during the last year and spent the

rest of it at the factory at standard work hours, it seems inappropriate to say of him that he worked at the factory for the last year. In this section we deal with the problem of the length of the gaps and not with that of the relevant moments.

[10] Partee has mentioned to me that definition (137) would not work for the interval [b,b]. According to definition (137), [Become ϕ] is true at [b,b] iff:

(1) $\exists$ j containing b such that $\sim\phi$ is true at j.

(2) $\exists$ k containing b such that ϕ is true at k.

It follows from (1) that $\sim\phi$ is true at b, and from (2) that ϕ is true at b. So, contradiction. Thus for definition (137) [a,b] can not be a=b.

C H A P T E R II

CAUSATIVE VERBS AND ASPECTUALITY

1. Accomplishments, Causatives and Aspect

1.1. Not all Causatives are Event Type Verbs

In my brief review of verb classification I discussed accomplishment verbs and the linguistic tests which determine this class. The activity involved in building a house or drawing a circle is that of bringing about some result state- that of a house having been built or a circle having been drawn. In chapter I in my discussion of inchoatives, I discussed the operator Become which is present in the logical representation of achievement sentences. The logical representation of accomplishment sentences consists partially of that of achievement sentences and, as is the case with the latter, also involves the operator Become. In his aspect calculus Dowty suggests constructing all accomplishments as having a logical structure [ϕ CAUSE ψ] where ϕ and ψ are sentences. He does not place any restrictions on the aspectual type of ϕ and ψ but notes that in most cases ϕ is a become-sentence or contains an activity predicate, and ψ is a

become-sentence. The sentence John killed Bill has the following logical structure:

(1) ([John do something] CAUSE [Become not [Bill is alive]])

The motivation for analyzing CAUSE as a bi-sentential operator will be discussed in 1.2.

Dowty suggests analyzing all accomplishment verbs as having a CAUSE operator in their logical structure. In one place he says (Dowty 1979; pg.106): "As has often been noticed, natural language causative structures (accomplishment sentences) ordinarily single out....", and elsewhere he refers to a linguistic class of verbs as "causative/accomplishments" (Dowty 1979; pg.109). Nowhere does he claim explicitly that accomplishments and causatives are co-extensive (although by refering to a class of verbs as "causatives/accomplishments" he may imply this). He only insists that all accomplishments have in their logical structure a CAUSE operator. If we could find examples of causative verbs which aspectually are not classified as accomplishments (which are event-type verbs), it would show that causatives and accomplishments are not co-extensive. Such verbs exist, and many important issues concerning causation and aspect in natural language arise when dealing with them. We would like to discuss these issues in this chapter. Our discussion of causative verbs (a great number

of which are accomplishments) is related to many points raised in chapter I, where change and time were discussed.

I have already noted that Dowty does not place any restrictions on the aspectual type of two sentences combined by the CAUSE operator. He lists the following kinds of accomplishment sentences:

(A) Non-agentive accomplishment sentences which have two become-sentence clauses as in the door's opening causes the lamp to fall down.

(B) Non-intentional agentive accomplishments where the first clause is an activity sentence and the second one an accomplishment as in John broke the window.

(C) Agentive accomplishments with secondary agent as in John forced Bill to speak and intentional agentive accomplishments as in John murdered Bill.

Somewhere else he mentions Fillmore's example (1971) of stative causative sentences like Mary's living nearby causes John to prefer his neighborhood. There is no English verb which is a stative causative, just as there is no English verb which exemplifies the first class of accomplishments given above.

Accomplishments and causatives are not co-extensive. A group of causatives behave aspectually like processes. Consider:

(2) John galloped the horse for three hours.

(3) The mother fed her baby for half an hour.

In line with what was said before, the logical representation of sentence (4)

(4) John galloped the horse.

should be:

(5) [[John do something] CAUSE [the horse gallop]]

The only reading of sentence (4) is the process one. Sentence (4) can not be uttered in a situation where John did something abruptly which made the horse start galloping, like for example pricking his back once with a spear. To describe such a situation a periphrastic causative must be employed as in (6):

(6) John made the horse gallop.

The activity specified by the causative verb is almost always that of the subject of its second underlying clause. In most cases this subject undergoes a change of state but sometimes it is the agent of the activity described by the causative verb. The causative verbs gallop, walk constitute such examples where their IV counterparts have agentive subjects:

(7) The horse galloped.

(8) The dog walked.

The activity of the subject of the sentence in the first clause underlying the causative verb is usually unspecified. Mary can kill Bill in many ways: she may poison him, strangle him, put a bullet through his chest or push him through a window on the 70th floor of the Empire State building. The consequences of all these vicious acts are one- Bill undergoes a change of state from being alive to being not alive. The activity of John in sentence (4) is unspecified as well: he might have been sitting on the horse's back kicking him with the spurs on his boots or running beside his horse whipping it occasionally. All the possible contextualizations of (4) involve an activity on John's part which is durative in nature. Sentence (4) can not be uttered in a situation where John fired a single shot in the air as a consequence of which his horse started galloping; nor in one in which he kicks his horse continuously, but it jumps only once. The sentences in the two clauses underlying the causatives gallop and walk are process type one. Roughly speaking, the causal connection between John's kicking the horse and its galloping as a result occurs repeatedly or continuously. A formal explication of this is given in section 2. of this chapter.

The class of verbs discussed here, which we will call "causative process verbs" (CPV), is very small in English, as is illustrated in the following list of transitive verbs:

(9) gallop
feed
run
bounce
walk
roll

In Hebrew, the class of CPV is somewhat larger, but still small when considering the total number of Hebrew verbs. What is of interest to us is the fact that Hebrew CPV constitute a morphological class. The list of Hebrew CPV is:

(10)	hidhir	'gallop'
	heric	'made run'
	hiska	'made drink'
	he'exil	'made eat'
	hikpic	'bounced'
	gilgel	'made roll'
	holix	'made walk'
	hirkid	'made dance'
	hirkiv	'made ride'
	?hilbiš	'dressed'
	?hifšit	'undressed'

To show that Hebrew CPV form a morphological natural class, a brief introduction to the Hebrew binyanim system must be provided.

There are seven morphological verb patterns (conjugations or binyanim) in Hebrew. A verbal root normally consists of three consonants, and can be realized in one or

more of the seven binyanim. The root p,',l (actually p,ʕ,l, synchronically realized as p,',l owing to the merger of ʕ with ') is used traditionally as a prototype, where p stands for the first radical, ' the second one and l the third. The stem forms of the seven binyanim are:

(11)
CaCaC	- pa'al
ni+CCaC	- nif'al
CiCeC	- pi'el
CuCaC	- pu'al
hit+CaCeC	- hitpa'el
hu+CCal	- huf'al

Adjectives and nouns follow other morphological patterns (miskalim) whose number is greater than that of the binyanim. Verbs can only be realized in one or more of the seven binyanim. The binyanim tend to carry certain syntactic and semantic characterizations described in table 2. More detailed tables which characterize the binyanim will be given in chapter IV 1.2., where I discuss the interaction of the Hebrew binyanim and aspect.

Table 2. The Hebrew Binyanim (I)

name of binyan	syntactic function	meaning	example
pa'al	base form ±[transitive]		šamar 'guarded'
nif'al	passive of pa'al -[transitive]	inchoatives	nexlaš 'became week'
pi'el	+[transitive]	causativization repetition intensifying	šilem 'paid'
pu'al	passive of pi'el		sulam 'was paid'
hitpa'el	-[transitive]	inchoative reflexive reciprocal	hitraxec 'washed himself'
hif'il	normally transitive	causative inchoative	hiškiv 'made lie down'
huf'al	passive of hif'il		huškav 'was laid down'

Almost all traditional Hebrew linguists agree that verbs occurring in the binyanim bear partially systematic semantic and syntactic relations to the root. The evidence provided in Chapter IV shows these regularities can not be captured

by syntactic rules, but at the same time, one wants to represent them as part of the speaker's knowledge of Hebrew.

Bolozky and Saad (1983) have shown how different semantic properties are distributed among verb-patterns (binyanim) in Arabic and Hebrew. One of the semantic properties they discuss is what they call "activity". An active verb is a transitive verb whose object is agentive (gallop) and a non-active verb is a TV with a non-agentive object (wash). Arabic and Hebrew demonstrate two morphological causative verb patterns: Arabic 'afʕala/Hebrew hif'il and Arabic faʕʕala/Hebrew pi'el. They claim that hif'il is the unmarked causative form and that it is not restricted with respect to causativization. There exist non-active verbs which are causativizable in pi'el only, and non-active verbs which are causativizable in hif'il only. Some non-active verbs are causativizable in both hif'il and pi'el. The distribution of causativizable active verbs between pi'el and hif'il is different. There are active verbs causativizable in hif'il only and some active verbs which are causativizable in both. But there are no active verbs which are causativizable only in pi'el. The same generalization about the distribution of causativizable active and non-active verbs among the binyanim holds also for Arabic where 'afʕala corresponds to Hebrew hif'il and faʕʕala to Hebrew pi'el.

To make this clearer, tables 3 and 4 contain the distinctions made by Bolozky and Saad and illustrates them with examples of Hebrew verbs which appear in their lists.

Table 3. Non-Active Verbs

base form	causativizable in pi'el only	causativizable in hif'il only	causativizable in both
ratav 'was wet'		hirtiv 'made wet'	
balat 'stood out'		hivlit 'made stand out'	
yafe 'be beatiful'	yipa 'beautified'		
kava 'died out'	kiba 'put out (fire)'		
rava 'quenched'			riva hirva 'saturated'
xay 'lived'			hexya xiya 'revived'

Table 4. Active Verbs

base form	causativizable in pi'el only	causativizable in hif'il only	causativizable in both
ba 'came'		hevi' 'brought'	
halax 'went'		holix 'made walk'	
	NONE		
yaga 'labored'			hogia 'made yigea tire out'
karav 'drew close'			hikriv 'made kerev draw close'

hif'il is the unmarked causative binyan for active verbs since there are no active verbs causativizable only in pi'el and only few active verbs are causativizable in both.

The fact that most process verbs have agentive subjects led some linguists and philosophers to define process verbs in terms of agency. However, the property of subintervality and agency must not be confused- the first has to do with properties of time and the second with notions such as volition, intention, effectiveness etc. The set of process verbs and that of agentive verbs are not co-extensive.

Bolozky has pointed out that causatives with agentive objects (and also agentive subjects) are conjugated in

hif'il (and a few verbs in both hif'il and pi'el). Similarly, Hebrew CPV are exclusively conjugated in hif'il and in this sense, form a morphological class in Hebrew. We see that Hebrew morphology treats causative verbs which are processes, and causative verbs with an agentive object and an agentive subject, in the same way by assigning them to the same binyan. There are interesting relations between the class of process verbs and the class of active verbs but, as remarked above, they are not co-extensive. There are causative active verbs which are not CPV, and also causative process verbs with non agentive objects (non active verbs). hekim 'made stand up' and he'ziv are examples of the first kind: the subjects of kam 'stood up' and 'azav 'left' are agentive but the activity described by the verbs is not durative. On the other hand, hikpic 'bounced', hilbiš 'dressed' and hifšit 'undressed' are CPV which are non-active. In John hikpic et hakadur 'John bounced the ball', the ball is not an agent, but the activity it is involved in is durative (an iterative event). In hayalda hilbiša et habuba 'the girl dressed the doll', the object of the verb is inanimate, so it is not agentive, though it is involved in a process. (There is a sense of perfection in the meaning of dressing and undressing so hilbiš and hifšit may by thought of as non-specific between a process and an event reading).

Notice also that he'exil 'fed' does not always behave as a CPV. The sentence ha'em he'exila et haxatul 'the mother fed the cat' can describe a situation where the mother fills the cat's plate with Purina before it starts eating. The mother's act is punctual, and even if it takes time it does not occur at the same period at which the cat eats Purina.

In Chapter I we discussed inchoatives which behave aspectually like process verbs. We claimed these verbs are derived from vague adjectives and have a comparative component in their logical representation. We distinguished between inchoative process verbs such as cool, warm, redden which involve change, and primitive process verbs like walk and run. There are many causatives which have a process inchoative verb in their second clause, such as cool_{TV}, warm_{TV} and redden_{TV}.

Verbs which are formed by a causativization of inchoative process verbs are usually conjugated in pi'el. Pi'el is the causativization conjugation of verbs in hitpa'el. One of the meanings of verbs in hitpa'el is that of inchoation (see chapter IV section 2.1.). Only a few such causatives (let us call them 'inchoative process causatives') may come in hif'il and they are derived from color term predicates like he'edim 'reddened $_{TV}$' or human quality properties like hišmin 'fattened$_{TV}$'. Examples of process inchoative causatives and the verbs they are derived

from are given below:

(12)

pi'el		hitpa'el	
kerer	'made cool'	hitkarer	'became cool'
ximem	'made warm'	hitxamem	'became warm'
kicer	'made short'	hitkacer	'became short'
niven	'made become decayed'	hitnaven	'became decay'
piteax	'made be developed'	hitpateax	'became developed'
xizek	'made strong'	hitxazek	'became strong'

We have here another case where Hebrew morphology distinguishes between CPV with a "primitive" process in their second clause, which come in hif'il only, and causative sentences with a process inchoative in their second clause, which usually come in pi'el.

To conclude, table 5 illustrates the distribution of different kinds of Hebrew causative verbs in the binyanim:

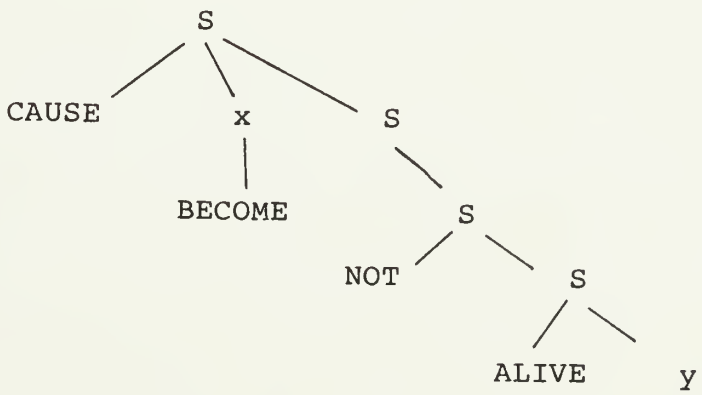
Table 5. The Distribution of Hebrew Causatives

Basic Form	Derived Forms	
pa'al	hif'il	pi'el
event causative verbs	event causative verbs	event causative verbs
	CPV	causatives whose second clause is an inchoative process verb

1.2. Evidence that Accomplishments Analyzed by CAUSE are Bi-Sentential

Generative semanticists proposed a level of linguistic representation which carries the meaning of a sentence. At that level abstract lexical items may be found that are not English words. In the course of a derivation individual lexical items replace parts of the underlying tree. Inchoatives and causatives were of major interest. McCawley (1968) suggested analyzing kill into the following components:

(13)



Different theories argued for different transformations, grouping underlying abstract elements into constituents before lexical insertion took place.

Rather than discuss these proposals, I will review the linguistic evidence which Dowty presents for his reconstruction of the bi-sentential analysis; his arguments were mainly borrowed from Generative Semantics. An

accomplishment construction known in traditional grammar as factitive is one of them. In these constructions, an activity verb combines with an adjective and an object NP to give an accomplishment, where the adjective describes the result state of the derived object. Consider:

(14) John hammered the metal flat.

By the analysis of accomplishments given above, sentence (10) could have the following representation:

(15) [[John hammered the metal] CAUSE
[Become [the metal flat]]

Other examples of the same kind are:

(16) Bill hung the picture straight.

(17) Peter painted the wall blue.

(18) Mary washed the dishes clean.

(19) The Boy Scouts beat the snails dead.

Another case mentioned by Dowty which calls for a bi-sentential analysis of accomplishments are those verbs which form a subset of verb particle constructions. The particle in example (20)-(21) expresses the location of the direct object, which is a consequence of the activity described by the verb. In English these sentences can be varied in two ways: the activity can be held constant and the result state varied, or the result state held constant

while the activity varies. Dowty gives the following examples:

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

(21) put NP away
throw NP away
send NP away
drive NP away
call NP away

Examples (20) and (21) suggest that verb particle constructions should be treated compositionally as consisting of an activity verb and a result state.

Other evidence to support the bi-sentential analysis of accomplishments is provided by examples of anaphora in some constructions. Jerry Fodor (1970), arguing against the transformational anaysis of verbs like melt and kill, mentions some traditional arguments used to show that these verbs are derived from cause to melt and cause to die. He mentions Lakoff (1965) who suggested that sentences like (22) derive from deep structures like (23):

(22) Floyd melted the glass.

(23) (Floyed cause (the glass melt))

Fodor noticed that (24) is ambiguous between two readings in just the way that the derivation of (22) from (23) would

predict: that what surprised the speaker is either that Floyed melted the glass or that what surprised the speaker is that the glass melted.

(24) Floyed melted the glass $\left\{\begin{matrix}\text{and that}\\ \text{and it}\\ \text{which}\end{matrix}\right\}$ surprised me.

Fodor notes that a similar argument holds for the "do so" construction associated with (22):

(25) Floyed melted the glass though it surprised me that <u>he</u> would do so.

(26) Floyed melted the glass though it surprised me that <u>it</u> would do so.

The <u>do so</u> in (25) replaces the matrix VP 'cause to melt' and in (26) it replaces the VP in the constituent sentence 'the glass melt'. Fodor noticed that such examples can not be formed with a verb like <u>kill</u>, which morphologically is unrelated to the intransitive verb <u>die</u>. Fodor raised objections to the transformational analysis of <u>melt</u> and <u>kill</u>, but did not provide an alternative explanation for examples (22)-(26), which encourage the analysis of many accomplishments with a bi-sentential abstract CAUSE operator.

Examples of adverb scope provide further evidence for the lexical decomposition of accomplishments. Dowty mentions Binnick who gave the following example:

(27) The sheriff of Nottingham jailed Robin Hood for four years.

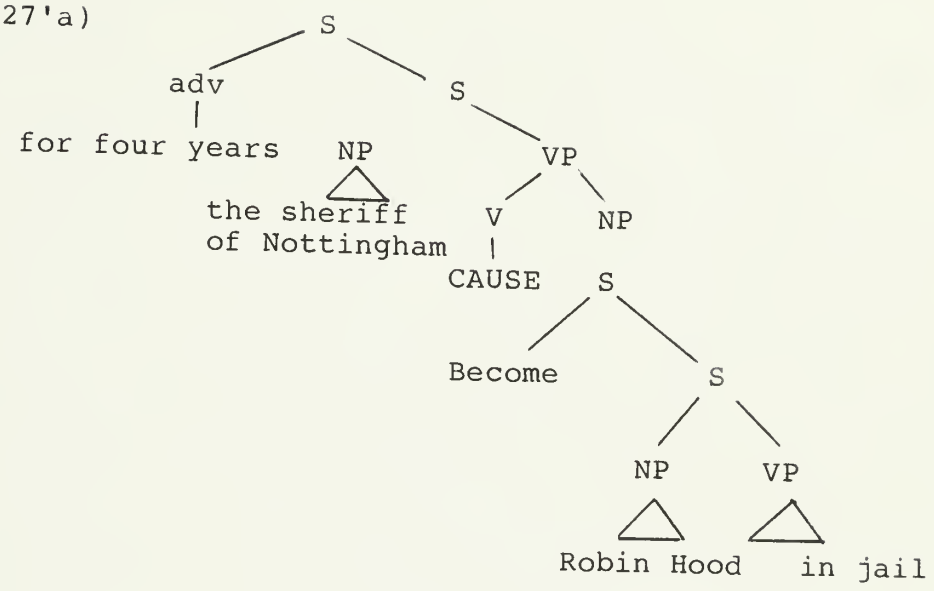
and noticed that this sentence has a durative reading (27a) as well as an internal one (27b):

(27a) The sheriff of Nottingham spent four years bringing it about that Robin Hood was in jail.

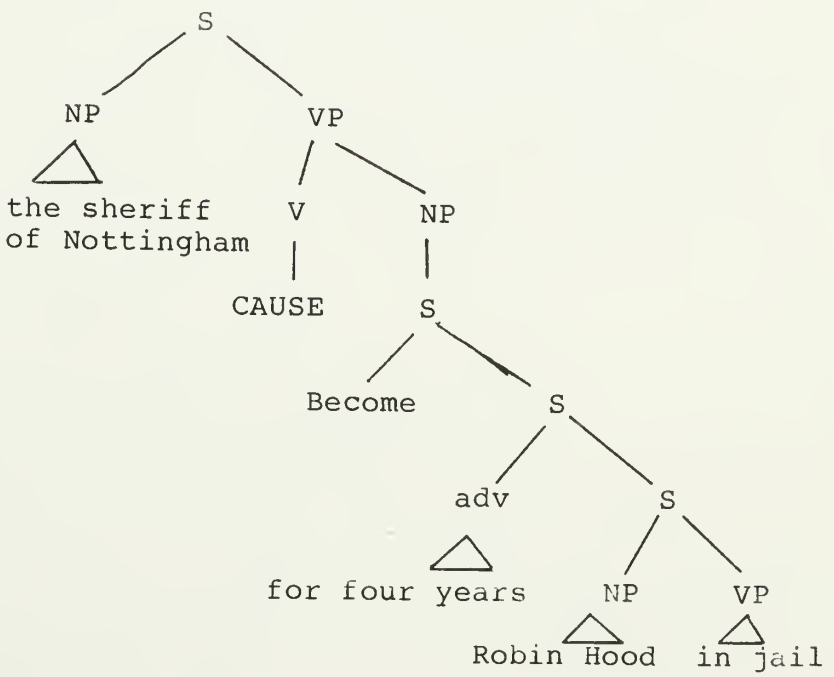
(27b) The sheriff of Nottingham brought it about that for four years Robin-Hood was in jail.

Dowty notes that (27a) may have in addition to the durative reading, an iterative one- according to which on multiple occasions throughout the four years, the sheriff of Nottingham jailed Robin Hood. The adverb in the durative reading specifies the time of the action denoted by the verb, and the adverb in the internal reading specifies the time through which the result state obtained. Given the Generative Semantics framework, Dowty suggests the following two structures to represent correspondingly the durative and internal readings:

(27'a)


S
adv
S
for four years
NP
VP
the sheriff
of Nottingham
V
NP
CAUSE
S
Become
S
NP
VP
Robin Hood
in jail

(27'b)


S
NP
VP
the sheriff
of Nottingham
V
NP
CAUSE
S
Become
S
adv
S
for four years
NP
VP
Robin Hood
in jail

Dowty mentioned other examples of adverbial scope given in the literature:

(28) John closed the door again.

(29) John lent his bicycle to Bill until tomorrow.

Sentence (28) has an external iterative reading, and an internal in which John caused the door to be again in a closed state (he need not have been the agent who closed it before). The durative reading does not exist, since again is a point-time adverbial which only implies that John closed the door at least once before. In (29), the future adverb until appears with the past tense verb lent. The failure of tense-adverb agreement can be explained by a decompositional analysis in which the adverb until modifies the result state clause as specified in (29'):

(29') John caused Bill to have possession of his bicycle untill tomorrow.

Dowty points out that the ambiguity involved in sentences like (27)-(29) is a structural one, since the internal reading is present only when the adverb appears at the end of the sentence. When the adverb is preposed, the result state reading is lost and only the external one remains:

(30) For four years the sheriff of Nottingham jailed Robin Hood.

(31) Again John closed the door.

(32) *Until tomorrow John lent his bicycle to Bill.

It is not so clear to me that a durative reading is involved in (27a) in addition to an iterative one. In the case of again in sentence (28), the activity of the subject can be iterated as well as the result state. I will replace the terminology durative/internal by external/result state readings.

Dowty attributes to Bennett the observation of a possible intentional interpretation of the result state reading. The result state reading of (27b) may refer to the length of time the agent intended the result of his action to last, and not to the length of time that Robin Hood remained in jail. To test this he constructs the following situation: imagine that John places a cake in the oven with the intention of leaving it there for forty five minutes. Mary enters the kitchen shortly after John left it and removes the cake ten minutes after it was put in the oven. The question is whether (33) is true when uttered at that situation:

(33) John put the cake in the oven for forty five minutes.

Dowty reports that speakers differ in their judgements of (33) uttered in the above context. The fact that some speakers accept (33) should not be taken as counterevidence

to the compositional analysis of accomplishments, since the scope of the durative adverb in (33) is still the intended result of the action and not the act of putting the cake in the oven. He noticed furthermore that the external/result state ambiguity can not be found in sentences with statives and process verbs:[1]

(40) John loved his wife until her death.

(41) The world champion ran the marathon again.

(42) The wounded soldier stayed at the hospital for five months.

In Hebrew a genuine ambiguity exists in the case of sentence (43) which is the Hebrew equivalent of sentence (27). The same ambiguity of adverb scope demonstrated in (27) occurs also in Hebrew with the durative time adverbial phrase bemešex. Hebrew has an additional durative time adverbial phrase lemešex which occurs only with the result state reading;

(43) hašerif šel Nottingham kala et Robin Hood bemešex arba šanim (ambiguous).

"The sheriff of Nottingham jailed Robin Hood for four years".

(44) hašerif šel Nottingham Kala et Robin Hood lemešex arba šanim (result state reading only).

"The sheriff of Nottingham jailed Robin Hood for four years".

be, le are Hebrew prepositional phrases which are cliticized to object NP's like in beganim 'in parks' and leganim 'to parks'. be is a prepositional phrase which usually means in as in hasfarim sgurim beargazim kvedim "The books are locked in heavy boxes". le is a directional preposition like in halaxti leganim ciburiyim "I went to public parks" or hikdašti et hasefer leyeladot ceirot "I dedicated the book to young girls". In colloquial Hebrew one may omit mešex 'duration' in lemešex and cliticize le to the object. Consider (44'), which like (44) has only the result state reading:

(44') hašerif šel Nottingham kala et Robin Hood learba šanim.

"The sheriff of Nottingham jailed Robin-Hood for four years".

In English when the adverb "for four years" is preposed the result state reading is lost; the same is true for Hebrew when preposing bemešex. When lemešex is preposed, the sentence sounds bad; this is predicted since lemešex only allows the result state reading:

(45) bemešex arba šanim hašerif šel Nottingham kala et Robin Hood (external reading only).

(46) *lemešex arba šanim hašerif šel Nottingham kala et Robin Hood.

As in English, Hebrew also allows the intentional result

state reading. lemešex may specify either the duration of the result state or the agent's intention as to its duration. Sentence (47) does not have the internal reading when uttered in a situation where Mary takes the cake out of the oven after John had put it there. Sentence (47) is false when uttered in such a situation.

(47) John sam et hauga batanur bemešex šaloš šaot.
"John put the cake in the oven for three hours".

However, (48) uttered under the same circumstances is fine:

(48) John sam et hauga batanur lemešex šaloš šaot.
"John put the cake in the oven for three hours".

This suggests perhaps that Hebrew has a genuine ambiguity between the intentional result state reading and the non-intentional one.

Can we make the generalization that lemešex occurs with the intensional result state reading only while bemešex occurs with the non-intentional one? To answer it we must examine sentences with lemešex with subjects which lack intentions. Consider (49)-(51):

(49) a. ahavat John hirgiza et Mary bemešex
šaloš šanim (only external reading).

b. *ahavat John hirgiza et Mary lemešex šaloš šanim.

"John's love irritated Mary for three years".

(50) *John hirgiz et Mary lemešex šaloš šanim.

"John irritated Mary for three years"

(51) a. haruax kerera et hamarak bemešex šaloš šaot (only external reading).

b. *haruax kerera et hamarak lemešex šalos šaot.

"The wind cooled the soup for three hours".

(52) *Dan kerer et hamarak lemešex šaloś šaot.

"Dan cooled the soup for three hours".

(49a) and (51a) are not ambiguous, and allow only the external reading (which in this case can be either iterative or durative depending on how one chooses to view change). The result state reading is blocked whether the agent is human (has intentions) or not. Both the intentional and the non-intentional readings of the result state are bad. But consider the following examples:

(53) a. ?Dan hiš'ir et hagufa al gdat-hanahar bemešex šaloš šaot.

b. Dan hiš'ir et hagufa al gdat-hanahar lemešex šaloš šaot.

"Dan left the body on the bank for three hours"

(54) *hanahar hiš'ir et hagufa al hagada lemešex šaloš šaot.

"The river left the body on the bank for three hours".

(55) a. hakala kista et panea becaif bemešex šaloš šaot.

b. hakala kista et panea becaif lemešex šalos šaot.

"The bride covered her face with a veil for three hours".

(56) *hasufa kista et habyit besmixat avak lemešex šaloš šaot.

"The storm covered the house with a blanket of dust for three hours".

Sentence (53a) is not so good but the result state reading is fine with lemešex, when the agent is human. Sentence (55a) has only the external reading and (55b) with lemešex has the result state reading only when the subject is agentive.

lehargiz 'to irritate' and lekarer 'to cool' do not have a temporal meaning built into them, as is the case with verbs like 'jail', 'crown' and 'nominate'. The subject of these verbs may be agentive or not- this does not affect the result state reading of sentences with such verbs. This is the reason that bemešex may occur with non-agentive subjects and have the result state reading:

(57) hacava hixtir oto lemelex bemešex šaloš šanim.

"The army crowned him for three years".

(58) ha'even al hadelet kal'a ota baxeder bemešex šaloš šaot.

"The stone on the door locked her in the room for three hours".

kista 'cover(+fem)', hiš'ir 'leave' do not necessarily have a temporal component incorporated in their meaning, but such a component may be present, given the intention of the subject of the verb that his activity will carry consequences which would last for a certain period of time, as demonstrated in (53b) and (55b): i.e, that the bride face would remain covered and the body would be left on the bank for a specified length of time. When no such intentions are involved, the specification of a certain length of time is odd since it is not part of the meaning of the verb, as examples (54) and (56) indicate. While lemešex occurs with the intensional result state reading, bemešex occurs with the result state reading, which is not intentional. lemešex specifies the subject intentions as to the duration of the result state and bemešex specifies the length of time of the result state which is part of the meaning of the verb. A period of time for which someone is crowned or nominated constitutes part of their meaning. This is why the result state reading is presented in sentences (57) and (58),

although intentions are lacking. With verbs like lehaš'ir 'to leave', lexasot 'to cover' it is the intentions of the agent which impose the result state reading. lehaš'ir implies, in a certain sense, a length of time for which the thing is to be left (This is not always true of the English verb "leave"). This is not the case with verbs like lekarer 'to cool' or lehargiz 'to irritate'. In some sense lehaš'ir and lexasot are institutional in terms of time, and it is the agent's intentions which impose the result state reading. (They are less institutional than verbs like 'jail', 'nominate' and 'crown' which are institutional whether intentions are present or not). With verbs like lekarer 'to cool' and lehargiz 'to irritate' which are non-institutional in terms of time, the agent's intentions can not impose the result state reading.

2. Time Adverbials and the Time of the Two Clauses of Causatives

2.1. Event Causative Verbs

In the previous section evidence from English and Hebrew was given to support the claim that accomplishments analyzed by CAUSE are bi-sentential. In this section we want to discuss various issues concerning the relationship between the interval specified by a time adverbial modifying

an accomplishment sentence, and the time at which its two constituent sentences combined by CAUSE are true. Causation was often regarded by philosophers as a a relation between events. Dowty's semantics for CAUSE, which we will discuss in section 3. of this chapter, is a version of David Lewis' treatment of causation. Lewis analyzed the operator CAUSE in terms of counterfactuals, and this is why it is a relation between propositions (the proposition that event e occurred, the proposition that event c occurred, etc). CAUSE is treated by Dowty as a sentential operator, so there is no need for him to construct expressions denoting events and form from them sentences which assert that events occurred (The sentences which are the argument of CAUSE already assert it).

It was claimed in section 1.1. that sentences combined by CAUSE might be of different aspectual kinds. Since the time adverb modifies the complex accomplishment sentence, interesting questions arise about the way in which it interacts with the time of the two constituent sentences, especially when they are not of the same aspectual type. We will discuss these issues, examining causatives of different aspectual kinds which occur with different time adverbials. We will look for a generalization which holds in all these cases.

Is it the case that we can always talk about the

aspectual kind of the sentences combined by the CAUSE operator? By looking at the meaning of the causative verb, it is not always possible to discover the two sentences combined by it. This is in particular difficult when we try to determine what the sentence in the first clause of the accomplishment (and causative) sentence is. Consider sentence (58):

(58) John killed Mary.

The sentence in the result state clause underlying (58) should be Mary is dead, but it is not clear what is the sentence which must appear in the first clause. It might be either John poisoned Mary, John shot Mary, John strangled Mary or many others. The two events described by the two clauses underlying sentences with event causative verbs (which we will refer to by ECV) do not have to occur at the same time. Consider sentences (59) and (60) with the frame adverbs:

(59) John killed Mary yesterday.

(60) John killed Mary between noon and midnight.

Sentence (59) could be uttered in a situation where John shot Mary at noon and she died in consequence four hours later. The only condition is that the time of shooting and the time of dying are contained in the interval specified by

yesterday. The frame adverb in (60) specifies an interval with a length of twelve hours, and the time of the two events of shooting and dying must be contained in the interval whose end points are noon and midnight of the same day (There is a restriction on the precedence order of the two events. Maybe this has to do with the nature of causation- a property of the model and not of the language). We can not utter sentence (61):

(61) John killed Mary on Sunday

in the case where John shot Mary on Sunday and she died as a result on the following Monday, or where John shot Mary on Saturday and she died on the next Sunday. The event verb shot specifies the activity of the subject of the sentence in the first clause. The subject of the sentence of the second clause might be dead, wounded, lightly injured etc. On the other hand, the ECV kill specifies only the result state described by the sentence in the second clause underlying (59) and (60). The ECV kill leaves a wide range of activities possible for the subject of the first clause underlying (59) and (60). In the case of the event verb shot it is not determined whether the subject of the sentence in the second clause is dead, wounded or unharmed. We said the time of the events described by the two sentences underlying the sentence with the event causative verb is contained in

the time specified by the adverb modifying this sentence. If this is correct, we expect that when the time adverb is punctual, the two events must occur simultaneously. Consider (62):

(62) John killed Bill at three o'clock.

It seems that sentence (62) can only be uttered in a situation where the shooting and the dying occured at very nearly the same time. Dowty does not discuss this issue in his book but a restriction which appears in clauses (1) and (2) in his definition of CAUSE (rule 15 pg. 353 in the fragment he provides) suggests he was thinking of cases like those discussed by us. Let us repeat his definition below:

(63) If $\phi, \psi \in ME_t$ then $(\phi$ CAUSE $\psi) \in ME_t$, and $[[(\phi$ CAUSE $\psi)]]_{\mathcal{Q},w,i,g}=1$ iff (1) there is some $i_1 \subseteq i$ such that $[[\phi]]_{\mathcal{Q},w,i1,g}=1$, (2) there is some $i_2 \subseteq i$ such that $[[\psi]]_{\mathcal{Q},w,i2,g}=1$, (3) there is no $i' \subseteq i$ meeting (1) and (2), and (4) there is a sequence of formulas $X_1, X_2, \ldots X_n$ where $\phi = X_1$ and $\psi = X_n$ such that $[[(\sim X_k \ \Box\!\!\rightarrow \sim X_{k+1})]]_{\mathcal{Q},w,j,g}=1$, where $1 \leq k < n$ and $j \subseteq i$.

Clause (1) in the above definition requires that the interval at which the first sentence ϕ of the causative

sentence is true (i_1 in the above definition) should be a subinterval of the interval i at which the causative sentence is true. Clause (2) requires that the interval at which the second sentence ψ is true (i_2 in the above definition) should be a subinterval of the interval i at which the causative sentence is true. Clause (3) says that i is minimal.

At present we will only concentrate on clauses (1) and (2) of the above definition and investigate whether they hold in the case of other causatives which are not ECV.

2.2 Process causative verbs

In our discussion of CPV we have said that the sentences in the two underlying clauses are processes. One can not utter sentences with CPV when the first clause or second clause specifies a punctual event. Although the causative gallop (like kill) leaves quite a wide range of possible activities that its subject may be involved in, all of them are durative in nature.

Spears (1977) distinguished between sentences with infinitival sensory complements and sentences with gerundive complements, for example:

(64) a. I watched Sheila build a cabin.

b. I watched Sheila building a cabin.

watch is a sensory verb and its infinitival complement build a cabin in (64a) implies that a cabin was completed. In sentence (64b) we have a gerundive complement and there is no implication of Sheila's completion of the cabin.

Infinitival and gerundive complements of verbs of (dis)liking are also perfective and imperfective correspondently. Spears gives the following examples:

(65) a. I hated to write that book. That's why I did not finish it.

b. I hated writing that book. That's why I did not finish it.

Sentence (65b) with the gerundive complement sounds better than (65a), since it is imperfective and does not contradict the subsequent sentence, which asserts that the writing of the book was not completed.

Spears notes that the same distinction holds with monoperfective predicates, which denote an event or state which can be completed only once as in write a book, eat an apple and grow up. Infinitival complements which are monoperfective predicates are perfective when they appear with the disliking verb hate. The gerundive complement of these verbs is imperfective ($\neq$ means that the sentence is anomalous):

(66) $\neq$ Flora hated to grow up in Brooklyn; that's why she committed suicide at the age of five.

(67) Flora hated growing up in Brooklyn; that's why she committed suicide at the age of five.

Sentence (66) is anomalous since the infinitival complement implies that Flora actually reached adulthood, and this contradicts the information in the subsequent sentence. Sentence (67) is fine since the gerundive doesn't have a perfective implication.

Sentences (64b), (65b), and (67), which have the gerundive complements, behave like CPV in the sense that the activities described by the sensory or (dis)liking verb are durative (The durative state of watching is described by the first clause of the first sentence of (64b), and that of working is described in its result state clause). The adverbial specifies the length of time for which these activities lasted. Consider:

(68) For ten hours I saw Sheila building a cabin.

(69) For eight months I hated writing the book.

(70) For ten years Flora hated growing up in Brooklyn.

The sensory and (dis)liking verbs in examples (68)-(70) are not causatives but exhibit a similar behavior to that of CPV. In these examples we have two different continuous activities which last for the time specified by the time adverbial.

When the subject of the causative verb is a gerund we

get the same effect as with CPV verbs. Consider:

(71) For a year exercising strengthened John's muscles.

(72) For three hours heating it darkened it.

(73) For ten years drinking gin weakened John's mind.

The time adverb was preposed in (71)-(73) to block the reading where it specifies the length of time of the result state. Sentence (71) can only describe a situation where John does exercises for a year and as a result of each exercise his muscles become stronger and stronger.

In (72) the two processes that of heating and that of becoming darker are continuous, while in (71) exercising and becoming stronger are not. In chapter I section 3.1. we discuss the difference between verbs which describe a continuous activity and these which describe an iterative one. The same issue is involved here.

It is the gerundive in the first clause of the causatives strengthen, darken and weaken which create the same effect as that in the CPV. The inchoatives strengthen, darken and weaken are non specific between the punctual reading (vague inchoatives) and the process reading, which involves a comparative component (see my discussion of these issues in chapter I), and it is the presence of the durative time adverb which imposes the durative reading on the ambigiuous inchoatives in the second clause of (71)-(73).

CPV take durative time adverbials. As earlier in dealing with ECV, we would like to investigate the relationship between the interval specified by the time adverb modifying the CPV-sentence and the time at which its two constituent sentences are true. This relationship is more complicated in the case of CPV, and this follows from the interpretation of the durative time adverb and its interaction with the two clauses. Something like a continuous or repeated causation is involved in the reading of sentence (74):

(74) John galloped the horse for three hours.

We get the "continuous causation" reading in the above sentence from the interpretation of the durative adverb "for three hours", and clauses (1) and (2) in the definition of CAUSE. To show how the interval specified by the time adverb relates to the time at which the two constituent sentences are true, and how the "continuous causation" reading of CPV is created, we must understand the way durative time adverbs work.

Dowty interprets <u>for</u> as belonging to the category (IV/IV)/(t/i). <u>For</u> combines with an expression denoting a property of intervals to form a verb phrase adverbial:

(75) $\lambda P_t \lambda P \lambda x[P_t\{n\} \ \& \ \forall t[t \subseteq n \rightarrow AT(t, P\{x\})]]$

We will try to understand what the above translation means. The indexical constant n (for "now") denotes at any index the time coordinate of that index, i.e at any index $\langle w,i \rangle$ the denotation of n is i. After applying lamda conversion three times and introducing a subject NP, a VP and a property of times we arrive at:

(74') $\hat{}$three hours'$\{n\}$ & $\forall t[t \subseteq n \rightarrow AT(t, \emptyset \text{ CAUSE } \psi)]$

evaluating (74') at an index $\langle w,i \rangle$ we get:

(74'') $[[\text{three hours}'(n) \ \& \ \forall t[t \subseteq n \rightarrow AT(t, \emptyset \text{ CAUSE } \psi)]]]_{\langle w,i \rangle}$

The denotation of $([[\text{three hours}']](n))_{\langle w,i \rangle}$ is that of $[[\text{three hours}']]_{\langle w,i \rangle}([[n]]_{\langle w,i \rangle})$, and this is equal to $[[\text{three hours}']]_{\langle w,i \rangle}(i)$. In the same way we get rid of the indexical constant in the second conjunct of (74''). When (74'') is true, then the duration of i is three hours and for all subintervals t of i $[[\emptyset \text{ CAUSE } \psi]]_{\langle w,t \rangle}=1$.

After applying the past tense to (74'') (rule S39 in Dowty's fragment) we end up with

(74''') $\exists t_1[Past(t_1) \ \& \ \text{three hours}'(t_1) \ \& \ \forall t[t \subseteq t_1 \rightarrow AT(t, \emptyset \text{ CAUSE } \psi)]]$

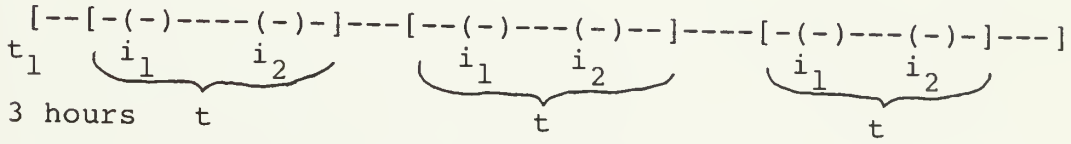
i.e for some past interval t_1, the duration of t_1 is three hours and for all subintervals t of t_1,

$[[\phi \text{ CAUSE } \psi]]_{<w,t>}=1$.

How do clauses (1) and (2) in the CAUSE definition interact with the interpretation of the durative time adverbial?

Consider (76) which describes a situation where (74) is true:

(76)



According to the interpretation of <u>for</u>, for each $t \subseteq t_1$, AT(t, ϕ CAUSE ψ).

From clauses (1) and (2) in the CAUSE definition it follows that for each $t \subseteq t_1$

1. for some $i_1 \subseteq t$, AT(i_1, ϕ) and
2. for some $i_2 \subseteq t$, AT(i_2, ψ)

and from the interpretation of <u>for</u>:

(77) $(\forall t)[(t \subseteq t_1) \rightarrow \exists i_1[(i_1 \subseteq t) \ \& \ AT(i_1, \phi)] \ \& \ \exists i_2[(i_2 \subseteq t) \ \& \ AT(i_2, \psi)]]$

The interpretation of the durative adverb and the requirements in clauses (1) and (2) of CAUSE are responsible

for the continuous causation reading of CPV. The requirement that the time at which the two sentences in the clauses of causative sentences be true must be contained in the interval specified by the time adverb modifying the CPV sentence is justified if we want to account for the special behavior of CPV.

2.3. Culmination Causative Verbs

Some causative verbs like build a house and write a symphony describe extended events, i.e their completion takes time. We will call such causative verbs culmination causative verbs (CCV). The relationship between the time specified by the time adverb modifying CCV-sentences and the time at which its constituent sentences are true involve issues which did not arise in the case of ECV and CPV. CCV take the time adverb in two hours. Consider:

(78) John built a house in two hours.

(79) The composer wrote the symphony in a year.

Dowty's translation of *in* in the time adverb *in n hours* is:

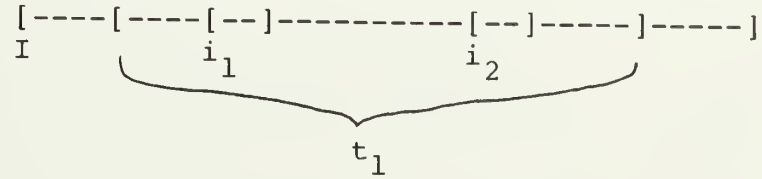
$$(80)\quad \lambda P_t\, \lambda P\, \lambda x[P_t\{n\} \;\&\; \exists t_1[t_1 \subseteq n \;\&\; AT(t_1, P\{x\})] \;\&\; \forall t_2[(t_2 \subseteq n \;\&\; AT(t_2, P\{x\})] \rightarrow t_2 = t_1]$$

The interpretation of *in* differs in two respects from that of *for*. We have an existential quantifier binding t_1 in the above translation while in the translation of *for* we had a universal quantifier at that position. It is required that the time of the verb's truth is some subset of the interval mentioned, though not necessarily a proper subset. Dowty suggests that for Gricean reasons we usually consider t_1 in the above interpretation of *in* to be equal to n; and in particular when dealing with multiple-change accomplishments as in *John washed the dishes in an hour*. If we expect the time that a certain verb takes to be shorter than that specified by the adverb, then the verb is understood to be true at a finite proper subinterval of the indicated interval as in *John closed the door in an hour*. We could utter this although we know it would take him one minute to do so.

The second respect in which the interpretation of *in* differs from that of *for* is in the requirement of the uniqueness of t_1. The uniqueness condition distinguishes accomplishments from statives. In order to explain why stative verbs do not take *in*-adverbs (*?John slept in an hour*) and accomplishments do take them, the translation of *in* must specify that the verb is true at a unique subinterval (not necessarily a proper one) of the measured interval. If John built a house in a year (where it took him a whole year to build it), it is false that he built a house in 364 days (if t_1 is a proper subset of n, the same uniqueness requirement holds for that subset). Stative verbs do not obey this requirement.

Let us consider again the requirement in clauses (1) and (2) of the definition of CAUSE, and their interaction with the above translation of *in*. (81) below describes the situation where [ϕ CAUSE ψ] in n hours is true:

(81)



The translation of *in* implies that for some interval I of duration n hours $\exists t_1 \subseteq I$ [AT(t_1, ϕ CAUSE ψ)] and this holds for no other interval than t_1.

Clauses (1) and (2) in the CAUSE definition require

that

(1) for some $i_1 \subseteq t_1$, $AT(i_1, \phi)$

(2) for some $i_2 \subseteq t_1$, $AT(i_2, \psi)$

The translation of in and clauses (1) and (2) of CAUSE specify only two intervals: that at which the event described by the first constituent sentence of the CCV-sentence occurred and that at which the event described by the second sentence occurred. Both are contained in a subset t_1 of I, where I is the interval specified by the time adverbial.

(81) does not seem appropriate when we take into account linguistic and metaphysical considerations which arise when dealing with CCV.

In our discussion of CPV we have claimed that the sentences in their two clauses must be of the same aspectual type- that of processes. A sentence with a CPV as its main verb can no longer be classified as a process when one of its constituent sentences is of a different aspectual type. We showed in detail the way in which the interval specified by the time adverb modifying the sentence relates to the time at which its two constituent sentences are true. When discussing sentences with event causative verbs like kill, we assumed that each of the sentences underlying it is an event type, and stated a condition about the relationship

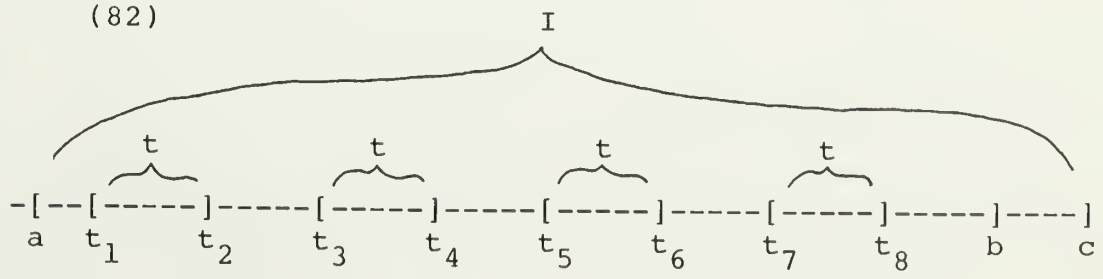
between the time at which they are true and the time specified by the time adverb.

That the two constituent sentences of a sentence containing a causative VP like John built a house in two years or The composer wrote a symphony last year are event type sentences is not so clear. The activity of writing a symphony takes a long time, but the result state where some piece of music becomes a symphony occurs at a point. Whatever the activity denoted in the first clause of the above sentences is, its nature is durative: that of writing a symphony and of building a house. Somebody is in the process of writing a symphony or building a house before the house or the symphony are completed (see my discussion of Vlach in chapter III 2.1.). There are certain rituals and conventions involved in activities of such kinds (which usually lead to the completion of a certain object) that make them such activities and not others. And if the first sentence underlying a CCV sentence is a process while the second is an event type (an achievement sentence), then we have a case where the two constituent sentences disagree in their aspectual type. If this is the case, it is not so clear how the time indicated by the time adverb modifying the CCV-sentence relates to the time at which its two constituent sentences are true.

One may claim that the activity unspecified in the

first constituent sentence is an extended event rather than a process. If this is so, this event could not be that of building a house or writing a symphony since the house or the symphony are not yet completed. Also, it could not be the event of building one third of a house or half a house, because neither of these when considered separately is the cause of the result state, where a house came into existence. We can think about different events underlying the activity described in the first sentence of the CCV-sentence, each of which has a different object (building a roof, building a window), and all of which constitute an extended event which causes the result state of a house that came into existence. Each of these events is complex since each of them contains a causal element. If this description of the activity underlying the first clause of the CCV is correct, then either picture (81) is wrong or ϕ in $[\phi$ CAUSE $\psi]$ is a causative sentence itself whose first constituent is a causative sentence, and so on. To describe the way in which the time adverb relates to the two clauses such a situation is very complex. Consider diagram (82):

(82)



I is an interval of length n at which John build a house is true. At a, John started to build a house and at c he finished it. There exist subintervals t of I where at t_1 John does something and at t_2 some result state obtains. The sequence of events which occur at the interval [a,b] cause the result state to obtain at c.

One may argue that all these complications which arise when we think about the world do not prevent us from considering in our semantics the interval [a,b] as the one at which an extended event occurred. In such a situation, the time relationship between the interval specified by the time adverbial and the time of the two sentences is as described in (81), and not different from that which holds for ECV. But what kind of extended event occurred at the interval [a,b]? It is difficult to think of such a specific event which is the cause of the result state where a house came into existence.

Let us discuss the possibility in which the first sentence underlying the CCV is a process while the second one is an event. Since we are dealing with aspectual properties of languages and not of the world (for a discussion of this distinction see section 1.1. on verb classification in chapter I) we must look for linguistic evidence. Consider the following sentence,

(83) ?John warmed the soup at three o'clock.

which is fine for some speakers. For these speakers the punctual time adverbial refers to the time at which the soup became warm rather than the time at which John started to warm it. Three o'clock can not indicate the time both of John turning on the gas and of that at which the soup became warm. John's act may be a durative one- that of refraining from turning off the gas. Such a situation is described in sentence (84):

(84) John warmed the soup for half an hour by letting it stand on the fire.

The time specified by the durative time adverb indicates the duration of the process of having the soup stand on the gas. The causative verb warm in (84) is a process rather than an accomplishment and the verb in the result state clause is the process inchoative verb become warmer (We say The soup warmed for three hours). The sentences in the two clauses of (84) are of the same aspectual type- that of a process; and the time adverb relates to them in the same way as in the case of CPV. Warm in (84) is ambigiuous between a process and an accomplishment in the same way that wash is (this ambiguity was mentioned to me by Partee):

(85) The maid washed the clothes in two hours.

(86) The maid washed the clothes for two hours.

Sentence (86) describes the process of washing connected with certain rituals as rubbing the clothes with a soap, dipping them in the water, etc rather than the result state where the clothes are clean.

Consider the following sentences:

(87) John was cured by administering vitamins.

(88) The door was closed by blowing at it.

(89) The lock was broken by kicking at the door continuously.

In sentence (87) the activity of the missing deep structure subject (let us say it is the doctor) is durative; it is that of administering vitamins. In the result clause we have an achievement "got healthy". The same contrast in the aspectual type of the sentences in the two clauses also exists in (88)-(89). In the case of the causative verb cure, only the result state of its object ("get healthy") is specified but not the activity of its subject. The VP's administering vitamins, blowing at it and kicking at the door are process type verbs. Consider:

(90) The doctor administered vitamins for three hours.

(91) The wolf blew at the door for half an hour.

(92) The police kicked the door continuously.

This perhaps suggests that culmination causative verbs have a process type sentence in the first clause and an event

type sentence in the result state clause.

The instrumental adverb "by administering vitamins" in (87) shares the verb cure with the missing deep structure subject of the sentence. It was the doctor who administered vitamins, not John. Jerry Fodor (1970) observed that many instrumental adverbial phrases share the deep underlying NP with the verb they modify. In his example (93) it is the deep subject John rather than Mary who used the phone:

(93) John contacted Mary by using the phone.

He also mentioned that instrumental adverbs can not appear in full passive due to a surface constraint on iteration of 'by' as in *Mary was found by John by using radar, but are fine when they appear in agentless passives like (87)-(89). Since the adverb for n hours in sentence (94) is a constituent of the by-phrase, it specifies the length of the duration of the activity of the doctor and not that of John. Consider:

(94) John was cured by administering vitamins for three week.

(95) The door was closed by blowing at it for half an hour.

When the for n hours adverb is extracted from the VP and preposed, sentences (87)-(89) are no longer good:

(96) *For three weeks John was cured by administering vitamins.

(97) *For ten minutes the door was closed by blowing at it.

This is so because in (96)-(97) the for-adverb modifies the whole sentence, as in the case of CPV. But for CCV like cure and close (as in (87)-(89)) the for-adverb inside the by-phrase modifies the VP in the by-phrase.

Although sentences (87)-(89) have an achievement verb in their second clause, they are semi-grammatical with a punctual time adverbial:

(98) ?John was cured at three o'clock
by administering vitamins for three hours.

(99) ?The door was closed at two o'clock
by blowing at it for half an hour.

Sentences (98)-(99) are only partially acceptable, so they do not allow the reading (which (87)-(89) have) where the administering of vitamins which lasted for three weeks preceded the time at which John got healthy. It is not the case that (98)-(99) are ruled out because of a restriction that only one time adverb can occur at a sentence; something else is involved here. In a construction where the main sentence is restricted by a frame adverb and also contains an additional durative time adverb, the time specified by the durative adverb can not be longer that that specified by

the frame adverb. Sentences (98)-(99) are bad because the time of the durative adverb is longer than that indicated by the time adverb restricting the main sentence:

Sentence (100) which does not violate the above condition is fine:

(100) John was cured yesterday by administering vitamins for three hours.

Notice that when the verb completed appear in the main sentence, you can have a durative adverb in the other:

(101) *John painted the picture at three o'clock by using an air brush for three hours.

(102) John completed the picture by using an air brush for three hours.

To complete does not always imply finishing something at a point. If an activity takes some time, its last stage can be considered as its completion. Sentence (102) can be uttered in a situation where John was painting a picture for three months or even longer. (The completion of the picture lasted three days and during one of these days John was using an air-brush for three hours). Quite surprisingly, we can add a punctual time adverb to the main sentence when the other one is modified by continuously:

(103) The police broke the door at three o'clock by kicking at it continuously.

We can utter (103) in a situation where the kicking of the door by the police lasted through a short interval of time, for example, two to five minutes. In the same way we can say of John that he picked up his mail at noon when it took him five minutes to pick it up, but not when it took him three hours to do so. This follows from the fact that 'at n o'clock' lacks a definite time reference; it depends on how we choose to construct time. 'At three o'clock' indicates a time around three o'clock and not necessarily the time when the small and big arms of the clock point to the numbers three and twelve respectively. In sentence (103), continuously modifies a process sentence and the activity described by it lasts for an interval of a few moments duration. This short interval is contained in the interval specified by the "at three o'clock" adverb, so the above restriction is not violated and this accounts for the acceptability of (103).

Partee and Bennett (1978) gave examples of adverbial phrases which serve both as durative and frame adverbial phrases. Consider:

(104) John was hungry all day yesterday.

(105) John walked from two to three o'clock.

(106) John will be building a house until tomorrow.

But culmination causative verbs can not appear with such

examples.

3. The Semantics of CAUSE and Aspectuality

3.1. The Semantics Analysis of CAUSE

In his paper on causation (1973) David Lewis analyzed this notion in terms of counterfactuals. Dowty adopted Lewis' analysis of causation for his bi-sentential operator CAUSE and further revised it. We will present both Lewis' analysis of causation and Dowty's version of this analysis and then we will point to difficulties which arise with the semantics of CAUSE and other issues concerning its interaction with aspectuality.

Causation is a relation between events, but when treated in terms of counterfactuals it is a relation between propositions. Lewis does not analyze a relation between events e and c but a relation between propositions O(e) and O(c) which assert correspondingly that event e occurred and event c occurred. Dowty's CAUSE is a sentential operator and the sentences which are its arguments assert that events occurred. We have to distinguish between the events e and c and the sentences O(c) and O(e) (causative stative sentences can not be analyzed as relation between events).

Lewis defines the relation of causal dependence between event e and c in terms of the notion of counterfactual

dependence between the propositions that events occurred. e depends causally on c (cDe) iff $O(c) \boxdot\!\!\rightarrow O(e)$ and $\sim O(c) \boxdot\!\!\rightarrow \sim O(e)$.

For Lewis, causal dependence is a different relation from causation: while causation is transitive, causal dependence need not be (causal dependence is not transitive since it fails for Lewis' counterfactual connective $\boxdot\!\!\rightarrow$). Causation is defined by Lewis in terms of causal dependence: actual event c causes an event e just in case there is a series of events c, c_1, c_2, c_3.....,c_n, e such that c_1 depends causally on c, c_2 depends causally on c_1 etc.

Causation (C) is the transitive closure[2] of the converse of causal dependence (D) and is defined as follows:

(107) cCe iff $(\exists a_1.....,a_n)$ $[a_2Da_1$ &
a_3Da_2 &.....a_nDa_{n-1} & $c=a_1$ and $e=a_n]$

Causation does not entail causal dependence (because causal dependence is not transitive) but causal dependence entails causation.

Lewis' treatment of causation contains two components: its definition in terms of the notion of causal dependence and the definition of causal dependence in terms of the counterfactual connective $\boxdot\!\!\rightarrow$ (see Lewis' counterfactual analysis in his (1073a).

Dowty remarks that there is another important issue which he calls the "causal selection", which must be considered in the definition of CAUSE. Causation statements in natural language ordinarily single out one event as "the cause" of the other, while the counterfactual analysis allows a number of events to be considered as causes. He mentions Kim (1973) and Abbott (1974), who have shown that a large number of counterfactuals are odd when converted to causal statements, quoting some of Abbot's examples:

(108) a. If I had not lit John's cigarette, he wouldn't have smoked it.

b. My lighting John's cigarette caused him to smoke it.

(109) a. If I had not been born I would not have come to Amherst.

b. My being born caused me to come to Amherst.

(110) a. If Mary had not gotten married, she would have not become a widow.

b. Mary's getting married caused her to become a widow.

Since English causative statements require a causal selection as the abnormal sentences (108b)-(110b) illustrate, Lewis' analysis of causation in terms of counterfactuals is problematic when taken as an account for causative sentences in languages. Dowty's CAUSE operator is supposed to account for causative statements in natural

languages. Therefore he suggests adding to its definition another clause which will take care of the above mentioned difficulties. He suggests that one select "the cause" of an event as the one whose deletion from the actual course of events would result in the least departure from the actual world. If we quantify over a multiple of causes of an event, we can identify as "the cause" the one whose non-occurrence can be found in worlds at least as similar or more similar to the actual world than the non-occurrence of any of the other causes of the event. (Since sometimes more than one cause could be equally easy to get rid off, Dowty would like the world in which the cause does not occur to be as similar to the actual world as any other worlds where other causes do not occur).

Perhaps this is why we so often find human actions identified as "the cause" in a causal chain of events. We feel intuitively that the actions of human agents usually could be different from what they are but that this is not so often true for inanimate objects which obey physical laws. To see this more clearly consider the following example: John pulled the trigger of the gun, lifted the barrel, the bullet travelled along a parabola and Bill died as a consequence. John's pulling of the trigger is "the cause" of Bill's death rather than the bullet going in a parabola. This is so since worlds in which bullets do not

go in straight lines are less similar to the actual one than those in which John didn't fire his gun.

Dowty's definition of CAUSE has three clauses: In clause (111a) he adds some conditions to Lewis' definition of causal dependence (which is defined in terms of counterfactuals) by requiring that ϕ and ψ should be true. If ϕ and ψ are true, then $\psi \mathbin{\square\!\!\rightarrow} \phi$ is also true and this is why Dowty drops it from clause (111a) in his definition of CAUSE. In clause (111b) the definition of "causal factor" is his adaptation of Lewis' analysis of causation as a transitive closure of the converse of causal dependence. The third clause (111c) in Dowty is the causal selection condition, which was discussed above.

When ϕ and ψ are arbitrary sentences the truth conditions for [ϕ CAUSE ψ] are given by the following definition:

(111) a. ϕ depends causally on ψ iff ϕ, ψ and $\sim\psi \mathbin{\square\!\!\rightarrow} \sim\phi$ are all true.

b. ϕ is a causal factor for ψ iff 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.

c. [ϕ CAUSE ψ] is true iff (1) ϕ is a causal factor for ψ, and (2) for all other ϕ' such that ϕ' is also a causal factor for ψ, some $\sim\phi$-world is as similar or more similar to the actual world that any $\sim\phi'$-world is.

3.2. Partitivity, Additivity and Process Verbs

In section 1.2. of chapter I we discussed the properties of additivity and partitivity which were connected with process verbs and mass nouns (for which we must maintain a weaker version of partitivity). Sentences which contain CPV have two underlying sentences ϕ and ψ, each of them describing a process. Can we show that if ϕ and ψ are process sentences then it follows by logic that [ϕ CAUSE ψ] is a process sentence?

If something is a process sentence iff it is partitive and additive then to answer the above question we must show that if ϕ and ψ are partitive and additive so is [ϕ CAUSE ψ]. We will show that this consequence does not hold for a weaker relation than CAUSE which we will call KAUSE. When ϕ and ψ are partitive and additive then [ϕ KAUSE ψ] is additive but not partitive. We will also show that this is consistent with linguistic facts concerning the interaction of partitivity and causative process verbs. Here we have a nice case where logic and

language coincide.

The relation KAUSE in [ϕ KAUSE ψ] is the converse of Dowty's relation of causal dependence in clause A of the definition of CAUSE. We do not know how partitivity and additivity interact with the notion of causal chains (clause (111b) in the definition of CAUSE) and how relevant the notion of causal selection to our proof is.

In our proof we will use Lewis' definition of the counterfactual conditional, Dowty's definition of causal dependence and Dowty's definition of $[\phi \text{ CAUSE } \psi]_{\mathcal{Q},w,i,g}$ where the relation between the time at which the causative sentence is true and the time at which ϕ and ψ are true is made explicit. Lewis' definition of the counterfactual connective $\Box\!\!\rightarrow$ is:

(112) If $\phi, \psi \in ME_t$, then $(\phi \Box\!\!\rightarrow \psi) \in ME_t$, and $[[(\phi \Box\!\!\rightarrow \psi)]]_{\mathcal{Q},w,g,i}=1$ iff either (1) there is no set $S \in \$_w$ for which there is $w' \in S$ such that $[[\phi]]_{\mathcal{Q},w',i,g}=1$ or else (2) there is some set $S \in \$_w$ such that $[[\phi]]_{\mathcal{Q},w',i,g}=1$ for some $w' \in S$ and for all $w'' \in S$, $[[(\phi \rightarrow \psi)]]_{\mathcal{Q},w'',i,g}=1$.

We want to prove that:

(113) ϕ is partivive and additive

ψ is partitive and additive

therefore, [[ϕ KAUSE ψ]] is additive

The formal proof is given in the appendix.

We still need to show that partitivity does not hold in general, i.e there is a model where ϕ and ψ are additive and partitive and [ϕ KAUSE ψ] fails to be partitive. Let our model have two worlds $\{w,w'\}$ and three intervals I_1, I_2 and I_3 where $I_3=I_1 \cup I_2$. ϕ is partitive in a model A iff for any worlds w and time intervals I_1, I_2

$([[\phi]]_{I1,w} = 1 \ \& \ I_2 \subseteq I_1) \longrightarrow [[\phi]]_{I2,w}=1.$

ϕ and ψ have the indicated truth values in w and w':

(114)

w

	I_1	I_2	I_3
ϕ	1	1	1
ψ	1	1	1
$\sim\phi \longrightarrow \sim\psi$	1	1	1

w'

	I_1	I_2	I_3
ϕ	0	1	0
ψ	1	0	0
$\sim\phi \longrightarrow \sim\psi$	0	1	1

In this model, ϕ and ψ are both additive and partitive at both w and w'. A counterexample to additivity would be a row of the form 1 1 0 ; a counterexample to partitivity would be a row of the form 0 1 1 or 1 0 1 or 0 0 1.

There are no such rows for ϕ or for ψ.

There is a world w' where $\sim\phi$ is true at I_3 and $\sim\phi \rightarrow \sim\psi$ holds with respect to (w,I_3) and (w',I_3), i.e, in the sphere $\{w,w'\}$. So, $[[\sim\phi \,\Box\!\!\rightarrow \sim\psi\,]]_{w,I3}=1$. $\sim\phi$ holds at (w',I_1) and $\sim\phi \rightarrow \sim\psi$ at (w',I_1) is false. Since there are no worlds closer to w than w' where $\sim\phi$ holds, then $[[\sim\phi \,\Box\!\!\rightarrow \sim\psi]]_{w,I1}=0$. This counterexample shows that the non-partitivity of KAUSE is consistent with the additivity and partitivity of ϕ and ψ : $AT(I_3,w)$ we have ϕ, ψ and $\sim\phi \,\Box\!\!\rightarrow \sim\psi$, so ϕ KAUSE ψ . $At(I_1,w)$ we have ϕ, ψ and $\sim[\sim\phi \,\Box\!\!\rightarrow \sim\psi]$, so $\sim[\phi$ KAUSE $\psi]$. So KAUSE is not partitive in this model.

The following two examples illustrate why partitivity fails to hold. Causative VP's with bare plural objects are processes and this is why sentence (115) may appear with a durative time adverb:

(115) For two weeks the workers built cabins.

If the workers build different cabins at different subintervals of the interval specified by the time adverb, e.g if they build a different one each day, then <u>the workers built cabins</u> is partitive at the two week interval, since it is true at its appropriate large subintervals. But in a model where all the workers finished building all the cabins at the same time, i.e at the end of the two weeks, then <u>the</u>

workers built cabins is not partitive at the interval of two weeks, since it is not true at any of its subintervals. So in a model where the workers finished building all the cabins at the same time, i.e by the end of the two weeks, then the workers built cabins is not partitive at the interval of two weeks duration, since it is not true at any of its subintervals. Thus, causatives which take bare plurals are process verbs (as the for-adverb linguistic test indicates) and partitivity doesn't hold for process sentences which contain causative verbs. There are quite plausible situation for which The workers built cabins is partitive at the interval with respect to which it is true, and there are equally plausible situations for which this is not so.

There is another example which illustrates the same point. Consider sentence (116):

(116) John rolled the drum down the street.

Imagine John pushed the drum for ten minutes from 1 o'clock to ten minutes past 1 o'clock and also that the drum rolled down the street during that period. (116) is a CPV-sentence for which partitivity holds: if John rolled the drum down the street is true at the interval $[1^{00}, 1^{10}]$, then it is true for its subintervals. But in a model where John pushed the drum for two minutes (his pushing is a process) and then

stopped and the drum kept rolling round the street for another 8 minutes, (116) is not partitive. In such a model (116) is true at the interval $[1^{00}, 1^{10}]$ but not at $[1^{03}, 1^{10}]$, $[1^{04}, 1^{10}]$, etc.

We have given two examples of process sentences which involve causative verbs and for which partitivity does not hold. These examples agree with the results we arrived at by using logic. My discussion of additivity, partitivity and process sentences shows that the interaction of these notions is more complicated than has been assumed in the literature. We did not provide a complete theory about their relationship- this is a topic for further research and we hope that the issues and examples mentioned here will open up a new perspective for dealing with process verbs.

FOOTNOTES

[1]Emmon Bach has suggested to me the following counterexample of a sentence with a stative verbs which is ambigious between the external/intentional readings: The exhibition was in New York for three days.

[2]Suppose R is an arbitrary relation, represented as a set of ordered pairs, which need not be transitive. We can extend R to a transitive relation R' by adding pairs. For instance, if $(a,b) \in R$ and $(b,c) \in R$ but $(a,c) \notin R$ we should add the pair (a,c). In general, we add (x,y) if there is some finite sequences connecting x and y: for all x,y, $(x,y) \in R$ iff for some natural number n there is a finite sequence $a_1 \ldots\ldots a_n$ such that:

(1) For all $1 \leq i \leq n$, $R(a_i, a_{i+1})$

(2) $a_1 = x$ and $a_n = y$.

C H A P T E R III

ISSUES IN THE SEMANTIC ANALYSIS OF THE PROGRESSIVE

1. The Traditional Approach to the Progressive

1.1. Montague's Definition and the Continuum Failure

The purpose of this chapter is to compare two main analyses suggested for the progressive, which I will refer to as the traditional approach vs. the non-topological one. To illustrate the different problems involved in the analysis of the progressive I will review the history of the argumentation given by philosophers and linguists in favour of one analysis or another and outline the objections which might be raised in each case.

I find such an historical survey important due to the volume of literature on this topic, which I think ought to be related and compared. I will point to the differences among the treatments of the progressive within two main streams. These treatments were often suggested as responses and improvements over previous ones. After discussing in detail the various theoretical issues involved and pointing to problems which were left unresolved in the treatments of the progressive in the two main streams, I will offer my own

analysis.

Montague (1970) suggested a treatment for the progressive stated as follows in Bennett and Partee's (1978):[1]

(1) John is walking is true at time p iff there exists an open interval of moments of time, say I, such that p is a moment of I and for all time t in I John walks is true at t.

In the above definition the truth of the tensed sentence Prog[ϕ] at a moment of time is dependent on the truth of the constituent sentence ϕ at other moments. The progressive John is walking is true at a moment of time t just in case John walk is true at all moments of some open interval which contains t.

Definition (1) is too strong. The two objections to be raised differ slightly, although the same criticism, which I will refer to as the 'continuum failure' is involved in presenting them. The first objection can be illustrated by an example of process verbs like walk and read. One can spend an hour at walking or reading without being literally involved in that activity at every moment within that hour, as required in the above definition.[2]

The second objection is a more crucial one and involves accomplishment/achievement verbs. The above definition of the progressive works only for process verbs and is not general enough to include other aspectual types of verbs.

With accomplishment/achievement verbs the truth of the tensed sentence seems not to require the truth of its constituent sentence(s) at all moments within that interval. John was building a house at t does not mean that the simple tense sentence John build a house was true at all moments in an interval surrounding t. On the contrary, it was not true at any moment of the open interval.

Vlach (1981) provides a nice example which illustrates a comparable problem with an achievement verb: If Mary starts a race at 3.10 and wins at 3.16, then there is a third instant t' between 3.10 and 3.16 such that she pulls ahead at t' and stays ahead until 3.16. Mary is winning is true at every instant between t' and 3.16, but Mary win is only true at 3.16. Thus, it is false that Prog[ϕ] is true only at instants contained in an interval at moments of which ϕ is true. It seems that a better definition for the progressive is required.

1.2. Bennett and Partee and Interval Semantics

To account for the continuum failure discussed above, Bennett and Partee (1978) take the notion of truth at an interval as basic. According to their suggestion sentences in the simple tense can be true at an interval which is not a moment. Their intention is that a sentence in the simple tense be true at an interval I if I has an initial and a

final point such that the event described by it starts at the initial point and stops at the final point. Here is the definition they give for the progressive:

> (2) John is building a house is true at I iff I is a moment of time, there exists an interval of time I', such that I is in I', I is not an endpoint for I', and John builds a house is true at I'.

We see that Bennett and Partee avoid the continuum failure (which arises by defining the truth of the progressive at a moment t in terms of the truth of the simple tense at moments of time) by defining the truth of the simple tense with respect to an interval rather than a moment. In this sense they avoid referring to moments when defining the truth of a simple tense sentence, and consequently avoid referring to moments when defining the truth of the progressive. In their definition of the progressive given above, the verb which appears is an accomplishment, build; by what they have said, the simple tense sentence which contains it should be evaluated with respect to an interval. We will see later that Dowty's semantics for verbs of change (accomplishments and achievements) employs Bennett and Partee's basic idea about the truth of the simple tense sentence with accomplishment and achievement verbs.

As in Montague's analysis the progressive is defined in terms of the simple tense, and in this sense both approaches

are said to be compositional-the meaning of the whole, which in our case is the progressive sentence, is defined in terms of the meaning of its parts, in this case the simple tense sentence.

This analysis like the former calls for further revisions. The next section deals with it.

1.3. The Modal-Temporal Treatment of The Progressive

1.3.1. Dowty's suggestion. The failure of inference from the progressive to the simple tense was recognized a long time ago and recently was labeled with the name "the imperfective paradox" by Dowty (1979). The imperfective paradox is common to accomplishments and certain achievements which take the progressive. In the following sentence the process verb in the progressive entails the simple tense but the accomplishment and achievement verbs may fail to make such an entailment:

(3) That John was pushing a cart entails that John pushed a cart.

(4) That John was crossing the road does not entails John crossed the road.

(5) That John was falling asleep does not entail that John fell asleep.

Bennett and Partee's definition of the progressive (as well as Montague's) fail to distinguish between the different entailments in (3)-(5). According to Bennett and Partee's

John is crossing the street is true at a moment I just in case John cross the street is true at some interval I' containing I, which require that John completes the crossing of the street. However, this must not always be the case since a car could have hit John and prevented him from reaching the other side of the pavement. The analysis of the progressive given in 1.1. and 1.2. predicts that the sentence

(6) John was crossing the street when he was hit by a car.

can never be true since there is no interval at which John cross the street is true. However, there is nothing strange in the utterance of sentence (6).

Dowty offered an analysis to account for the imperfective paradox in the framework of his aspect calculus. He claimed that the Become-operator which denotes a change of state is what accomplishments and achievements share in their logical structure and concludes from it that the solution to the analysis of the progressive lies in a correct formulation of truth conditions for Prog[ϕ] and Become[ϕ]. In his treatment of Become[ϕ] he accounts for what I have referred to as the 'continuum failure' and in his analysis of the progressive he gives an account for the imperfective paradox.

In Dowty's definition of Become[ϕ] a solution to the

'continuum failure' is offered. He adopts the definition of the interval and related notions from Bennett and Partee and uses them in his truth conditions for Become[ϕ]. The semantics for Become[ϕ] captures the intuition that a sentence can be true at an interval without being true at all times within the interval. The general idea is to define the truth of Become at an interval with reference to the truth of ϕ at the ends of the interval:

(7) [Become ϕ] is true at I iff (1) there is an interval j containing the initial bound of I such that $\sim\phi$ is true at J (2) there is an interval K containing the final bound of I such that ϕ is true at K, and (3) there is no non-empty interval I' such that $I' \subset I$ and conditions (1) and (2) hold for I' as well as I.

As I noted above, Bennett and Partee's definition was motivated by accomplishment sentences which in Dowty's aspect calculus are represented with a Become-operator. Dowty was influenced by Von Wright's (1963) logic of change, which regarded events in general as transformations of state. Accomplishments and achievements in Dowty (which are events in Von Wright) are represented by a Become-operator which has a stative predicate (or adjective) as an argument. Thus, the intransitive verb <u>open</u> is represented by λx[Become open'(x)] where open' is an adjective translation and Become is defined as above.

The truth of a sentence in the progressive with an

accomplishment verb is evaluated with respect to an index consisting of an interval and a world. By considering only the endpoints of the interval, the "continuum failure" which arose in the case of accomplishment verbs is accounted for. The second component, i.e the world, has to do with the imperfective paradox.

To account for the imperfective paradox Dowty suggests treating the progressive as a modal-temporal operator. He assigns truth conditions to a progressive sentence relative to an index of an interval I and a possible world. From the sentence John was drawing a circle one can conclude that the existence of a circle was a possible outcome of John's activity. This line of thought suggests that the truth value of the progressive at indices consisting of an interval I and a world w depends on the truth of ϕ at indices <I',w'>, where I' contains I and w' is exactly like w at all time preceding and including I.

In his final definition of the progressive Dowty adds a primitive function "Inr" which assigns to each index consisting of a world and an interval of time, a set of worlds which he calls inertia worlds. Inertia worlds are worlds which are exactly like the given world up to the time in question and in which the future course of events after this time develops in ways most compatible with the past course of events:

(8) [Prog ϕ] is true at <I,w> iff for some interval I' such that $I \subset I'$ and I is not a final subinterval of I', and for all w' such that $w' \in Inr(<I,w>)$, ϕ is true at <I',w'>.

We see that the truth condition for Prog[ϕ] requires not only the truth of ϕ at some possible world like the actual one up to a certain time, but its truth in all of such worlds that meet certain conditions. This is to take care of cases of a coin which is being flipped but has not yet landed and of begining to draw a picture without yet deciding whether it is to be a painting of a horse or a unicorn. In the case of the flipped coin the coin is coming up heads or the coin is coming up tails both can not be true since the relevant set of worlds would include both worlds in which it comes up heads and in which it comes up tails.

Stump (1981) provided examples of present participle adjuncts which exhibit the imperfective paradox:

(9) Crossing the street, John was hit by a car.

He observed several differences between present participle adjuncts and the progressive. Some predicates may occur as present participle adjuncts but not with the progressive:

(10) a. Being a sailor, John smokes a pipe.

b. *John is being a sailor.

Also, a VP in the perfect may occur as a present participle

adjunct but never as a progressive:

(11) a. Having finished his work, John went to bed.

b. *John is having finished his work.

Stump also observed that present participle adjuncts deriving from VP's in the perfect may themselves contain a progressive:

(12) Having been reading the book, John knew the answers.

In order to decide which part of the meaning of the present participle in free adjuncts constructions derives from the meaning of the present participle phrase and which from the meaning of the free adjunct, he checked free adjuncts with other constructions like past participle phrase, adjective phrase, prepositional phrase etc. In all these cases the imperfective reading of the free adjunct is not possible- as for example, in the case of a past participle:

(13) Beaten, the Phillies left the field. (perfective reading)

Furthermore, he has shown that the present participle in other constructions may be understood imperfectively:

(14) Mary found the dying man.

(15) John sat reciting the Iliad.

(16) While copying the sentence into his notebook, he ran out of ink.

All this shows, claims Stump, that the progressive semantic aspect does not have an independent status in English. He offers a semantics for the present participle phrase by defining Ing, an intensional logical expression of type <<s,t>,t>:

(17) Where ϕ denotes a proposition p, Ing(ϕ) is true at an index <w,i> iff for some interval i' such that $i \subset i'$ and i is not a final subinterval for i', and for all w' Inr(<w,i>), p((<w',i'>)=1.

Stump, as we see, identifies the problem of the imperfective paradox with the semantics of the present participle which may appear in different constructions, and the semantics he gives to Ing is basically Dowty's treatment of the progressive. The progressive is for Stump a predicative construction consisting of a copula be and the present participle phrase. Therefore the objections which may be raised against Dowty's modal-temporal treatment of the progressive hold also for Stump's analysis.

1.3.2. Some objections. Dowty does not provide us with a characterization of the relation which holds between inertia worlds and the actual one. For him the inertia function is a primitive notion. He rejects Lewis' similarity relation which was used in his counterfactual analysis and which requires that the actual world be at

least as similar to itself as to any other world. This of course would lead him back to the imperfective paradox. He also rejects the notion of probability by which 'natural course of events' may be defined. We can say by looking at the past that a certain accomplishment or achievement was occurring at the time, even though the probability of its completion was very small.

At a certain point Dowty mentions that the beliefs of the agent (in the case where the logical subject can be thought of as an agent) may be involved in deciding what worlds count as inertia worlds. However, he finally rejects the idea that the meaning of progressive sentences should be a function of the speakers' or hearers' beliefs.

Some attempts were made to introduce the intentions of the agent of a progressive sentence to bring about an accomplishment as determining what worlds count as inertia worlds. However, it is easy to show that such an intention is neither a sufficient nor a necessary condition for the truth of all sentences in the progressive. Consider the example suggested to me by Partee:

(18) John is building a perpetual motion machine.

Sentence (18) can not be true, although John has the intention to build a perpetual motion machine. This shows that the agent's intentions are not a sufficient condition for the truth of progressive sentences. It also should be

possible for the agent to fulfill his intentions. Given the natural laws, there are no inertia worlds at which there exists a perpetual motion machine. If the agent's intentions were a sufficient condition for the truth of progressive sentences, then John is building a house could be true even before he became physically involved in the process associated with building houses, i.e when he merely planned in his mind to build a house sometime in the future. We do not want to accept such a consequence especially since the case may be extended further by allowing intentions to be random, or even subconscious. All this suggests that the agent's intention is not a sufficient condition for the truth of all sentences in the progressive.

The agent's intentions are also not a necessary condition for the truth of all sentences in the progressive. In

(19) The stone was rolling down the hill when it exploded.

there are inertia worlds where the stone reached the bottom of the hill although no intention is involved here. A similar example involving a human agent was given by Hinrichs (1983):

(20) The old composer was writing a symphony even though he knew he would not finish it.

Sentence (20) can be true although due to his imminent death the composer might have no intention of finishing the symphony. He can still be in the process of writing the first movement, making (20) true.

There is another problem with the definition of the progressive which reveals itself in when-clauses. Consider the following sentence:

(21) John was watching T.V when Bill entered the room.

If when is interpreted as suggested in Bennett and Partee (there, p.31) as "at the time that" or "during the time that" then sentence (21) entails that the time of John watching T.V actually extended at least a few moments beyond the time that Bill entered the room. This is so since the time at which the truth of the progressive is evaluated, let call it t, is identical with the time of Bill's entering the room, and since the progressive is evaluated with respect to a bigger interval where John watched T.V is to be true. According to Bennett and Partee's definition of the progressive, sentence (22):

(22) John was watching T.V when he fell asleep.

entails that the period of John's watching T.V extended beyond the time of his falling asleep. This was noticed by Dowty and avoided by him in his analysis of the progressive, where he only required that it was possible for John's

activity to continue beyond the time specified by the when-clause.

A genuine difficulty for Dowty which arises in the case of when-clauses is the following. Consider again the sentence:

(23) John was crossing the street when he was hit by a truck.

If the when-clause event and the main-clause event occur at the same time, then the event of John being hit by a truck falls within the interval I in Dowty's definition at which the progressive operator is to be interpreted for the main-clause. Since inertia worlds are identical to the actual world up to the point of evaluation, then every inertia world defined at I will contain the fact that John is hit by a truck at I. It follows from this that there are no inertia worlds where ϕ is true. We want to fix the point of evaluation in a way that would not include the moment he was hit by a truck.

To conclude, there are two puzzles still left unresolved in the temporal-modal treatment of the progressive: the first concerns the nature of the inertia function (or the accessibility relation) so crucial in the solution of the imperfective paradox and the second concerns fixing the time of evaluation of the progressive in when-clauses.

2. Non-Topological Truth Conditions for the Progressive

2.1. Vlach's Suggestion

Vlach (1981) claims that any correct truth condition for the progressive operator applied to accomplishment and achievement sentences must be non-topological. By this he means that the set of instants at which Prog[ϕ] is true can not be a function of the set of instants and intervals at which ϕ is true. The definitions of Montague, Bennett and Partee are topological in this sense. Dowty's definition is not purely topological because of his introduction of possible worlds, but in the cases where ϕ in Prog[ϕ] is true in the actual world, it is topological as well.

Vlach introduces a counterexample which applies to all the previous definitions of the progressive. Consider the following sentences:

(a) Max dies.

(b) Max's life ends.

(c) Max is dying.

(d) Max's life is ending.

Furthermore, suppose that a bus is about to hit Max. In that case we say that (d) is true and (c) is false. However, according to the topologically specified truth conditions for the progressive, since both achievements _die_ and _ends one's life_ have the same extension, and Prog[ϕ] at t or I is

defined in terms of ϕ at some interval containing t or I, sentence (c) and (d) can not have different truth conditions.

Vlach suggests that John's life can be in the process of ending without John being in the process of dying. The idea is that the process of dying is specifically biological, while the process of ending one's life is more general. Thus, while (a) and (b) are true at the same moments, (d) can be true in circumstances where (c) is false, e.g. in the case where the truck is approaching John, but has not yet hit him.

What Vlach is pointing out is that the truth of Prog[ϕ] for achievements and accomplishments is not exclusively depended on the truth of ϕ but on the process that must be going on in order to make the progressive of a sentence true.

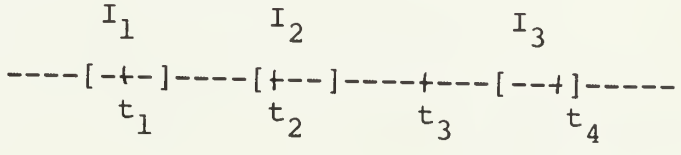
The process that must be going on to make the progressive of a sentence ϕ true is always a process that is connected with the truth of ϕ. If ϕ is a process sentence, then the process that goes on when the progressive of ϕ is true is the same one that goes on when ϕ is true. If ϕ is an accomplishment or achievement sentence, then the process that goes on when the progressive of ϕ is true, is the one that will lead, if continued, to the truth of ϕ.

2.2. Bennett's Suggestion

Bennett (1981) distinguishes between closed and open intervals. Occurences of processes (activities) are represented by Bennett by open intervals and occurences of accomplishments (performances in his terms) like John builds a house are represented by a union of closed intervals.

Sentences can be evaluated with respect to unions of intervals, not just intervals. The closed intervals in (24) represent period of work and the gaps represent rest. John starts building a house at t_1 and finishes it at t_4. At t_2 he is building a house but not at t_3.

(24)



However, John build a house is not true merely with respect to $I_1 \cup I_2 \cup I_3$. The sentence is not true at any other closed point sets. However, it is true at the open subintervals of I_1, I_2, I_3; this analysis retains an open subinterval condition on accomplishment sentences. If an accomplishment sentence is true at a union of closed intervals, then it is true at every open, connected subinterval of that union.

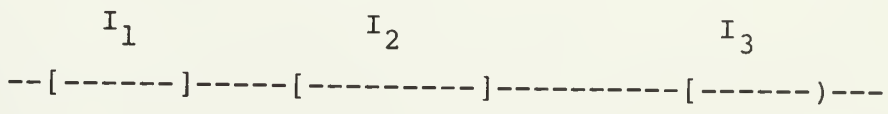
Bennett defines the truth of a progressive sentence in the following way:

(25) Prog ϕ is true at a union of intervals A iff A is a moment of time, and there exists a union of intervals A' such that A' is an open, connected interval, $A \subseteq A'$, and ϕ is true at A'.

In this way, John is building a house is true at t_2 because there are open intervals A' (for instance the interior of I_2) at which John build a house is true. The fact that John build a house is true at the open subintervals of $I_1 \cup I_2 \cup I_3$ does not affect the truth of non-progressive sentences, since in the recursive truth definition, these are always evaluated with respect to closed point sets.

Bennett exploits the distinction between closed and open sets to solve the imperfective paradox. The truth of a sentence in the progressive depends on the tenseless sentence being true at an open interval. The truth of a simple tense sentence on the tenseless sentence being true at a closed interval. This allows Bennett to represent an incomplete building of a house in the following way:

(26)



As before we stipulate that the tenseless sentence John build a house is true at every open subinterval of $I_1 \cup I_2 \cup I_3$. However, in this case there is no closed union of intervals at which John build a house is true.

Bennett's definition of the progressive is compositional like that of Montague's, Bennett and Partee's and Dowty's. In a certain sense his analysis is similar to Vlach's. There is a single basic notion of truth with respect to an interval, but there are two kinds of intervals- open ones and closed ones. Vlach did not distinguish between two kinds of intervals but had two components in the lexical meaning of the verb- an event and a process part. According to Vlach the process part of the meaning of the verb can be true at an interval although the event part of the meaning is false for that interval. For Bennett, a basic sentence would be true with respect to the open interval and false with respect to the closed one. Thus, although Bennett's analysis is compositional it shares some features with Vlach's and hence is exposed to the same objection. The basic lexical meaning of a verb encodes the same information in the two proposals.

2.3. Some Difficulties with Non-Topological Truth Conditions for the Progressive

As we have said, under Vlach's approach the lexical meaning of the verb has two components- an event and a process, and the progressive is defined in terms of the process component of the lexical meaning. In the traditional approach the lexical entry of the verb does not

have two components and that is why the progressive of a sentence with an accomplishment is defined in terms of the truth of the event sentence.

Neither Vlach nor Bennett specifies or formalizes the link between the meaning of the accomplishment/achievement verb and the meaning of the activity (process) corresponding to them- a link which has been incorporated into their analysis of the progressive. Consider the following sentence suggested by Dowty:

(27) John was making Bill a millionaire.

There are many ways in which John can accomplish making Bill a millionaire. John might be about to die leaving his millions to Bill, he might be gambling, he might be stealing money or looking for an hidden treasure- all these activities have no necessary link to the accomplishment of making someone a millionaire. Each of these activities viewed independently of the context in which (27) is uttered and of the meaning of the accomplishment VP <u>make one a millionaire</u> does not guarantee John's possession at some point in time of millions of dollars.

The meaning of the above accomplishment (in addition to the context) tells us what the possible associated activities are which may lead to its fulfillment. There is no single activity connected with the meaning of the

accomplishment. Vlach's definition of the progressive can not explain how speakers have learned the meaning of (27).

I find another difficulty with the non-topological approach. Consider the following sentence:

(28) John is polishing every boot.

Sentence (28) is ambiguous. When the universal quantifier has a wide scope over the progressive, sentence (28) says that John is polishing every boot at the same instant. To get the possibly sequential reading the quantifier _every boot_ must be in the scope of the progressive operator.

We can establish the truth value of _John loves every woman_ if we know the extension of _love_, which is a relation. Consider now the sequential reading of Prog(_John polish every boot_). It is not apparent that the process part of the meaning of _polish every boot_ can be derived from the basic lexical meaning of _polish_ (even if we include the process part of the basic lexical meaning). It seems that Vlach's theory handles cases of the progressive of atomic formulas, but not of complex ones. One way to circumvent this problem is to say that the process part of the verb is intensional in the object position. If we apply the process part of the meaning of _polish_ to the generalized quantifier which is the meaning of _every boot_, then we get the process part of the meaning of _polish every boot_ , as desired. But

then we will have to say that the process version of any accomplishment and achievement verb is intensional. In PTQ, all verbs are treated as intensional in the grammar and extensional transitive verbs are governed by meaning postulates. It seems perfectly possible to limit the extensionality meaning postulates to the event part of the meaning of a verb. Thus my objection to Vlach's proposal may not be insurmaountable.

Another example which may be raised is that mentioned by Parsons (1983) as a possible objection to his analysis. If Mary is building a house then her building event has an object which is a house and so there is a house that she is building. Let us suppose Mary dies when the house is only one fifth finished. Some might claim there is no house here, since an unfinished house is not a house. The question is: how much of a house needs to be built before the agent's activity is described as one of building a house? In other words, when do we say that a certain activity which goes on is an activity of a certain kind if it is not the output of the process which determines this? (This is of course problematic only for the progressive of accomplishments and some achievements).

Åqvist's example mentioned by Parsons (1983) raises a similar point, consider:

(29) Mary is drawing a circle.

If Mary is interrupted, then no circle gets completed. Many will insist that an incomplete circle is no circle at all but an arc with constant curvature. There is a present object of Mary's activity, but it is not clear which object exactly it is. There is no single way to describe the activity she is involved in: is it the drawing of a circle or the drawing of an arc? Such cases lead us to agree that the progressive is dependent on the meaning of the atomic sentence.

3. A New Proposal

3.1. The Vagueness of the Progressive

Angelika Kratzer (1977) offered an analysis of must and can within the framework of possible world semantics. A similar idea to that which she employed in her analysis of modal verbs may be employed in the treatment of the progressive. My suggestion is in line with that of Dowty's i.e, treating the progressive as a modal-temporal operator, but abandons the notion that there is a single primitive inertia function, which I have shown in 1.3.2. to be unsatisfactory.

Kratzer claimed that different notions of must and can are involved in sentences in which these words are uttered. She gives the following example to demonstrate it:

(30) All Maori children **must** learn the name of their ancestors.

(31) The ancestors of the Maoris **must** have arrived from Tahiti.

(32) If you **must** sneeze, at least use your handkerchief.

(33) When Kahukura-nui died, the people of Kahungunu said:Rakaipaka **must** be the chief.

The must in sentence (30) is a deontic one which refers to a duty, the must in sentence (31) is an epistemic one, that in sentence (32) a dispositional one and the must involved in (33) is what is often called a preferential must which refers to wishes and preferences. Kratzer paraphrases (30)-(33) to illustrate what is meant by must in the utterances of these sentences:

(30') **In view of what their tribal duties are,** the Maoris children **must** learn the names of their ancestors.

(31') **In view of what is known,** the ancestors of the Maoris **must** have arrived from Tahiti.

(32') If **In view of what your dispositions are-** you **must** sneeze, at least use your handkerchief.

(33') When Kahukura-nui died, the people of Kahunguru said: **In view of what is good for us** Rakaipaka **must** be our chief.

The suggestion is to treat must as a relative modal phrase must in view of which has two arguments: a phrase like "what is known" and a sentence. The first argument which is

provided by phrases like "what is known" or "what is good for us" is very often missing in our use of English, as can be seen from the examples (30)-(33). It is the context of utterance which provides a deontic argument when uttering (30), an epistemic argument when uttering (31), etc. It follows from this that it is not must which has different meanings but the missing argument whose presence was felt in all the occurences of the verb must.

After making these observations Kratzer describes how must and can should be treated within a framework of possible world semantics. The meaning of the phrase "what is known" is that function from the set of possible worlds into the set of all propositions which assigns to each possible world the set of propositions which are known in that world. In general, the first argument of the modal will be a function f from worlds to sets of propositions. The meaning of must in view of (lets call it Must) is a function which assigns a proposition to a pair consisting of a function like f and a proposition p. Must assigns to the pair consisting of f and p that proposition which is true in exactly these possible worlds w where p follows logically from the set of propositions which f assigns to w.

To make it more clear, I state her suggestion by using lambda-operators. Where w is a set of worlds, f a function from a set of possible worlds to the set of sets of

propositions, then must in view of (Must) is defined as follows:

(34) Must(f,p)= λw[p follows from f(w)]

(which is a characteristic function of a set of worlds, i.e. a proposition). Let us illustrate the definition for sentence (31). Where f is as before (a function from a set of possible worlds to the set of sets of propositions which assigns to each possible world the set of propositions which are known in that world.) and p is the proposition [The ancestors of the Maoris arrived from Tahiti]'. (The latter abbreviates the denotation of The ancestors of the Mauris arrived from Tahiti. Known' is a relation between propositions and worlds and Known'(q,w) means that q is known in w)

(35) Must $\{\lambda v\ \lambda q$[Known'(q,v)], [Ancestors of the Maoris have arrived from Tahiti]'$\}$ =
$\lambda w\{$[Ancestors of the Maoris have arrived from Tahiti]' follows from ($\lambda v\ \lambda q$[Known'(q,v)] (w))$\}$

and by λ-conversion:

(36) $\lambda w\{$[Ancestors of the Maoris have arrived from Tahiti]' follows from λq[Known'(q,w)]$\}$

The same idea can be developed in our analysis of the

progressive. Let's repeat Dowty's definition:

(37) [Prog ϕ] is true at <I,w> iff for some interval I' such that $I \subset I'$ and I is not a final subinterval for I', and for all w' such that $w' \in Inr(<I,w>)$, ϕ is true at <I',w'>.

The inertia function in Dowty's definition is a constant one, a primitive function. Dowty did not characterize the nature of that function (or in Lewis' terms the "accessibility relation") which selects the inertia worlds. In 1.3.2. I introduced different notions which seem to be involved in determining inertia worlds which are like the actual one up to a certain time, and differ afterwards. I mentioned the possibilities where the selected inertia worlds are determined by the agent's intention, the similarity relation, physical laws etc, and have claimed that no single one of these is satisfactory or can be regarded as a necessary or sufficient condition for the truth of progressive sentences. The difficulty arose because we wanted to pick up one of these notions in order to describe the nature of the inertia function taken as a constant, and none of them was satisfactory when taken in isolation. However, it seems that all these notions (and maybe others) are involved in the truth conditions for the progressive and the following examples demonstrate it:

(38) Given his intentions, John was going to Boston when he was hit by the truck.

(39) Given the laws of motion, John's life was ending when God rescued him.

(40) Given the legal practices in the country, John was being framed for the murder, when his rich father rescued him.

In (38) it is John's intentions which determine the inertia worlds where the progressive is evaluated. In these worlds John went to Boston although in the actual world he was hit by a truck. In the case of sentence (39), assume it is uttered in the case where a truck is about to hit John when God's hand appears out of the darkness and snatches him away. In this case the inertia worlds which are picked up are determined solely by physical laws (we assume God stays outside physics) and in these worlds John dies although in the actual world God rescues him. For example (40), let John be Rockefeller's son. A certain organization is interested in sullying John's name by accusing him with the murder of a communist. His enemies supply the court with convincing false evidence by which the law should have found him guilty. The inertia worlds selected here are these in which the courts operate in the way they usually do and John is framed for murder. In the real world his rich father, Rockefeller, bribes the judge and saves him.[3]

The fact that we can utter sentences like (38)-(40) and many others with Given x, and the progressive and these sentences can have an imperfective reading, suggests that in

the meaning of the progressive there is a free variable over sets of worlds which is determined by the context. In Dowty the function from indices (worlds and times) to propositions is a constant; we want it to be a free variable over worlds which receives a value by a context. Sometimes the context selects the inertia worlds which are the agent's intentions, sometimes the inertia worlds are determined by physical laws etc. Kratzer argued that the first argument of Must i.e, the function f, is often misssing in must- sentences and is determined by the context, and the same is true in the use of progressive sentences where the phrase Given x is often missing and is covered by context. The notion of necessity is involved in both Kratzer's and my suggestion. This suggests that the appeal to a contextually specified notion of inertia world may not be unprincipled: the contextual delimitation of the domain of the quantification over worlds induced by a natural language expression of necessity may be a general phenomenon.[4]

Ed Gettier has suggested (personal communication) another argument which can be used against Dowty's idea of a single primitive inertia function in his definition of the progressive, and which supports my own theory of the vagueness of the progressive. The VPs cross the street and walk to one's own death are both accomplishments. Let us assume John was hit by a car at 12 o'clock. The sentences

(41) John was crossing the street.

(42) John was walking to his death.

are both true at 11:59. This can not be the case if we have a single inertia function since in all inertia worlds at which John died he did not cross the street and in all inertia worlds at which he crossed the street he did not die. Since at 11:59 both sentences (41) and (42) are true, a modal treatment of the progressive which employs the notion of a single inertia function makes the wrong prediction in this case. However, under my own treatment of the progressive both (41) and (42) can be true at the same time since the corresponding simple tense sentences are evaluated with respect to different classes of inertia worlds. The inertia worlds relevant for the truth of (41) are those in which John's intentions are fulfilled and those relevant for the truth of (42) are those where physical laws hold.

Gettier has also suggested that in my analysis of the progressive a problem may arise when trying to account for the truth of sentences like (19) repeated below:

(19) The stone was rolling down the hill when it exploded.

Since the stone does not have intentions it is not clear what are the inertia worlds which account for the truth of

(19). The laws of nature are those which enable the stone to reach the bottom of the hill and those which enable it to explode. So, we can not pick the laws of nature as those which determine the inertia worlds at which the stone reached the bottom of the hill. One way to avoid this difficulty is by restricting the set of natural laws to subsets like the laws of motion, law of genetics, hydrostatics, chemistry, etc. It is the inertia worlds at which the laws of motion hold but not chemistry, which are responsible for the truth of (19). But consider the following example

(43) The wheel was rolling across the road when it was knocked over by the falling rock.

The rolling of the wheel and the falling of the rock are both governed by the laws of motion, so we can not pick a notion of inertia that contains one but not the other.

Michael Jubien has suggested (personal communication) an example in which the progressive is used to report that somebody is engaged in a certain activity and has nothing to do with modality. Someone can describe a section of a baseball game he has been watching as follows:

(44) Smith was pitching a no hitter, when John tripled to left.

It is not Smith's intentions or physical laws which are

relevant for the truth of (44) but a sequence of structured activities which constitute pitching a no hitter in a baseball game. One may object to this example by claiming that pitch a no hitter is a process verb rather than an accomplishment, so (44) can not be taken as a case that the modal treatment of the progressive can not handle. But if pitch a no hitter is a process verb like run, then we could have used (46) as well as (45) to report:

(45) I saw Smith run yesterday.

(46) I saw Smith pitch a no hitter yesterday.

but (46) is not true in a case where Smith did not finish pitching a no hitter. So this example raises a difficulty for my treatment of the progressive as well as for Dowty's.

3.2. When-Clauses and the Imperfective Paradox

One of the objections raised in section 1.3.2. against Dowty's definition of the progressive was the claim that if the interval at which the main-clause sentence is evaluated is the same as that at which the sentence in the when-clause is, then the event of John being hit by a truck described in sentence (23):

(23) John was crossing the street when he was hit by a truck.

falls within the interval I at which the progressive main

sentence is evaluated, and therefore in every inertia world (which is exactly like the actual world up to and including I) John was hit by a truck. It follows from this that there are no inertia worlds where John crossed the street is true and therefore, contrary to our intuition, sentence (23) is false.

Hinrichs (1981) suggested a treatment of tenses, adverbs and temporal anaphora in sentences with when, before and after-clauses which was pursued in the framework of Kamp's discourse representation structures. Hinrichs focused on temporal structures of past tense narrative discourse and like Kamp (1981b) and Bach (1980; 1981) took events, processes and states (which Bach gave the generic term "eventualities") and the relations of precedence and overlap between them as primitive, rather than moments or intervals of times. In the heart of his treatment of temporal anaphora lies Reichenbach's notion of reference time, which Hinrichs extended into a formal semantics framework. Partee has pointed out (1984) that the theory of discourse representation which has provided a unified treatment of pronouns and the approach which takes eventualities rather than times as basic together with the notion of reference time can explain to a greater extent the analogies between nominal and temporal anaphora noticed by her in an earlier paper (1973). In that paper Partee

observed that tenses (which involve several categories of expressions like tenses, adverbials and adverbial clauses), like pronouns, are anaphoric and can have either a linguistic or a non-linguistic antecedent. The tense morpheme was treated by her in that paper as a pronoun-like variable over time. Partee later observed (1984) that this can be carried out more elegantly by using reference times which do not correspond to any constituent in the sentence but are part of a necessary context for interpreting tensed sentences. In the same paper she presents the general approach taken by Hinrichs in his treatment of temporal structures for a fragment of English and further extends it. We will summarize below the main features of Hinrichs' and of Partee's treatments in order to pursue the issue of temporal reference in when-clauses like (23).

In Kamp's theory (1981a), discourse representation structures are descriptions of partial models and are true with respect to a complete model if they are embeddable in it (embeddability plays in his theory the same role that satisfaction does in predicate logic). In Kamp's account of nominal reference each occurence of a proper name or an indefinite noun phraze introduces a new element into the discourse representation, while pronouns refer to elements already introduced. Discourse representations can be used in a similar way to describe temporal reference as suggested

by Kamp (1981b) and Hinrichs (1981). In the following little narrative taken from Hinrichs and given in Partee (1984),

(47) Jameson entered the room, shut the door carefully
e_1 e_2
and switched off the light.
e_3
It was pitch dark around him,
s_1
because the venetian blinds were closed.
s_2

the clauses labled e_1-e_3 describe events (e_1 is the event of Jameson entering the room) while s_1-s_2 describe states. It was observed that an event sentence moves the action forwards in time while a state sentence describes how things are at the time of the last mentioned event. Partee represents the discourse representation (47) in the box given below by using "$<$" for the relation of complete precedence, "O" for overlapping, "$\subseteq$" for the relation of temporal inclusion, and r_s for the speech time. There is a past reference time which is specified at the begining of the discourse and is moved forwards with the introduction of each new event-sentence. Each new past tense event occurs within the then-current reference time and causes the reference time to be shifted to a new reference time which follows the just introduced event (In Partee's discourse representation structures given below r_0 is the past

reference time, r_s the present reference time and r_1, r_2, r_3 are the "updated" reference times introduced between r_0 and r_s). States and processes include the current reference time but need not overlap the event that led to the introduction of that reference time.

Partee represents (47) in a discourse representation box following Kamp (ms. 1981b)

(47')

r_0 e_1 r_1 e_2 r_2 e_3 r_3 s_1
s_2 r_s

$e_1 \subseteq r_0$
$e_1 < r_1 < r_s$
$e_2 \subseteq r_1$
$e_2 < r_2 < r_s$
$e_3 \subseteq r_2$
$e_3 < r_3 < r_s$
$r_3 \subseteq s_1$
$r_3 \subseteq s_2$

e_1: Jameson entered the room
...

e_2: .....
....

In the discourse representation (47') e_1 is the event-token of the event type given in the box following it. As a consequence of the ordering specifications s_1 and s_2 must both overlap some time "just after" e_3 (this is Partee's term, and will be explicated later) and may but need not

overlap e_3 itself.

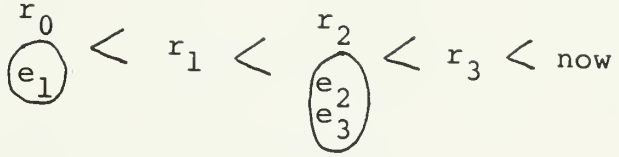
To conclude, a single sentence is interpreted with respect to a reference time. If it is a state or a process sentence the state or process must hold or go on at the current reference time; when it is an event sentence, the event occurs within the then-occuring reference time while a new reference time following it is introduced.

Hinrichs assigns different roles to the main and subordinate clauses with respect to the dynamic of reference time. Suppose we interpret a simple past tense narrative where the past reference time is r_1 and the next sentence begins with a <u>when</u>-clause. The <u>when</u>-clause introduces a new reference time r_2 which follows r_1 and the main-clause is interpreted with respect to r_2. To demonstrate how reference time is triggered in <u>when</u>-clauses under Hinrichs' treatment Partee suggested the following little discourse:

(48) Mary turned the corner. When John saw her, she crossed the street.
e_1 e_2 e_3

and extracts from it the following temporal conditions of discourse representation structures (where circles represent inclusion i.e $e_1 \subseteq r_0$, $e_2 \subseteq r_2$, $e_3 \subseteq r_2$)

(48')



Hinrichs does not impose any relative ordering on the events in the when and main-clauses and gives examples in which the event in the main-clause does not follow that in the when-clause. In example (49) both events can happen at the same time and in (50) the event in the when-clause follows that in the main-clause (both examples are Hinrichs', adjusted by Partee to keep the surface order of the clauses constant):

(49) When John wrecked the Pinto, he broke his arm.

(50) When the Smith threw a party, they invited all their friends.

Partee distinguishes between the temporal relation "just after" represented by "$\lessapprox$" and the relation of precedence represented by "$<$". The reference time introduced by an event sentence is located "just after" the event (According to Partee a newly introduced reference time is definite if it is "just after" some uniquely specified event, and indefinite when it is after, before, or within some given event or "just after" an event not specified uniquely). Hinrichs only requires that the reference time be put within or surrounding the when-clause in stative or eventive

sentences. The "just after" relation introduced by Partee is represented in the temporal condition (48'') of the discourse representation structure of (48):

(48'') $\overset{r_0}{(e_1)} \lessapprox r_1 < e_2 \leqslant \overset{r_2}{(e_3)} \lessapprox r_3 < \text{now}$

The main difference between her treatment of when-clauses and Hinrichs' is in how the when-clause characterizes the new reference time introduced by it. Partee says that the primary function of a when-clause in simple linear narrative is to provide a new reference time for the main-clause, and the event described in the when-clause does not have to occur within the then-current reference time. This is consistent with the temporal condition conveyed in (48'') where e_2 introduces the new reference time r_2, but does not occur within it, nor within r_1. She provides the following example to account for the role when-clauses play in linear discourse in the introduction of a new reference time:

(51) People began to leave. (e_1) The room was empty. (s_1)
The janitor came in. (e_2)

(52) People began to leave. (e_1) When the room was empty, (e_2)
the janitor came in. (e_3)

Discourse (51) is anomalous because the state described by s_1 of the room being empty is not expected to hold just after people began to leave, and since s_1 can not move the action forwards, The janitor came in can not be interpreted with respect to a time after people began to leave, and just after the room was empty. Such a problem does not arise in the case of discourse (52) since the when-clause (which is an inchoative and not a stative sentence) introduces a later reference time (and the event it describes is not within any previous reference time). So the janitor is understood to come in after people began to leave and just after the room was empty.

Partee has also provided examples with before and after which show that as with when-clauses the subordinate clause is always processed before the main-clause and interpreted with respect to the main clause introduced by it.

So far examples have been given of the three possible temporal conditions which govern discourse representation structures of narratives with when-clauses. These three possibilities are listed in cases (a)-(c):

(a) The when-event and the main-clause event can occur at the same time, as is the case in example (49).

(b) The event in the main-clause is just after the event in the when-clause as in example (48) (The "just after" relation may also distinguish between the ordering of events in when and after-clauses).

(c) The event in the when-clause is just after the event in the main-clause, as is the case in example (50).

Case (b) is the only one handled by Partee and case (c) is disallowed by her scheme. Sentences (53)-(54) are examples of case (a) where the events in the two clauses occurred at the same time:

(53) When John became chairman of the board, Mary became president.

(54) When the pressure of the gas rose, the temperature increased.

The same temporal relations hold when the main-clause comes before the when-clause in the linear order of the discourse:

(55) John broke his arm, when he wrecked his Pinto.

(56) Mary became president, when John became chairman of the board.

(57) The temperature increaesed, when the pressure of the gas rose.

At the begining of this section we have said that if the temporal relation between the two clauses are as stated in case (a), then Dowty's analysis of the progressive, an extended version of which was adopted by us, is problematic. In evaluating the truth of sentence (23) every inertia world includes the fact that John was hit by a truck, so it is not true in any of them that he crossed the

street and thus, contrary to our intuition, sentence (23) should be false.

Simple past tense discourse in which the ordering of events is as described in case (b), i.e the event in the main-clause comes just after that of the when-clause, is the most common one among the three possible temporal relations among events described in (a)-(c). As we have already mentioned, Partee handled only case (b). However this relation can not hold between a when-clause in the progressive and a main-clause in sentences like (23) which demonstrate the imperfective paradox. This is so since it implies that first John was hit by the truck and only just after that event occurred was he crossing the street. A progressive sentence is stative. We said before that a state described by a stative sentence must overlap some time just after the event in the when-clause and may but need not overlap that event. In sentences involving the imperfective paradox we must require that the state described by the progressive main-clause should never overlap the event in the when-clause. As we said before, in the case of sentence (23) it can not follow that event.

Partee does not discuss cases where in the linear order of the discourse the main-clause precedes the when-clause and how this affects the dynamic of reference time and the relative ordering of the events described in them. In

sentences (23) the when-clause follows the main clause in the linear order. In examples (55)-(57) the postposing of the when-clause does not affect the relative ordering of the events. The same is true of examples (59) and (61).

(58) When the room emptied, the janitor came in.

(59) The janitor came in, when the room emptied.

(60) When the janitor came in, the room emptied.

(61) The room emptied, when the janitor came in.

In (58)-(59) the janitor came in just after the room was empty and in (60)-(61) just after the janitor came in the room emptied (the later event must occur in a very short time). Sentences (58) and (59) are paraphrases and so are (60) and (61). In the same way the when-clause can be preposed in sentence (23) to yield (62), which is its paraphrase:

(62) When John was hit by a truck, he was crossing the street.

If the linear order of processing when-clauses does not affect the ordering of the events in the two clauses as is the case in (55)-(57) and (58)-(59), and if Partee's description of the ordering of events in when-clauses (case (b)) and the way reference time is triggered is correct, one wonders how sentence (23) can be true given the modal definition of the progressive.

Examples of temporal relations as in case (c) where the when-clause event follows the main-clause are quite rare. However, this is exactly the event ordering which we want to hold in example (23). John was crossing the street is true at an interval I iff in all worlds exactly like the actual one up to and including I and in which the future course of events is that in which John's intentions are fulfilled, John crossed the street is true. Since he was hit by a truck some time after he was crossing the street, inertia worlds need not include the fact that a truck prevented him from completing his crossing.

The temporal relation described in (b) is the most common in the progression of simple past when-clauses but is the least plausible one to hold between a main-progressive clause and a when-clause in sentences which demonstrate the imperfective paradox. On the other hand the least common ordering of events in simple past when-clauses, which was described in (c), is the one which must hold in sentences involving the imperfective paradox. We can not explain this mystery but only point out that the theory provided for the organization of time in when-clauses in past simple tense makes the wrong prediction for progressive sentences like (23), which exhibit the imperfective paradox.

FOOTNOTES

[1]Montague's remark suggests that this analysis might be due to Dana Scott.

[2]This complicated issue is discussed in chapter I 3.1. where I compare the condition on the lengh of the gaps in the case of process and inchoative process verbs.

[3]Partee has mentioned to me that the notion of inertia world in which John's intentions are fulfilled is not always sufficient. We must also add a condition that it is possible for John to be in Boston, i.e there are no intervenning forces which make it impossible for him to be there. Such a condition also takes care of sentence (18), mentioned before, John is building a perpetual motion machine, which can not be true, although John has intentions to build such a machine. The possibility conditon may also be added to inertia worlds which are not determined by intentions such as in examples (39) and (40).

[4]More work is required to determine what sorts of functions can be specified by the context in the case of the Progressive operator and what functions are good for different operators like Must, Can, etc.

C H A P T E R IV

ASPECTUAL VERBS AND MORPHOLOGY- EVIDENCE FROM HEBREW

1. Aspectual Verbs and Lexical Rules

1.1. Lexical vs. Syntactic Rules

In various places in the literature (Jackendoff 1975, Aronoff 1976, Dowty 1978, 1979, and Bresnan 1978) it is argued that the regularities among sets of morphologically related words should be described by a set of rules distinct from syntactic ones called "lexical rules". Lexical rules are responsible for derivational morphology, zero derivation, compound formation, etc. In the process of derivational morphology, a word is prefixed or suffixed with a new phonological component which does not constitute an independent word, as in red-redden. The process of zero derivation changes a word's grammatical class and meaning, but not its form, as in the formation of the verb warm from the adjective warm. In compound formation, two words are concatenated to form a third word, as in pocket-money.

Various facts concerning word formation have led linguists to distinguish lexical rules from syntactic. Certain linguistic phenomena which in traditional grammar

were explained by word formation appear to be less systematic than those which traditionally were treated within the domain of syntax. Not all potential derived words of a certain morphological pattern of a language are actual words in that language. Consider for example red-redden vs. brown-*brownen and beauty-beautify vs. ugly-*uglify, where * indicates a potential but not an actual word of a language. A word marked by * must be distinguished from an impossible derived word which does not correspond to any existing morphological pattern,for instance, red-redmer. Unlike syntactic transformations, for example wh-movement, the lexical rule which adds the derivational affix en to an adjective is only partially productive. Lexical rules are also not always compositional- the meaning of a derived word can not always be predicted from the meaning of its parts. This was pointed out earlier in Chomsky's paper on nominalizations (Chomsky, 1970). Dowty mentions the example of the suffix able: where V is a transitive verb, v-able usually means 'capable of being V-ed'. Examples are washable, bearable and lovable. But changeable means 'capable of changing' rather than 'capable of being changed' and readable means 'capable of being read without undue effort' rather that 'capable of being read'. This shows that besides being partially productive, lexical rules are also not always regular in

their semantics.

Dowty claims that partial productivity and semantic unpredictability are the properties which distinguish lexical from syntactic rules. He suggests that morphological and syntactic operations should be regarded as distinct classes, although they have the same form in the grammar. In the context of this proposal he mentions Partee's suggestion (1979) of reducing the number of syntactic operations and replacing them with a set of primitive operations such as concatenation, substitution for a variable, etc. The composite syntactic operation of each particular syntactic rule must be built up recursively from the set of the primitive operations. Both morphological and syntactic rules employ primitive operations. Unlike syntactic operations, morphological ones always give a fixed linear order of elements. Syntactic operations may interrupt and rearrange constituents formed by other syntactic operations but not by morphological ones.

Partial productivity and semantic unpredictability are the criteria which distinguish lexical from syntactic rules, but each of these two features may characterize a morphological or a syntactic operation. Dowty gives the formation of a verb adjective construction (hammer flat) as an example of a lexical rule which employs a syntactic operation. The verb-adjective construction is a

discontinuous constituent and as such is subject to a syntactic operation, but since many verb-adjective combinations are ruled out in English, this construction must be derived by a lexical rule. The converse case is of a syntactic rule which uses a morphological operation. Inflectional morphology, which is highly productive and semantically regular, provides such examples, as for instance English past tense formation in which the suffix ed is added to the verb.

From the viewpoint of semantic decomposition, accomplishments, achievements and statives are related; accomplishments contain a meaning component present in the logical representation of achievements and the latter have a meaning component present in the logical representation of statives. This raises the question whether the semantic relationships between these classes of verbs are reflected in a different level of the language. Word-formation is the domain which deals with the relationships between various verbs and, as was mentioned before, morphological operations can be used by either syntactic or lexical rules. If there exist morphological operations which relate aspectual classes of verbs, we will inquire to what degree they are productive and semantically regular. And if lexical rather than syntactic rules are responsible for the derivation of different aspectual classes of verbs, then their inclusion

in a Montague Grammar-like framework violates the notion of a rule defined by such a framework whose rules are compositional and productive.

Dowty derives different classes of aspectual verbs by lexical rules which take the same form as syntactic ones. His introduction of lexical rules to derive English aspectual verbs suggests that their morphological relationships are unsystematic and semantically irregular. Adjectives are basic expressions from which inchoatives are derived by adding the suffix _en_. Two lexical rules are introduced to derive causatives (in addition to two rules which derive factitives). The first lexical causative rule is a zero derivation of a causative-TV from an IV of the same pattern, as in $\underline{\text{cool}}_{IV}$-$\underline{\text{cool}}_{TV}$ and $\underline{\text{redden}}_{IV}$-$\underline{\text{redden}}_{TV}$. The second rule derives a causative from an adjective by suffixing it with _ize_, as in the pairs _random_-_randomize_ and _real_-_realize_.

Morphology plays a marginal role in the formation of English aspectual verbs. Most English causatives are basic lexical items and the derived causatives constitute only a small subset of the class of English causatives. (The rule which derives English causatives from adjectives by suffixing them with _ize_ is much more productive than the one which forms causatives by zero derivation.) Inchoatives derived from adjectives by adding the suffix _en_ are few in

comparison to the number of English achievements. English process verbs, which were analyzed in Dowty's aspectual calculus as semantically complex, do not bear any morphological relations to other words or other aspectual verbs. These facts suggest that English morphology reflects aspectual properties of verbs only to a limited extent.

The Hebrew system of morphological verb patterns called "binyanim" interacts with aspectual properties of verbs in an indirect way which may support Dowty's construction of his aspectual calculus, discussed in chapters I and II. The analysis of the interaction of Hebrew verb-pattern and aspect will be postponed to section 2, after discussing the issue of the status of lexical rules in a Montague Grammar-like framework.

Dowty presents a theory of lexical rules which have the particular properties assigned to them by linguists and which may exist within the framework of UG. A lexical component W of a language L is formally defined as a language independent of L (here a "language" is used in the sense of the grammar and not the generated sentences), although it has certain parts in common with L. W has its own set of lexical rules and a set of basic expressions, the same as that of L. Since not all possible derived words in W are actual words in L, Dowty defines various kinds of lexical extensions of L, relative to some lexical component

W of L, which adds to it a new basic expression which is one of the possible derived words specified by W. The new basic expression added to L, which I will call E, was formerly a derived expression in the lexical component W. If E were a derived expression in L, it might have failed to satisfy the requirements of compositionality and full productivity which all rules in UG must satisfy. The introduction of a lexical component and a lexical extension avoid this consequence.

I repeat Dowty's suggestion below to make it more clear:

Table 6. Lexical Rules in a Montague Grammar

The Language L	The Interpretation of L
L1: a set of names of syntactic categories.	
L2: the set of basic expressions of each syntactic category.	L5: the interpretation of each basic expression of L.
L3: the set of syntactic rules.	L6: an interpretation rule corresponding to each syntactic rule in L3.
L1-L3 recursively determine L4 which is the set of well-formed expressions in each category of L.	L5-L6 recursively determine L7 which is an interpretation for each of the well-formed expressions in L4.
A Lexical Component W of L	**The Interpretation of W**
W1: a set of names of syntactic categories of W (W1)=(L1).	
W2: a set of basic expressions for each category (W2)=(L2).	W5: an interpretation of each of the basic expressions.
W3: a set of lexical rules (W3) $\neq$ (L3).	W6: an interpretation rule corresponding to each lexical rule in W3.
W1-W3 recursively determine W4 which is the set of possible derived words of L for each syntactic category.	W5-W6 recursively determine W7 which is the derivationally predicted interpretation of possible derived words in W4.

(A) A semantically transparent lexical extension of L is a lexical extension of L in which (1) the new basic expression added is one of the possible derived words of L according to W and (2) the interpretation assigned to this new expression in L' is the interpretation given it by W.

(B) A semantically non- transparent lexical extension of L is a lexical extension of L meeting conditions (1) in (A) but not condition (2).

(C) A non-derivational lexical extension of L is a lexical extension of L meeting neither condition (1) nor condition (2) in (A).

A lexical semantic shift in an interpreted language L is an interpreted language L' exactly like L except that the interpretation of some basic expression in L' is different from the interpretation of that expression in L.

A lexical semantic shift explains cases where the speakers interpret correctly the meaning of a new derived word through their knowledge of the lexical rule and later on they learn its idiosyncratic meaning. The effect of this process, which is a two-step one, is the same as that of a semantically non-transparent lexical extension.

1.2. Lexical Rules and the Hebrew Binyanim

We have said above that Hebrew morphology interacts indirectly with aspectual properties of verbs in a more productive way than English morphology does, and promised to discuss this issue further. We think that this interaction may be taken as evidence supporting Dowty's construction of his aspectual calculus discussed in chpater I and II, where it was shown how classes of verbs are derived from others by means of semantic operators and logical connectives. I will argue in section 2. that the semantic operators responsible for the derivation of different aspectual classes of verbs interact with the distribution of Hebrew verbs among the morphological patterns called "binyanim". Since the regulations which govern the distribution of verbs among the binyanim have not been discussed yet in detail, we will present that issue in this section.

We have already discussed the distinction between lexical and syntactic rules, and between morphological and syntactic operations. The survey given below of the regulations characterizing the binyanim system suggests that the latter are governed by lexical and not syntactic rules and that the operations employed by the lexical rules are morphological ones. Dowty's suggestion discussed above with regard to the incorporation of lexical rules in a Montague Grammar-like framework may be adopted as well for the Hebrew

binyanim system.

There are seven morphological verb patterns of conjugation (binyanim) in Hebrew. A verbal root can be realized in one or more of the seven morphological verb patterns. The root p,',l (historically p,ʕ,l) is used traditionally as a prototype, where p stands for the first, ' the second and l the third. The stem forms of the seven binyanim are:

CaCaC - pa'al
Ni+CCaC - nif'al
CiCaC - pi'el
CuCaC - pu'al
hit+CaCeC - hitpa'el
Hu+CCaC - huf'al

Adjectives and nouns follow other morphological patterns (miskalim). There are more miskalim than binyanim. Verbs can only be realized in one or more of the seven binyanim.

Almost all traditional Hebrew linguists agree that, to some extent, the binyanim system predicts semantic and syntactic relations of the root. The syntactic functions of the binyanim are quite productive. The active/passive relationships are very productive in the case of pi'el/pu'al and hif'il/ huf'al but less so in the case of pa'al/

nif'al. As far as transitivity is concerned, nif'al and hitpa'el are typically non-transitive: that is, they do not take et NP (et is the definite direct object marker). Pi'el and hif'il are typically intransitive and pu'al is neutral in this respect. The table below lists the independent syntactic functions attributed to the binyanim in a typical school of grammar[1]. (All verbs are represented in the third person. masc. sing. past tense.)

Table 7. The Hebrew Binyanim (II)

name of binyan	Traditional syntactic function	Examples	
pa'al	unmarked base form		
nif'al	passive of pa'al	nišlax passive of šalax	'was sent'
pi'el	normally transitive	sider	'arranged'
pu'al	passive of pi'el	sudar	'was arranged'
hitpa'el	middle voice, normally intransitive counterpart of pi'el or pa'al.	hitlabeš	'got dressed'
hif'il	normally transitive	hixtiv	'dictated'
huf'al	passive of hif'il	huxtav	'was dictated'

The only significant change in the above traditional list is the replacement of pa'al by pi'el as the productive unmarked

form. There are many pi'el verbs which do not have pa'al counterparts and are not derived from pa'al or any other binyan. Perhaps the fact that pa'al is neutral with respect to transitivity is responsible for this, in addition to pa'al's failure to accomodate quadriliterals and quintiliterals.

Linguists usually agree that, to some extent, special meanings of the binyanim are productive in Hebrew. The following table illustrates the meanings common to a group of verbs realized in each binyan. The most common meaning of each binyan is listed first.

Table 8. The Hebrew Benyanim (III)

Name of binyan	Meaning	Example	
nif'al	change of state	nidlak vs. dalak	'turn on' (light.int)
pi'el	intensified form of pa'al	šiber	'smashed' intensified form of šavar 'break'
hitpa'el	reflexive	hitraxec	'washed'(oneself)
	inchoative	hitraxev	'widened'(int)
	reciprocal	hitvakeax	'argued'
hif'il	causative	higdil	'enlarged' (tr)
	inchoative	hichiv	'became yellow'

Bolozky (1978) constructed tests which show that the selection of the binyan a root is realized in is influenced by phonological considerations. A root can not be realized in a binyan if the resulting verb has an unpronounceable consonant cluster. In this case the root is realized in the binyan with the closest meaning in which the verb can be pronounced. For example, a long noun like torpedo realized in hif'il yields *hitprid which has an unpronounceable cluster, so it is shifted to pi'el to yield tirped. Realizations preserving the consonant cluster of original nouns are preferred to these which "break" them. The verb derived in productivity tests from the noun snob was conjugated in hif'il hisnib instead of pi'el sineb since the former preserves the consonant cluster /sn/. Also, when a slot is already occupied by a verb, the semantically closest binyan is chosen.

Evidence is given below to show that the regularities of the binyanim can not be captured by syntactic rules, but at the same time one wants to represent them as part of the speakers' knowledge of Hebrew.

The main observations that have been made of verb pattern behaviour in Hebrew can be summarized in the following six points:

1. Partial productivity- Only a small percentage of Hebrew roots occur in all seven binyanim. Schwarzwald

(1975) found that only 2.3% of the roots occur in all seven binyanim. Speakers learn idiosyncratically which roots are possible in which binyan.

2. Homonymy- Since a number of roots are homonymous, the realization of a phonological root in one conjugation is unrelated semantically to the realization of the same phonological root in another conjugation. 'ibek means 'dusted' and hit'abek means 'wrestled'; 'izen means 'balanced' and he'ezin means 'listened'.

3. Semantic Irregularity- Even among the non-homonymous roots, one can find semantic irregularities. Many roots do not receive the expected meaning of the binyan and their meaning is learned independently. Gereš means 'sent away' and hitgareš means 'divorced'. The latter verb takes the unmarked feature of reciprocality from hitpa'el ('sent each other away') but is more specific in meaning.

4. Several meanings- Most binyanim are connected with several meanings. A verb in hitpa'el may have an inchoative, reciprocal or reflexive meaning. The speaker must learn which of these is related to a certain root.

5.Speakers' mistakes- Speakers shift verbs from their original binyanim to other more 'appropriate' ones. Such mistakes are especially common in language acquisition.

6. Recent innovation and potential words- Bolozky (1982) has shown that assignment of recent and potential

innovations to canonical morphological forms in the verb system is essentially semantic.

The facts presented in (1)-(6) suggest that the binyanim defy precise systematization, but that there exist syntactic and semantic regularities among sets of morphologically related words. These regularities should be treated by lexical rules. Lexical rules reconcile failure of productivity (case 1) and failure of semantic compositionality (case 3) where the meaning of the word is not determined by the meaning of its parts. On the other hand, speakers' mistakes (case 5) and recent innovations in addition to the cases where the meaning of the derived verb is predicted (case 6) suggest that to some extent the binyanim are governed by semantic properties. The operation employed by the Hebrew lexical rules are morphological and not syntactic.

2. Aspectual Verbs and the Hebrew Binyanim

2.1. Deriving Inchoatives in Hebrew

Bolozky investigated Modern Hebrew verb formation strategies and showed that assignment of recent and potential innovations to the binyanim is essentially semantic. In an earlier paper (1978), he suggested that the distribution of verbs among the binyanim is based on the

division between transitive and intransitive verbs and in a later one (1982), he replaced this by a more complex system which includes notions like 'agency', 'causation' and 'activity' to be discussed later. Bolozky claimed that non-agentive verbs are normally realized in hitpa'el. In a canonical pattern like hit+CaCeC the root s,p,r 'cut hair' is inserted to yield <u>histaper</u> 'cut one's hair' and s,m,r to yield <u>histamer</u>. To support the claim that non-agentive verbs are realized in hitpa'el he provided a list of recent Hebrew innovations of verbs which are non-agentive. The majority of his examples repeated below are inchoatives:

(1)

hit'azreax	'became a citizen'
hit'axzev	'became disappointed'
hitparxeax	'became a hoodlum'
hitmaked	'became focused'
hitxatex	'became handsome'
hitmames	'became a reality'
hitrakez	'concentrated'
hityaded	'became friend'
hištavec	'had a heart attack'
hitpancer	'failed because of mishap'

Bolozky also tested the productivity of formation of new verbs from existing nouns and adjectives whether borrowed, native, old or new. The nouns selected in the two tests he constructed were triconsonantal (to avoid phonological restrictions on the choice of binyan) and non-native (to avoid clash with existing forms). In the first test the subjects were asked to invoke active formation of denominative verbs. The nouns were read aloud with their

paraphrased target meaning and the subjects were asked to fill in their suggested realizations for corresponding verbs in short sentences prepared in advance. For example, the noun šerif 'sheriff' was read aloud and then its target meaning 'he became a sheriff'. The same method was used in test II except that below each of the given sentences there were a few alternative verbal realizations of the noun. The noun and its target meanings were read aloud and the subjects were asked to choose the one that best characterized the given meaning and to fill it into the given short sentence. I will list below only the denominative verbs constructed from the nouns whose target meaning was that of inchoation. Bolozky reports that the preference to realize inchoatives in hitpa'el in productivity tests was 100% :

(2) hištaref 'became a sheriff'
hitvasel 'became a vassal'
histalen 'became an armchair revolutionary'
histnobeb 'became snobbish'
hitmarkses 'became a Marxist'
hitšmalcec 'became schmalzy'

Hitpa'el is the only non-passive binyan which is marked exclusively as syntactic intransitive. Since inchoatives are always syntactic intransitive, it is very likely that they will be realized in hitpa'el. Inchoatives in hitp'ael are derived from adjectives. For example:

(3)

Adjectives		Inchoatives	
kar	'cold'	hitkarer	'became cold'
xam	'warm'	hitxamem	'became warm'
raxav	'wide'	hitraxev	'became wide'
'adom	'red'	hit'adem	'became red'
šikor	'is drunk'	hištker	'became drunk'
kacar	'short'	hitkacer	'became short'

Hebrew adjectives follow certain morphological patterns (of which there are a much greater number than for the verbs). However, since in Dowty's English aspect calculus, which we adopt for Hebrew, stative predicates (which adjectives form most of them) constitute the basic expressions of the language (i.e, they are not semantically derived), they need no further consideration.

In chapter I we discussed three kinds of inchoatives- absolute, vague and comparative inchoatives. Aspectually there are two kinds of inchoatives in English and Hebrew- event inchoatives and process ones. Absolute and vague inchoatives are event type verbs, and process inchoatives, which were claimed to derive from comparative inchoatives, are processes. The verbs listed as vague inchoatives also have the become-adj-er reading. Both vague and comparative inchoatives are event type verbs. Examples of absolute, vague and process inchoatives are provided below (see the discussion of these distinctions in chapter II, section 2.). All three kinds of inchoatives are realized in hitpa'el. Consider the following examples:

(4) Simple Inchoatives (Absolute)

hitazre'ax	'became a citizen'
hitpager	'die'
hitroken	'became empty'

(5) Vague Inchoatives

hitkacer	'shortened'(int)
hit'adem	'reddened'(int)
hitxamem	'warmed'(int)
hitkarer	'cooled'(int)
hištaker	'became drunk'
hitmoses	'melted'(int)

(6) Process Inchoatives

hitnaven	'decayed'
hitpateax	'developed'
hištaper	'improved'
hitragel	'got used'
hištaxlel	'became technically better and better'
hištalhev	'became more and more excited'

The base form pa'al is neutral with respect to transitivity: yašav 'set down' is an IV and axal 'ate' is a TV. Since the verbs in pa'al are basic and not derived, they may exhibit the different shades of meanings which govern the binyanim system. Verbs of all aspectual classes may be found in pa'al and among them inchoatives. Some examples of inchoatives in pa'al are given below:

(7)

gavah	'became tall'
gadal	'grew'
raza	'became thin'
kafa	'froze'(int)
kaha	'darkened'(int)
names	'melted'(int)
xala	'became sick'

A small class of color inchoatives are assigned to hif'il:

(8)

hichiv	'became yellow'
horik	'became green'
he'edim	'became red'
he'efir	'became grey'
hišxir	'became black'
hešxim	'became brown'
hivhir	'became bright'
hixxil	'became blue'
hilbin	'became white'

Also to be found in hif'il are a few human and physical quality terms,for example:

(9)

hifšir	'melted'(int)
hexmic	'became sour'
hismin	'became fat'
hivri'	'got healthy'

All the above verbs in hif'il are ambigious between the inchoative and causative reading as in the case of the English verbs cool, warm, melt, etc. There may be a lexical rule which derives color term inchoatives in hif'il. This rule does not derive all possible color inchoatives since *hisgil 'became purple', *hixtim 'become orange', for example, are not Hebrew words. There are no color term inchoatives in any of the other binyanim except for hit'adem 'became red' in hitpa'el which has an equivalent hif'il counterpart: he'edim. The question of whether color term inchoatives are rule-governed or learned idiosyncratically will be left open.

To conclude, the lexical rule which forms Hebrew

inchoatives is highly productive. It takes an adjective and inserts it in hitpa'el. Since lexical rules are not systematic it is expected that a few inchoatives may be found in other derived binyanim as is the case with color inchoatives which come in hif'il.

The verb pattern hit+CaCeC has two other meanings beside that of inchoation: reflexivity and reciprocality. Hebrew reflexives are formed in two ways- by adding the reflexive pronoun 'myself', 'yourself', etc to a verb in one of the transitive active binyanim, or by realizing the root in hitpa el. Consider (et is the direct object marker and acmo means "self"):

(10) {raxac et acmo / hitraxec} 'washed himself'

{cava' et acmo / hictabea'} 'painted himself'

{serek et acmo / histarek} 'combed himself'

{'iper et acmo / hit'aper} 'put on makeup'

The following verbs are examples of reciprocals in hitpa'el:

(11) hitgaršu '(they) got divorced'
hityadedu '(they) befriended'
hitpaysu '(they) made peace with each other'
hitnašku '(they) kissed each other'
histaxsexu '(they) quarreled'

We see that the verb pattern hit+CaCeC shares several

meanings- that of reflexivity, reciprocality and inchoation. The verb hitxamem seems ambiguous between the reflexive and the inchoative meaning (perhaps only a vagueness rather than an ambiguity is involved here, and in this case no difficulty arises). The verb in ha'iš hitxamem al yad hatanur "the man warmed himself next to the heater" has the reflexive reading only since ha'iš ximem et acmo leyad hatanur "the man warmed himself next to the heater" is acceptable, but not *ha'iš na'asa yoter xam leyad hatanur "the man became warmer next to the heater". Hamarak hitxamem al hagaz "the soup warmed on the gas" has the inchoative reading since hamarak na'asa yoter xam al hagaz "the soup became warmer on the gas" is acceptable, but not *hamarak ximem et acmo al hagaz "the soup warmed itself on the gas". Since the translation rules which derive reflexives and inchoatives are different, we end up with two different expressions in the intensional logic. The morphological operation which derives different kinds of verbs may be the same as is the case with the formation of Hebrew reflexives and reciprocals as long as their translations are different.

As we illustrated above, process inchoatives as well as simple and vague inchoatives are derived in hitpa'el. The morphological operation takes an adjective and turns it into a hitpa'el verb. The lexical inchoative rule is:

(12) L_{wl}: If $\alpha \in P_{adj}$, then $F_{wl}(\alpha) \in P_{IV}$,
where $F_{wl}(\alpha)$= α conjugated in hitpa'el.

Two translation rules are needed to derive the vague and comparative inchoatives discussed in chapter I. The rule which derives vague inchoatives says that if α is an adjective with translation α' then inchoative(α') is a verb with translation $\lambda x[become(cool'_c(x))]$. The rule which derives comparative inchoatives states that if α is an adjective with translation α' then inchoative(α') is a verb with translation $\lambda x \exists c[become(cool'_c(x))]$.

The comparative translation rule and the vague one give the same results for absolute (non-vague) adjectives like <u>fourlegged</u>. When α is an absolute adjective then the contextual parameter in the translation of vague inchoatives does not affect interpretation. Since <u>fourlegged</u> is non-vague, $(\forall c)(\forall c')[fourlegged'_c = fourlegged'_{c'}]$. When an absolute adjective appears in the translation of comparative inchoatives we get: $\lambda x \exists c[Become(fourlegged'_c(x))]$. By the above generalization we can replace c by c' so $\lambda x \exists c[Become(fourlegged'_{c'})]$. Since the existential quantifier does not bind anything we can eliminate it and end up with a translation of an absolute inchoative $\lambda x[become(fourlegged'_{c'}(x))]$.

2.2. Hebrew Causative Verbs

Hebrew derived causatives are formed in hif'il (60%) and pi'el (40%). A verb in the base form pa'al is causativized by being inserted in one of the two binyanim according to certain regularities which will be discussed below. Katav 'wrote' is causativized in hif'il to yield hixtiv 'dictated', and lamad 'studied' is causativized in pi'el to yield limed 'taught'. Many of the pa'al verbs from which the causatives are derived are no longer used in Modern Hebrew and not all verbs in pa'al are causativizable. As to semantic predictability, all derived transitive verbs in hif'il are causatives except for the small group of color term inchoatives mentioned before. There are basic accomplishments in the basic binyan pa'al, such as harag 'kill' bana 'built', xanak 'strangled', etc.

Some notions interact with causative verbs affecting their distribution between the two causative binyanim. Causatives may be divided into three classes:

(a) Causatives whose objects are agentive like hekim 'made stand up', he'eziv 'made leave' and hitrim 'made contribute'.

(b) Causatives which aspectually are processes (CPV) like holix 'made walk', hikpic 'bounced' and gilgel 'made roll'.

(c) Causatives whose object is a patient which undergoes a

change of state.

Causative process verbs (CPV) which belong to the second class were discussed at length in chapter II, section 2.3. In that chapter we also discussed Bolozky's distinction (1983) between causative verbs with agentive objects (which he calls "active verbs") and causatives with objects which are patient and undergo a change of state ("non-active verbs"). Tables 3 and 4 showing the distribution of active and non-active causatives between hif'il and pi'el were presented in chapter II, section 1.1. Bolozky claimed that there is no restriction on the distribution of causatives with patient objects but that there are no causatives with agentive objects which are conjugated exclusively in pi'el. Many causatives with agentive objects are conjugated in hif'il and some are formed in both binyanim.

Hif'il has causative verbs with agentive objects as well as causatives with patient objects that undergo a change of state, like hilbin 'made become white', hikpi' 'froze'(tr) and hikdir 'darkened'(tr). Pi'el has causatives with patient objects like kicer 'shortened', niven 'made become decayed' and šiper 'improved'(tr).

Bolozky (1982) has drawn another distinction between verbs which are causatives and verbs which are agentive. Causative verbs are realized in hif'il, and to some extent in pi'el, and there exist transitive verbs which are

agentive but not causative and these are realized in pi'el. The subject of an agentive verb initiates some activity with regard to an entity and this is weaker than causing an object to act or undergo a change of state. Bolozky does not supply us with a definition of causation or initiation which might point to the sense in which causative and agentive verbs differ. However he offers lists of causative and agentive verbs and these suggest there is a genuine difference between the verbs in each category. Some of his examples are listed below:

(13)

Causative Verbs in hif'il (recent innovations)		Agentive Verbs in pi'el (recent innovations)	
hitrim	'cause to contribute'	mikem	'put in place'
he'eziv	'made leave'	miked	'focused'
hidhir	'galloped'(tr)	šivek	'marketed'
šigea	'made crazy'	tiyek	'filed'
gidel	'grew' (tr)	gišer	'bridged'
pinčer	'cause a mishap'	viset	'regulated'
ixzev	'disappointed'	biyel	'stamped'
		kifter	'buttoned'
		kitleg	'cataloged'

The difference between the verbs in the two lists may be informally stated as follows: the result state or effect of most activities described by the causatives may exist independently of the subject or causer of that activity. A flower may grow by itself (notice you can not say 'the earth

grew the flower' since it is thought of as growing by itself; something like Dowty's causal factor is needed here. See my discussion of this point in chapter II, section 3.1.) Similarly, a person can be disappointed without someone forcing him to that state; I may leave the room without being forced to do so; or I may get crazy without anyone driving me into that state of mind. The result state of the activity described by an agentive verb is intrinsically related to the activity of the subject of that verb- the result state can not exist independently of the subject's activity which brings it about. The result state is always specified in causatives, but not the activity of their subject. On the other hand an envelope can not be stamped by itself, a camera can not be focused without somebody focusing it and documents are not filed by themselves. Although the distinction I have drawn is stated rather informally, I believe it captures a genuine difference which exists between causative and agentive verbs. Bolozky has shown the difference between them is reflected in Hebrew morphology, since agentive verbs are conjugated in pi'el while causatives tend to be conjugated in hif'il.

The distinction made so far may be summarized as follows:

hif'il	pi'el
causatives with agentive objects*	agentive verbs
causatives with objects which undergo a change of state	causatives with objects which undergo a change of state
causative process verbs	

(*some causative verbs with agentive objects come in both hif'il and pi'el).

2.3. Accomplishments, Causatives and Hebrew Morphology

In chapter II, section 1.2. we discussed Dowty's suggestion that accomplishment verbs be presented by a bi-sentential CAUSE operator whose second clause is usually a become-sentence. We have already seen that Hebrew exhibits a highly productive rule for deriving inchoatives and we shall investigate whether the same is true for accomplishments. Since the latter are analyzed by a CAUSE operator, the relationship they bear to causative verbs must be examined carefully. Hebrew morphology may help us here. Since it was assumed in traditional Hebrew grammar that hif'il verbs are causatives (apart from a small group of color term inchoatives), we can ask whether verbs which carry the hif'il morphological pattern are accomplishments or not. English does not have a unique morphological pattern to mark most of its causatives, so it is impossible

to determine this issue in that language.

Pi'el is the secondary causative binyan in Hebrew, but since traditional Hebrew grammarians agree that not all of its verbs are causatives, its morphological pattern alone can not identify causative verbs for us and we must establish an additional criterion for sorting "natural causatives" in that binyan. The criterion established should also be capable of identifying underived causatives in the basic binyan pa'al such that we could ask with regard to them whether they are also accomplishments.

Two issues need to be clarified: (1) Are Hebrew binyanim sensitive to the aspectual property of being an accomplishment, and (2) What evidence can Hebrew provide to support the hypothesis that accomplishments should be analyzed in terms of CAUSE?.

To answer this we must deal with two questions:

(a) Whether all Hebrew causatives are accomplishments, and

(b) Whether all Hebrew transitive accomplishments are causatives.

The first question has already been answered negatively in chapter II, where causative process verbs (CPV) were discussed. Hebrew CPV are conjugated in the causative binyan hif'il and aspectually are process verbs and not accomplishments. A parallel example exists with process

inchoative verbs which are formed in hitpa'el along with simple and vague inchoatives. Although aspectually those verbs are processes and not achievements, they are formed in hitpa'el which is the main inchoative binyan. It is the semantic operator Become, denoting change, which is present in the logical representation of process inchoative verbs, that determines their formation in hitpa'el, and in the same way, it is the semantic operator CAUSE and not the aspectual property of being an accomplishment which determines the formation of CPV in hif'il. This does not refute the claim concerning the relationships between causation and accomplishments and between change and achievements, but only shows that Hebrew morphology is sensitive to the semantic features of change and causation and not to the aspectual properties connected with being an accomplishment or an achievement.

Let us turn to the second question. Since traditional grammarians agree that hif'il verbs are causatives, we must look for transitive accomplishment verbs in pi'el and pa'al which are not causatives. In several places we have claimed that the state described in the result state clause of causative verbs can exist independently of one of the assumed unspecified activities in their first clause. A "natural causative of a language" will be defined as a verb whose "resultant" is expressed in that language by an

adjective or verb morphologically as simple as or simpler than the causative verb. If a pa'al or pi'el transitive verb has a result state expressed as an adjective or verb which is as simple as or simpler than the pi'el or pa'al verb, then that verb is a Hebrew causative. Ximem 'warmed' is a pi'el causative since its result state is expressed in Hebrew as a morphologically simpler adjective xam 'warm' and kicer 'shortened' is also a pi'el causative since the adjective kacar 'short' is morphologically simpler than the verb. Accomplishments, on the other hand, will be defined as non-subinterval verbs. If it took x n hours to V, where V is an accomplishment, then it is not true that x V-ed in any smaller interval than that of n hours duration. We will look for Hebrew verbs which fail to satisfy the subinterval condition and which do not have a result state expressed as an adjective morphologically as simple as or simpler than the verb.

The problem with the criterion above is that almost all Hebrew transitive verbs have corresponding adjectives expressing their result states. There are many morphological patterns of Hebrew adjectives. Certain adjectives, which may be considered the result states of causatives, have the pattern of the passive binyan corresponding to the active binyan in which the causatives are conjugated. Biyel 'stamped' in pi'el has its result

state expressed in pu'al, (simple present tense) which is the passive binyan of pi'el to yield mevuyal 'is stamped'; and similarly the result state of tiyek 'filed' is expressed by metuyak 'is filed'. (The corresponding statives in English are expressed by the present participle). It appears that an adjective formed in a passive binyan of the corresponding causative is morphologically more complicated than the causative in the active binyan. If this is true, then verbs with morphologically more complicated adjectives are not natural causatives. All the verbs in pi'el listed in 2.2. which were called "agentive verbs" have result states expressed as adjectives in their corresponding passive binyan, and since those adjectives are morphologically more complicated than the verbs, the latter are not causatives according to our criterion. The verbs tiyek 'filed' and biyel 'stamped' are accomplishments, and so are the agentive verbs in pi'el tiyek 'filed', miked 'focused', etc. If what we have said above is correct, then we have examples of accomplishments which are not causatives. According to our new criterion for defining causatives, not all hif'il verbs are causatives since the result states of some of them are expressed in adjectives formed in their corresponding passive binyan, for example, hixtim 'stained'- muxtam 'is stained'; hivriš 'brushed'- muvraš 'is brushed'.[2]

Are there Hebrew accomplishments which lack corresponding adjectives to express their possible result states? The only example I am aware of is the VP laxac yadaim 'shook hands'.[3] laxac yadaim is an accomplishment whose duration is very short. Also, the verb is formed in the basic binyan pa'al. A slow motion movie in which a shaking of hands is filmed consists of different sequential hand gestures with the last gesture the shaking of interlocked palms. Not until the last stage has been reached, can it be said that the shaking of hands has occurred. In this respect laxac yadaim is an accomplishment, since it fails to satisfy the subinterval condition. There is no Hebrew adjective morphologically related to the accomplishment laxac yadaim- lexuc yadaim 'is hands shaken' sounds peculiar in Hebrew. The function of the custom of shaking hands in western society is that of greeting, making acquaintance, congratulating, etc. You can not say of someone whose hand you have shaken that he is mevorax 'is greeted'. There are no Hebrew adjectives expressing the result state of leaxel 'to congratulate' or lehitvadea 'to make acquaintance'. Hebrew does not have a result state adjective morphologically related to laxac yadaim and there are no adjectives (morphologically unrelated) which can be used to express the result state of that accomplishment. So here we have a case of an

accomplishment verb with no corresponding adjective expressing its result state.

This is a case where language and metaphysics coincide. Why is not there a Hebrew adjective expressing the state of having had one's hand shaken? There are Hebrew adjectives expressing the state of being blessed (e.g., by the pope) (mevorax) or being baptized (mutbal). In the religious sense, the result state of being baptized or being blessed by the pope changes the state of the world, while the result state of having had one's hand shaken does not change the state of the world in any significant way. This of course, can not be separated from our conceptual schemes, beliefs and metaphysics which very often are reflected in language. It seems to us more appropriate to include in our ontology the states of being baptized or blessed than the state of having had one's hand shaken. Perhaps this is why Hebrew does not have an adjective to express such a state. The fact that mevorax 'is blessed' and mutbal 'is baptized' come in the passive binyanim huf'al and pu'al of the causatives hitbil 'baptized' and berex 'blessed' (i.e are more complicated morphologically) coincides with our intuition that those verbs are "less natural causatives" than he'edim 'reddened', hirxiv 'widened' or hišmin 'fattened'. The result states of the latter are expressed by Hebrew adjectives simpler than the corresponding verbs

('adom 'red', raxav 'wide', šamen 'fat'). Given our conceptual schemes, physical states and human quality states "exist" in our world. This has probably to do with the fact that such states are expressed in Hebrew by adjectives which are morphologically simpler than the related verbs.

Partee has brought to my attention another interesting fact. The VP's break windows and shake hands can both be modified with a by-phrase. Consider:

(14) John broke the window by hitting it with a book.

(15) John shook Bill's hand by clasping it and moving his arm.

We have argued in chapter II, section 2.3. that what is inside the by- phrase modifying a causative verb specifies the activity of the subject of the causative, i.e the causee of the result state. However, in sentence (15) the clasping and moving of Bill's arm are not the causee of Bill's having his hand shaken; they only constitute part of the accomplishment of shaking his hand. In contrast, in (14) the hitting of the window with a book is what caused it to break. In addition to the lack of an adjective expressing the result state of the verb laxac yadaim 'shook hands', what is inside the scope of the by-phrase that modifies the VP is not a causee. laxac yadaim 'shook hands' is an accomplishment which is not a causative.

What conclusion can be drawn from this discussion? The

fact that we have found only one example of an Hebrew transitive accomplishment which does not have an adjective expressing its result state makes Dowty's analysis of accomplishments as bi-sentential combined by CAUSE very appealing. Hebrew accomplishments almost always have adjectives expressing their result states and those adjectives are embedded under a Become operator in the second clause of the CAUSE operator. However, sometimes those adjectives are morphologically more complicated than the accomplishments whose result states they express (the adjectives appear to be derived from the verb and not vice versa) and in this respect they do not satisfy the definition of natural causatives we provided. If we stick to that definition then there are Hebrew accomplishments which are not causatives and this can be taken as a counterevidence to Dowty's hypothesis. On the other hand, we may allow "resultant" of causatives to be expressed in adjectives morphologically more complex than the verbs they are related to. The states expressed by those adjectives, although derived from the verbs, are now part of the "metaphysics of the language" and the adjectives express "genuine" result states.

The Hebrew binyanim system derives causatives and not accomplishments. But according to the about remarks about Hebrew accomplishments and their result states, their

analysis by a bi-sentential CAUSE operator whose second clause expresses a result state which came into existence is an attractive prposal. This also explains why most accomplishments are formed in hif'il and pi'el.

FOOTNOTES

[1]The two lists provided are taken from Bolozky's 1978 paper.

[2]There are CPV in hif'il which satisfy our new criterion of defining causatives, so our claim that Hebrew morphology is sensitive to causatives and not accomplishments is still valid.

[3]Perhaps laxac yadaim is an idiomatic expression, since not every shake of hands is a handshake- the context seems to determine this.

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APPENDIX

In several places in the proof, I use assumptions about interval semantics, specifically about the interaction of truth functions and intervals, which may be controversial. I would like to point out what these assumptions are. Essentially, I assume that truth functions and intervals do not interact, i.e., that

$[[\sim\phi]]_I = [[\phi]]_I$

$[[\phi \ \& \ \psi]]_I = [[\phi]]_I \ \& \ [[\psi]]_I$

(The truth functions on the left are those of the object language; those on the right those of the metalanguage). In the proof, the sole relation between $[[\phi]]_I$ and $[[\phi]]_{I'}$, where I and I' are different intervals, is provided by the axioms of additivity and partitivity.

We begin by stating the axioms of partitivity and additivity.

Partitivity Axiom:

$[[\phi]]_{Q,w,[t1,t3],g}=1 \rightarrow (\forall t_2 \in [t_1,t_3]([[\phi]]_{Q,w,[t2,t3],g}=1 \ \& \ [[\phi]]_{Q,w,[t1,t2],g,}=1)$

Additivity Axiom

$([[\phi]]_{Q,w,[t1,t2],g}=1 \ \& \ [[\phi]]_{Q,w,[t2,t3],g}=1) \rightarrow [[\phi]]_{Q,w,[t1,t3],g}=1.$

Proposition. Let ϕ and ψ be additive and partitive. Then $[\phi$ KAUSE $\psi]$ is additive.

Proof.

$[\phi$ KAUSE $\psi]$ is additive if the following inference is valid:

$$\frac{\begin{array}{l}[[\phi \text{ KAUSE } \psi]]_{\mathcal{Q},w,[t1,t2],g}=1 \\ [[\phi \text{ KAUSE } \psi]]_{\mathcal{Q},w,[t2,t3],g}=1\end{array}}{\text{show: } [[\phi \text{ KAUSE } \psi]]_{\mathcal{Q},w,[t1,t3],g}=1}$$

Below the formulas occuring in this inference have been expanded, using the defintion of KAUSE. ($[[\alpha]]_{w,[t1,t2]}$ abbreviates $[[\alpha]]_{\mathcal{Q},w,[t1,t2],g}$).

$$\frac{\begin{array}{l}A.\ [[\phi]]_{w,[t1,t2]}\&[[\psi]]_{w,[t1,t2]}\&[[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t1,t2]} \\ B.\ [[\phi]]_{w,[t2,t3]}\&[[\psi]]_{w,[t2,t3]}\&[[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t2,t3]}\end{array}}{\text{show: } [[\phi]]_{w,[t1,t3]}\&[[\psi]]_{w,[t1,t3]}\&[[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t1,t3]}}$$

By additivity and premises A and B we have $[[\phi]]_{w,[t1,t3]}$ and $[[\psi]]_{w,[t1,t3]}$. We still have to show: $[[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t1,t3]}$. We will prove a slightly stronger result, deriving this from the final conjucts in A and B:

$$\frac{\begin{array}{l}A'.\quad [[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t1,t2]} \\ B'.\quad [[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t2,t3]}\end{array}}{\text{show: } [[\sim\phi \mathrel{\Box\!\!\rightarrow} \sim\psi]]_{w,[t1,t3]}}$$

When the meaning of Lewis' counterfactual connective $\mathrel{\Box\!\!\rightarrow}$ in premise A' is made explicit, A' amounts to

$$\underbrace{(\forall w')[[\phi]]_{w',[t1,t2]=1}}_{\alpha} \vee$$

$$\underbrace{(\exists S \in \$_w)\ (\exists w' \in S)[[\sim\phi]]_{w',[t1,t2]=1}\ \&\ \forall w'' \in S[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t2]=1}}_{\beta}$$

The counterfactual connective $\Box\!\!\rightarrow$ in premise B' and the conclusion can be expanded in the same way. Since each premise is a disjunction, we have to show 4 cases:

1. premise A' disjunct
   premise B' disjunct
   ———————————
   conclusion

2. premise A' disjunct
   premise B' disjunct
   ———————————
   conclusion

3. premise A' disjunct
   premise B' disjunct
   ———————————
   conclusion

4. premise A' disjunct
   premise B' disjunct
   ———————————
   conclusion

In the first case, I will derive disjunct α of the conclusion. In the remaining cases, I will derive disjunct

β of the conclusion.

Case 1.

For case (1) we show:

a. $\forall w'[[\phi]]_{w',[t1,t2]}=1$

b. $\forall w'[[\phi]]_{w',[t2,t3]}=1$

show: $\forall w'[[\phi]]_{w',[t1,t3]}=1$

The conclusion follows from premises (a) and (b) by the additivity axiom.

Case 2.

For case (2) we have to show:

a. $(\exists S \in \$_w)(\exists w' \in S)\{[[\sim\phi]]_{w',[t1,t2]}=1 \ \&$
$\forall w'' \in S(\sim\phi \rightarrow \sim\psi]_{w'',[t1,t2]}=1\}$

b. $(\forall w')[[\phi]]_{w',[t2,t3]}=1$

show: $(\exists S \in \$_w)(\exists w' \in S)\ [[\sim\phi]]_{w',[t1,t3]}=1 \ \&$
$\forall w'' \in S(\sim\phi \rightarrow \sim\psi)_{w'',[t1,t3]}=1$

Let S, w', verify premise (a). Then $[[\sim\phi]]_{w',[t1,t2]}=1$ (from premise (a)) and $[[\phi]]_{w',[t2,t3]}=1$ (from premise (b)). We are to show $[[\sim\phi]]_{w',[t1,t3]}=1$. Suppose not. Then $[[\phi]]_{w',[t1,t3]}=1$. By partitivity $[[\phi]]_{w',[t1,t2]}=1$. This contradicts the formula derived from premise (a), as desired.

We still need to show $(\forall w'' \in S)[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t3]}=1$.

Let $w'' \in S$. From disjunct α of premise (b), $[[\phi]]_{w'',[t2,t3]}=1$. From disjunct β of premise (a), $[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t2]}=1$. By the semantics for $\rightarrow$ and $\sim$ we have

0. $[[\phi]]_{w'',[t1,t2]}=1 \vee [[\sim\psi]]_{w'',[t1,t2]}=1$.

We are to show that $[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t3]}=1$, equivalently that $[[\sim\phi]]_{w'',[t1,t3]}=1 \rightarrow [[\sim\psi]]_{w'',[t1,t3]}=1$.

We show this by conditional proof.

1.		$[[\sim\phi]]_{w'',[t1,t3]}=1$	assumption
2.	show:	$[[\sim\psi]]_{w'',[t1,t3]}=1$	indirect proof
3.		$[[\psi]]_{w'',[t1,t3]}=1$	assumption
4.		$[[\psi]]_{w'',[t1,t2]}=1$	by partitivity
5.		$[[\phi]]_{w'',[t1,t2]}=1$	by $\vee$ elimination from 4 and 0.
6.		$[[\phi]]_{w'',[t1,t3]}=1$	by additivity and instantiation of premise (b) and 5.
7.		p & ~p	contradiction, 6 and 1

Case 3.

This is symmetric to case 2.

Case 4.

For this case we assume that conjunct β holds for both intervals, that is, there are spheres S_1 and S_2 such that

a. $(\exists w' \in S_1)[[\sim\phi]]_{w',[t1,t2]}=1 \& (\forall w'' \in S_1)[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t2]}=1$

b. $(\exists w' \in S_2)[[\sim\phi]]_{w',[t2,t3]}=1 \& (\forall w'' \in S_2)[[\sim\phi \rightarrow \sim\psi]]_{w'',[t2,t3]}=1$

Since $\$_w$ is a nested family of spheres, either $S_1 \subseteq S_2$ or $S_2 \subseteq S_1$ (for both). Without loss of generality, we can assume $S_1 \subseteq S_2$; the other case is symmetric. Since S_1 S_2 we have, from the second conjunct of (b),

c. $(\forall w'' \in S_1)(\sim\phi \rightarrow \sim\psi)_{w'',[t2,t3]}=1$

We need first to show the first conjunct of the conclusion, i.e. $(\exists w' \in S_1)[[\sim\phi]]_{w',[t1,t3]}=1$. To show this we follow the procedure of case 2. From (a),

1.	$(\exists w' \in S_1)[[\sim\phi]]_{w',[t1,t2]}=1$	
2.	show: $(\exists w' \in S_1)[[\sim\phi]]_{w',[t1,t3]}=1$	existential deriviation
3.	$[[\sim\phi]]_{w',[t1,t2]}=1$	assumption, from 1
4.	show: $[[\sim\phi]]_{w',[t1,t3]}=1$	indirect proof
5.	$[[\phi]]_{w',[t1,t3]}=1$	assumption
6.	$[[\phi]]_{w',[t1,t2]}=1$	by partitivity from 5
7.	$p \ \& \sim p$	contradiction 3 and 6

We need still to show $(\forall w'' \in S_1)(\sim\phi \rightarrow \sim\psi)_{w'',[t1,t3]=1}$.

1. ~~show~~: $(\forall w'' \in S_1)[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t3]=1}$ — universal derivation

2. ~~show~~: $[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t3]=1}$ — conditional proof

3. $[[\sim\phi]]_{w'',[t1,t3]=1}$ — assumption

4. ~~show~~: $[[\sim\psi]]_{w'',[t1,t3]=1}$ — indirect proof

5. $[[\psi]]_{w'',[t1,t3]=1}$ — assumption

6. ~~show~~: $[[\sim\phi]]_{w'',[t1,t2]=1} \vee [[\sim\phi]]_{w'',[t2,t3]=1}$ — indirect proof

7. $\sim([[\sim\phi]]_{w'',[t1,t2]=1} \vee [[\sim\phi]]_{w'',[t2,t3]=1})$ — assumption

8. $\sim[[\sim\phi]]_{w'',[t1,t2]=1} \;\&\; \sim[[\sim\phi]]_{w'',[t1,t3]=1}$ — De Morgan, 7

9. $\sim[[\sim\phi]]_{w'',[t1,t2]=1}$ — & elimination, 8

10. $\sim[[\sim\phi]]_{w'',[t2,t3]=1}$ — & elimination, 8

11. $[[\phi]]_{w'',[t1,t2]=1}$ — truth definition for negation

12. $[[\phi]]_{w'',[t2,t3]=1}$ — truth definition for negation

13. $[[\phi]]_{w'',[t1,t3]=1}$ — by additivity from 11 and 12

14. $[[\sim\phi]]_{w'',[t1,t3]=0}$ — truth definition for negation

15. $p \;\&\sim p$ — contradiction, 3 and 14

16. $[[\sim\phi \rightarrow \sim\psi]]_{w'',[t1,t2]=1}$ — universal instantiation from second conjunct of (a)

17. $[[\psi]]_{w",[t1,t2]}=1$ &
$[[\psi]]_{w",[t2,t3]}=1$ } by partitivity from (5)

18. $[[\psi]]_{w",[t1,t2]}=1$ }
19 $[[\psi]]_{w",[t2,t3]}=1$ } & elimination, 17

20. $[[\phi]]_{w",[t1,t2]}=1$ and $\rightarrow$ semantics of $\rightarrow$, $\sim$ elimination, 16,18

21. $[[\sim\phi]]_{w",[t2,t3]}=1$ semantics for $\sim$, V elimination, 6,20

22. $[[\sim\phi\rightarrow\sim\psi]]_{w",[t2,t3]}=1$ universal instansiation from (c)

23. $[[\phi]]_{w",[t2,t3]}=1$ semantics for $\rightarrow$, $\sim$, $\rightarrow$ elimination, 19,22.

24. $p \ \& \sim p$ semantics for $\sim$ and contradiction 21,23