

Verbs of Change, Causation, and Time

by

Dorit Abusch

→ Verbs of change
of state
of time modifier

→ Looking at
the in terms of events
& possible
→ looking at
state of affairs
→ looking at
state of affairs

Copyright ©1986

Center for the Study of Language and Information
Leland Stanford Junior University

The preparation and publication of this report have been made possible in part through an award from the System Development Foundation.

Bethany SW

Verbs of Change, Causation, and Time

Dorit Abusch

1 Introduction*

Aristotle is cited as the first to mention aspectual differences among verbs. Within the philosophy of ordinary language tradition, Ryle (1947), Kenney (1963), and Vendler (1967) discussed at length the different temporal properties of classes of verbs employing tenses, logical entailments, and time adverbials as classifying criteria.

Following Vendler, David Dowty (1979) divided verbs into four aspectual classes: statives (*love, live in Palo Alto*), achievements (*die, win a race*), accomplishments (*build a house, draw a circle*), and processes (*run, push a cart*).¹ He claimed that the differences between classes of aspectual verbs may be captured by a class of predicates, which he calls “stative predicates,” and a few sentential operators and connectives which constitute his “aspectual calculus.” Statives, which Dowty assumes to be understood clearly, hold or do not hold of an individual in a world at a single moment. The appearance of sentential operators, like BECOME and CAUSE, in the logical structure of verbs should predict their aspectual properties. He presents a lexical decomposition analysis of word meaning in generative semantics. His decompositional analysis is presented as a fragment of “natural logic,” for which an explicit model theoretic interpretation is given.

In Dowty’s theory, achievement verbs, of which inchoatives form a subclass, denote a change of states. Inchoatives are derived from adjectives by means of an abstract element of change BECOME, which—according to the theory—is always to be found in the representation of achievement verbs.

achievements
↓
inchoatives
(chg. state)

* The main ideas in this paper are present in the first two chapters of my dissertation (Abusch, 1985). I would like to thank all the people mentioned there, in particular Mats Rooth and my thesis adviser Barbara Partee for their enlightening insights and comments.

¹ We replace the traditional 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.

Accomplishments, on the other hand, are analyzed as having in their representation a bi-sentential CAUSE operator, whose second argument is usually a BECOME-sentence.

It is important to note that the verb classification itself has no formal role in Dowty's theory. Rather, the predictions follow from:

- (a) The analysis of verbs in the aspectual calculus;
- (b) The semantics for operators like BECOME and CAUSE;
- (c) The semantics for time adverbials.

The first point of this paper, noted in part by Dowty, is that while achievements are analyzed with BECOME combined with a stative predicate and accomplishments in terms of CAUSE, the morphological categories of inchoatives and causatives are not of uniform aspectual type. There are some inchoatives (noticed by Dowty) which meet tests for process verbs, and there are some causatives which meet tests for process verbs. In Sections 2.3 and 3.2.2, we provide the semantic analysis of inchoative and causative process verbs and of their interaction with time adverbials.

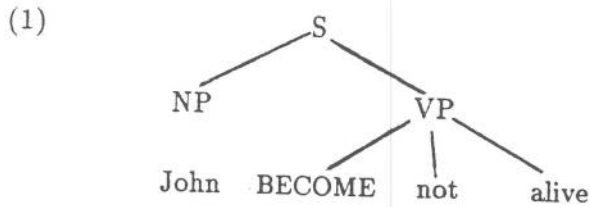
The second point is that verb classification itself breaks down for the above causatives and perhaps for the inchoatives, since according to the tests they are neither pure processes nor pure accomplishments/achievements. We will show that this fact will follow from the semantics for time adverbials and from that defined for the causatives and inchoatives. We believe that this result provides a novel perspective on Dowty's theory. Accomplishments are not identical with causatives, and the role of the verb classification is further weakened, in that the theory makes predictions about verbs which fall into the cracks of the classification.

2 Verbs of Change

2.1 Absolute Inchoatives

Achievements verbs like *cool*, *reach x*, and *die* denote a change from one state to another. Von Wright (1963) developed a formal calculus to represent change, where an event is a change of state and one state is the negation of the other. In Generative Semantics, a sentence like *John died* was argued to contain in its underlying representation a change element, BECOME, and was analyzed by the following tree (we ignore the various proposals as to the stages of lexical insertion and the syntactic nodes governing different

constituents):



Dowty analyzed BECOME in terms of Von Wright's logic of change, treating it as a sentential operator whose semantics is defined with respect to a model.²

Achievements are regarded in the literature as event type verbs. Often, they denote absolute changes of state as illustrated by the verbs *harden*, *freeze*, *reach the top of the mountain*, *win a race*. Inchoative verbs form a sub-class of achievements and usually denote a change of physical state. Some English inchoatives are morphologically related to adjectives which denote the state that undergoes the transformation described by the verb. *Harden_v* and *freeze_v* are morphologically related to *hard_{adj}* and *frozen_{adj}*, but there is no English adjective corresponding to the verbs *reach x* and *win y*.

in different direction!

English lexical rule for deriving inchoatives by adding the suffix *en* to the corresponding adjective is not very productive. For deriving inchoatives, Dowty offers a semantic lexical rule which corresponds to the syntactic one: where α belongs to the category *adjective* and F_2 belongs to the category *intransitive verb*, then $F_2(\alpha)$ translates into:

$$(2) \quad T_1 : \lambda x[\text{BECOME}(\alpha'(x))]$$

² Dowty's semantic definition for $\text{BECOME}[\phi]$ captures the intuition that a sentence can be true at an interval without being true at all times within the interval. Following Bennett and Partee (1978), he defines the truth of BECOME at an interval with reference to the truth of ϕ at the ends of the interval:

- (a) $[\text{BECOME } \phi]$ 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 .

The *clay hardened* is represented in intensional logic as (3), where *clay'* is represented by *c* and tenses are ignored.

- (3) a. $\lambda x[\text{BECOME}(\text{hard}'(x))](c)$
 b. $\text{BECOME}(\text{hard}'(c))$

T_1 captures our intuition about absolute change of states. Inchoatives which denote absolute change are event type verbs. The change represented by them is instantaneous. In the following section it will become clear that absolute inchoatives derived by Dowty's semantic rule T_1 constitute only a subclass of verbs of change. We will see that inchoatives are not necessarily event type verbs, but may be process ones as well. If this is true, then from the mere fact that a verb is derived from an adjective by BECOME we can not predict that it is an event. A similar claim concerning causative verbs will be introduced later.

2.2 Comparative and Vague Inchoatives

Dowty gave examples of verbs of change like *warm*, *grow*, and *redden* which behave like process verbs. Those verbs cannot occur with the punctual time adverbial *at t* and instead take the durative one *for* which does not come with achievement verbs. Like the process verb *run* such verbs extend through a period of time and possess the subinterval property characteristic of process verbs—when the air cools for three hours it cools at each subinterval within the three hours. Here are some examples:

- (4) The air *cooled* for three hours.
 (5) The Atlantic Ocean *widened* for three decades.
 (6) Bill's face *reddened* for two minutes.

Notice that unlike *run*, the verbs in (4)-(6) contain a sense of completion which has to do with the fact that they also express a change of state. This is probably why they can occur with the time adverbials *in an hour* and *it took A y time*, which can never accompany a verb like *run*.

The analysis in this subsection and the next one is influenced by Dowty's discussion of examples like (4)-(6). Inchoatives like *warm*, *widen*, *redden* are related to adjectives whose extension is hard to determine, since it is relative to a comparison scale or context. Such vague adjectives can form the comparative with no semantic anomaly:

- (7) x is $\left\{ \begin{array}{l} \text{warmer} \\ \text{wider} \\ \text{redder} \end{array} \right\}$ than y .

Adjectives like *dead* semantically related to verbs which involve instantaneous change cannot be used for comparison:

- (8) *John is deader than Bill.

Suggestions are made concerning the interaction of adjectives and comparatives in Kamp (1975), Klein (1980), and Hoepelmann (1982). We will not go into the details of each of the above proposals about deriving adjectives from comparatives and choose instead to state Kamp's main idea in a rather informal way:

Cool has different extensions in different contexts. Let $cool_c$ be the extension of *cool* in the context c . The comparative can be now formed from the positive as follows: a is cooler than b if for some c , a is in $cool_c$ but b is not in $cool_c$.

English exhibits three kinds of inchoatives (including the absolute inchoative) which are derived by two semantic rules. Once the distinctions among them are formalized, then following Dowty, the meaning of the verbs in (4)-(6) can be accounted for.

There exists evidence which suggests that inchoatives are ambiguous between a "become-adjective" and a "become-adjective-er" reading. Consider

- (9) The river widened, but it is not wide.

If in (9) *widen* denoted an absolute change from not wide to wide, it would be inconsistent to conjoin "the river widened" with "it is not wide."

Example (10)-(11) demonstrate a similar point:

- (10)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.
- (11)a. John is tall and is growing.
 b. *John is tall and becoming tall.
 c. John is tall and becoming taller.³

If *widening* in (10a) denoted a process of becoming wide (in an absolute sense), the ocean could not be widening when it is already wide. This is illustrated by (10b), which indeed sounds odd.

³ I used the progressive tense in (10)-(11) since *widen*, *grow* cannot appear in the simple tense. The switch of tenses should not affect my argument. I used the verb *grow* in (11) which morphologically is not related to *tall*, although semantically is analysed in terms of the vague adjective *tall*.

We assume that the meaning of vague adjectives like *wide* contains a context parameter *c*, written as a subscript *wide_c*. Sentences (10b) and (11b) 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. On the other hand, the Atlantic Ocean can be *wide_c* and can be still becoming wider as is illustrated by (10c) and (11c). It follows from the semantic analysis of the comparative that the width of the Atlantic Ocean is evaluated with respect to contexts distinct from *c*. In *c*, wide oceans are distinguished from non-wide ones in one way, but in evaluating the comparative, we take into account contexts which make the distinction in another way, for instance, distinguishing temporal stages of the Atlantic Ocean. Those facts suggest that *widening* in (10a) paraphrased by (10c) means "becoming wider" and not "becoming wide."

Partee has suggested to me that some degree modifiers that comparatives allow are the same as those which go with inchoatives:

(12)	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 lot
	*ten degrees cool	ten degrees cooler	has cooled ten degrees

The comparatives and inchoatives which allow or disallow the same degree modifiers seem to be related—the inchoatives seem to be of the become-adjective-er type. On the other hand, absolute modifiers like *completely*, *absolutely* go with adjectives and inchoatives but never with comparatives. In this case the inchoatives are vague and are derived from the corresponding vague adjective.

(13)	Adjective	Comparative	Inchoatives
	completely cool	*completely cooler	has cooled completely
	absolutely cool	*absolutely cooler	has cooled absolutely

Such facts reinforce our suspicions that inchoatives are ambiguous. Partee has also noted that we can say

(14) The weather has finally cooled.

(15) The weather has cooled considerably.

Finally in (14) implies an end state $cool_c$ and *considerably* in (15) implies a degree or comparative reading. The first adverb modifies a vague inchoative and the second a comparative one.

Two semantic rules derive English inchoatives. Where α' is an adjective translation in the intensional logic, and c a context parameter contained in the meaning of a vague adjective α , the translation rule for absolute and vague adjectives can be stated as follows:

$$(16) \quad T_2 : \lambda x[\text{BECOME}(\alpha'_c(x))]$$

The absolute simple inchoative is regarded as a special case. Since its meaning does not depend on context, we can suppress the context parameter in its representation. The second semantic rule derives comparative inchoatives which have the become-adjective-er reading. To get the correct meaning, we must introduce into T_3 an existential quantifier which binds the free variable over contexts:⁴

$$(17) \quad T_3 : \lambda x[(\exists c)\text{BECOME}(\alpha'_c(x))]$$

The following example illustrates the difference between T_2 and T_3 . Let us assume that the two contexts of use are Alaska and Egypt. In Alaska, anything under 0° centigrade is cool and anything which is above 0° centigrade is not cool. In Egypt, anything under 30° centigrade is cool and anything above it is not cool. Suppose a particular glass of lemonade went down from 31° to 29° centigrade. In this case

$$(18) \quad \text{The glass of lemonade cooled.}$$

when translated by T_2 and T_3 ((a) and (b) below) has different truth values with respect to the contexts of use Alaska and Egypt.

$$(a) \quad \text{BECOME}(\text{cool}'_c(l))$$

⁴ Notice that the comparative translation rule and the vague one give the same results for absolute inchoatives. We already said that when α is an absolute adjective then the contextual parameter in the translation of vague inchoatives does not affect interpretation. Since *fourlegged* is not vague $(\forall c)(\forall c')[\text{fourlegged}'_c = \text{fourlegged}'_{c'}]$. When an absolute adjective appears in the translation of comparative inchoatives we get $\lambda x[(\exists c)\text{BECOME}(\text{fourlegged}'_c(x))]$. By the above generalization we can replace c by c' so $\lambda x[(\exists c)\text{BECOME}(\text{fourlegged}'_{c'}(x))]$. Since the existential quantifier does not bind anything, we can eliminate it and end up with a translation of an absolute inchoative $\lambda x[\text{BECOME}(\text{fourlegged}'_{c'}(x))]$. Thus we need to have only two rules—one for deriving vague inchoatives and the other for deriving comparative one. Either of those can derive absolute inchoatives.

(b) $(\exists c)\text{BECOME}(\text{cool}'_c(l))$

(l stands for the glass of lemonade)

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

2.3 Inchoative Process Verbs

Consider again examples (4)-(6) repeated below:

- (4) The air cooled for three hours.
 (5) The Atlantic Ocean widened for three decades.
 (6) Bill's face reddened for two minutes.

Dowty pointed out that, on some semantic and syntactic grounds, those verbs seem to be achievements but nevertheless allow durative adverbs which occur with process verbs. The verbs in (4)-(6) express a change of state but do not imply that the same change occurred over and over. Dowty suggests analyzing (4) as asserting that for each time t within the interval of three hours there is some resolution of vagueness of *cool*, by which *the air is cool* is true at t , and false at $t - 1$. Different resolutions of vagueness should be used for each time covered by the durative adverb, where "a resolution of vagueness" has a narrower scope than the quantifier over times. Having at our disposal our comparative inchoative translation rule, we can formalize Dowty's suggestion and represent (4) by (19). To say that *the air cooled for three hours* 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 air become cool (*the air'* equals a):

(19) $(\exists I)\{\text{duration of } I \text{ is three hours} \wedge (\forall t)[t \in I \rightarrow (\exists c)\text{BECOME}(\text{cool}'_c(a)(t))]\}$

The existential quantifier over contexts has a narrower scope than that of the durative time adverb. The fact that for every two moments in the three hours the air turns from $\sim\text{cool}_c$ to cool_c , i.e, it becomes more and more cool, determines the gradual reading of (4).

Dowty has provided examples like (20) of achievement verbs with indefinite plurals or mass nouns as subject or object, which occur with durative adverbs:

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

This is the comparative reading.

Such examples involve an existential quantifier with a narrower scope than the adverb. G. Carlson (1977a, 1977b) accounted for the presence of an existential quantifier in sentences involving bare plurals.⁵ The existential quantifier in our representation of (4) ranges over contexts and there is no context involved in Carlson's theory. Our representation of (4) by (19) is an elaboration of a suggestion by Dowty which was influenced by Carlson's treatment of bare plurals. Our comparative inchoative rule introduces an existential quantifier like that which is implicit in the verb in Carlson's theory of bare plurals.

Verbs like those in (4)-(6), which take durative time adverbials and which are analyzed by (19), will be called "inchoative process verbs." The condition on the truth of sentences in which inchoative process verbs appear is different from that in which process verbs like *run* and *push a cart* occur. This has to do with the fact that the former but not the latter contain a change element, although aspectually both are processes.⁶

3 Causative Verbs and Time

3.1 Not all Causative Verbs are Event Type Verbs

Dowty suggests considering *all* accomplishments as having a logical structure [ϕ CAUSE ψ] where ϕ and ψ are sentences. The evidence he provides, mainly borrowed from generative semantics, aims to show that accomplishments analyzed by CAUSE are bi-sentential. Dowty 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-

⁵ Carlson argued that the existential quantifier is introduced by the verb. He claimed that bare plurals are names of kinds and 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 . 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. Dowty incorporated Carlson's theory into his BECOME analysis of achievements, and in this way (20) can be represented as follows:

(a) $(\exists I)\{\text{six weeks}(I) \wedge \forall t[t \in I \rightarrow \exists x[R(x, f) \wedge \text{John discover } x \text{ on his dog At } t]]\}$

⁶ In Section 3.1 of my dissertation (Abusch, 1985) I tried to account for certain differences in truth conditions of sentences with process and inchoative process verbs, arguing that tolerance for gaps is acting differently in the two cases.

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

- (21) [John do something] CAUSE [BECOME not [Bill is alive]]

Dowty suggests analyzing *all* accomplishment verbs as having a CAUSE operator in their logical structure. Nowhere does he claim explicitly that accomplishments and causatives are coextensive, but some passages in his work may imply it: "As has often been noticed, natural language causative structures (accomplishment sentences) ordinarily single out..." (Dowty, 1979, pg. 106). Elsewhere he refers to a linguistic class of verbs as causatives/accomplishments (Dowty, 1979, pg. 109). We argue causatives and accomplishments are not coextensive. There are causative verbs which are not event type verbs. Consider the following examples:

- (22) John galloped the horse.

- (23) The man walked his dog.

In line with what was said above, the logical representation of sentence (22) should be:

- (24) [John do something] CAUSE [the horse gallop]

Sentence (22) is a process sentence. It is not true in a situation where John did something abruptly which made the horse start galloping, as for example, pricking his back once with a spear or shooting in the air. Neither is it true in a situation in which John kicks his horse continuously, but it jumps only once. All the possible contextualizations of (22) involve an activity on both John's and the horse's part which is durative in nature.

Causatives like *gallop* and *walk* also take the durative time adverbial *for* which usually goes with process verbs:⁷

- (22') John galloped the horse for three minutes.

- (23') The man walked his dog for an hour.

⁷ In Dowty's verb classification 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 and Dowty's contradictory judgements on that point, we say accomplishments do not take *for*-adverbs, only process and stative verbs do.

The activity specified by causative verbs 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. *Gallop* and *walk* are such examples where their IV counterparts have agentive subjects which are involved in a process rather than undergo a change of state:⁸

(25) The horse galloped.

(26) 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: by poisoning him, strangling him, putting a bullet through his chest or pushing him through a window on the 70th floor of the Empire State Building. There is one consequence of all these vicious acts—Bill undergoes a change of state from being alive to being not alive. Notice that in the same way the activity of John in sentence (22) is unspecified: he might have been sitting on the horse's back kicking him with his spurs on his boot or running beside his horse whipping it occasionally. Whatever his activity is, its nature is durative. The sentences in the two clauses underlying the causatives *gallop* and *walk* are process-type. We will call causative verbs of this kind "causative process verbs" (CPV). Other examples of causative process verbs are:

(27) gallop
feed
run
bounce
walk
roll

The causal connection between John's kicking the horse and its galloping as a result occurs repeatedly or continuously. A formal explication of this relation in causative process verbs is given in the next section.

⁸ One should not confuse the property of being an agent and that of being involved in a process. The object of the causative verb *bounce* is involved in a process *the ball bounced* but is not agentive, while the object of the causative *teach* is an agent but its activity, if successful, is an achievement (*learn*, i.e., an event) rather than a process.

3.2 Time Adverbials and the Time of the Two Clauses of Causatives

3.2.1 Event Causative Verbs

What is 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?

We have shown in the previous section that sentences combined by CAUSE are not necessarily event-type ones. Since the time adverbial modifies the complex accomplishment sentence, interesting questions arise about the way in which it interacts with the time of the two constituent sentences. We said above that it is not always possible to point to the two sentences combined by CAUSE, and in particular to that which constitutes the first clause of the accomplishment. Consider again the sentence:

(28) John killed Mary

The sentence in the result state clause underlying (28) should be *Mary is dead*, but it is not clear what is the sentence which must appear in the first clause. It might be *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 do not have to occur at the same time. Consider (29)-(30) with the frame adverbs:

(29) John killed Mary yesterday.

(30) John killed Mary between noon and midnight.

(29) is true 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 time of the two events of shooting and dying (in 30) must be contained in the interval whose end points are noon and midnight of the same day. We do not say

(31) John killed Mary on Sunday.

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.

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. It should follow from this that when

the time adverb is punctual, the two events must occur simultaneously. This seems to be the case with (32):

(32) John killed Mary at three o'clock.

where the shooting and the dying must occur at very nearly the same time.

Dowty does not discuss this issue in his book, but a restriction which appears in clause (1) and (2) of his definition of CAUSE (rule 15, pg. 353, in the fragment he provides) suggests he may have been thinking of cases like those discussed here. Let us repeat clauses (1) and (2) in his definition of CAUSE:

- (33) If $\phi, \psi \in ME_t$ then $(\phi \text{ CAUSE } \psi) \in ME_t$,
 and $[(\phi \text{ CAUSE } \psi)]_{M,w,i,g=1}$ iff
 (1) there is some $i_1 \subseteq i$ such that $[[\phi]]_{M,w,i_1,g=1}$
 (2) there is some $i_2 \subseteq i$ such that $[[\psi]]_{M,w,i_2,g=1}$
 (3) there is no $i' \subseteq i$ meeting (1) and (2).

We omitted the fourth clause in Dowty's definition which is a version of David Lewis's treatment of causatives in terms of counterfactuals (1973). 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 clause 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. These restrictions predict that (29) is true where the time of John killing Mary (ϕ at i_1) and the time of Mary's death (ψ at i_2) are included in the interval *yesterday*. They also predict the falsehood of (31) where the killing of John and Mary's death fail to both occur on Sunday. In the next section, we will investigate whether the restrictions stated in clauses (1)-(3) are also valid in the case of causative process verbs.

3.2.2 Causative Process Verbs

In our discussion of CPV, we have said that the sentences in their two underlying clauses are processes. Aspectually, CPV are process verbs which take durative time adverbials. We also said that CPV have a continuous causation meaning. We will now see that in sentences containing CPV and explicit durative time adverbials, the continuous causation reading follows from the interpretation of the durative adverb and clauses (1)-(2) in the definition of CAUSE. CPV obey the same restriction as event causative verbs do regarding the relationship between the interval specified by the time adverbial 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 because of the interpretation of the durative time adverb and its interaction with the two clauses. Consider again

(34) John galloped the horse for three hours.

Dowty interprets *for* as belonging to the category (IV/IV)/*t/i*. *For* combines with an expression denoting a property of intervals to form a verb phrase adverbial. Dowty's interpretation of *for* is:

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

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 lambda conversion three times and introducing a subject NP, a VP and a property of times we arrive at:

(36) $\wedge \text{three hours}'\{n\} \wedge \forall t [t \subseteq n \rightarrow AT(t, \phi \text{ CAUSE } \psi)]$

evaluating (36) at an index $\langle w, i \rangle$ we get:

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

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 (37). When (37) is true, then the duration of *i* is three hours and for all subintervals *t* of *i* $[[\phi \text{ CAUSE } \psi]]_{\langle w, t \rangle} = 1$. After applying the past tense to (37) (rule S39 in Dowty's fragment), we end up with

(38) $\exists t_1 [\text{past}(t_1) \wedge \text{three hours}'(t_1) \wedge \forall t [t \subseteq t_1 \rightarrow AT(t, \phi \text{ CAUSE } \psi)]]$

i.e., for some past interval *t*₁, the denotation of *t*₁ is three hours and for all subintervals *t* of *t*₁, $[[\phi \text{ CAUSE } \psi]]_{\langle w, t \rangle} = 1$.

How do clauses (1) and (2) in the CAUSE definition interact with the interpretation of the durative time adverbial? Consider (39) which describes a situation where (34) is true:

(39)
$$\begin{array}{c} [\text{---} [\text{---} (\text{---}) \text{---}] \text{---} [\text{---} (\text{---}) \text{---}] \text{---} [\text{---} (\text{---}) \text{---}] \text{---}] \\ \begin{array}{ccc} t_1 & i_1 & i_2 \\ \underbrace{\hspace{1.5cm}} & \underbrace{\hspace{1.5cm}} & \underbrace{\hspace{1.5cm}} \\ 3 \text{ hours } t & t & t \end{array} \end{array}$$

According to the interpretation of *for*, for each $t \subseteq t_1$, $AT(t, \phi \text{ CAUSE } \psi)$. From clauses (1) and (2) in the CAUSE definition it follows that for each $t \subseteq t_1$,

- (a) for some $i_1 \subseteq t$, $AT(i_1, \phi)$ and
- (b) for some $i_2 \subseteq t$, $AT(i_2, \psi)$

and from the interpretation of *for*:

$$(40) \quad (\forall t)[(t \subseteq t_1) \rightarrow \exists i_1[(i_1 \subseteq t) \wedge AT(i_1, \phi)] \wedge \exists i_2[(i_2 \subseteq t) \wedge AT(i_2, \psi)]]$$

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. To account for the special behavior of CPV, we must maintain the following: the time at which the two sentences in the clauses of CPV sentences are true is contained in the interval specified by the time adverb modifying the CPV sentence. It seems that an analogy exists between inchoative and causative verbs: both kinds of verbs, whose meaning involves such notions as change and causation, appear in natural language as either event or process verbs. We have discussed the semantic analysis of inchoative process verbs, as well as that of causative process ones.

4 Verb Classification and Aspectual Theories

Let us turn to the second point mentioned in the introduction. We are going to show that verb classification itself breaks down for process causative and inchoative verbs, since according to the tests, they are neither pure events nor pure processes. We will now show that although verb classification does not play any formal role in Dowty's theory, we end up with the appropriate interpretations for each of these verbs. This result follows from the semantics for time adverbials and from that defined for process causatives and inchoatives.

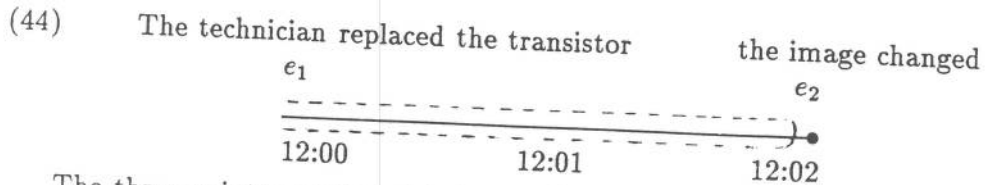
Consider the following example:

- (41) The technician changed the image in two minutes.
- (42) It took the technician two minutes to change the image.
- (43) The technician changed the image for two minutes.

The causative verb *change* in (41)-(42) comes with the time adverb *in two minutes*, which according to Dowty's tests appears with accomplishment verbs. In (43) *change* occurs with the time adverb *for* which comes with process verbs. (41)-(43) are all fine sentences.

We have already seen how we end up with the appropriate interpretation for causative process verbs.⁹ We still need to show how (41)-(42) receive the appropriate readings.

Imagine the following situation: the technician replaced the transistor starting at 12:00 o'clock and finishing at 12:02. The image changed instantaneously at 12:02 and did not change in the preceding two-minutes interval.



The three points mentioned below explain why the translation of (41)-(42) is true with respect to the interval [12:00 12:02].

- (a) The-technician-replaced-the-transistor' is true at [12:00 12:02], and the-image-changed' is true at 12:02. Both are subintervals of [12:00 12:02] as required by clauses (1) and (2) of the CAUSE definition.
- (b) We can set up the model in such a way that if the technician has not replaced the transistor, the image would not have changed (in line with Lewis (1973))
- (c) The uniqueness required by the interpretation of *in* in the time adverbial *in two minutes* is satisfied here. In Dowty's translation of *in*,¹⁰ it is required that the time of the verb's truth is some subset t_1 (not necessarily a proper one) of the interval mentioned i . There should be no proper subinterval of t_1 where ϕ is true. In our example, [12:00 12:02] is a unique interval meeting the above conditions.

The above considerations show that the fact that (41) and (42) are good (that a causative is consistent with an *in* adverbial) follows from the semantics for these sentences.

⁹ *change* in (41) is like *gallop* in (22) in the sense that the intransitive verb *gallop* and *change* both take the time adverb *for* which goes with processes. So the semantics for (41) is the same as that for (22). The difference between these verbs is that the intransitive verb *change* can also take a punctual time adverbial (and so does the causative *change*) while *gallop* can not (either in intransitive or causative form).

¹⁰ Dowty's translation for *in* is

(a) $\lambda P_t \lambda P \lambda x [P_t \{n\} \wedge \exists t_1 [t_1 \subseteq n \wedge AT(t_1, P\{x\})] \wedge \forall t_2 [(t_2 \subseteq n) \wedge AT(t_2, P\{x\})] \rightarrow t_2 = t_1]$

We see here that an existential quantifier binds t_1 in the above translation while in the translation of *for* Dowty had a universal quantifier in that position. The uniqueness condition which appears here distinguishes accomplishments from statives.

A similar claim can perhaps be made with regard to inchoative verbs. The time adverbial *at* is sometimes taken as a classifying test for event verbs (of which absolute and vague inchoatives form a subclass). *At* can also occur with inchoatives which have the comparative reading as is indicated in (45) by the phrase "although it is still not dark."¹¹ If *darken* in (45) were a vague inchoative, then under that assumption, once the sky has darkened, it could not turn darker. However, (45) is acceptable with the phrase "although it is still not dark" which implies that the sky will turn even darker. This is consistent with the meaning of a comparative inchoative.

(45) The sky darkened at three o'clock, although it is not still dark.

The comparative inchoative we have met so far took the durative time adverbial and had the process reading (see (4)). The *at* test does not appear in Dowty's classifying chart, so we can not claim as we did before with regard to the causative *change*, that *darken* does not fit into his classification test. But given that *at* is sometimes used as a test for events, it is of interest to note that the comparative inchoative *darken* is consistent with an *at* adverbial, and that this follows from our theory. (45) requires that *the sky darkened* be true at a moment (or at a very short interval). The change described by the comparative inchoative *darken* can occur instantaneously, so there is no inconsistency for both *at* and *darken* to occur in the same sentence and yield an acceptable reading.

The fact that the change described by *darken* can be either punctual (as in (45)) or a process (as in (4)) follows from the meanings of the verb and the time adverbial in each case.

To summarize, we have shown that there are some verbs which pass tests for both events and processes. The existence of such examples appears problematic for aspectual theories in which the distinction between events, processes and states does play a formal role. However, this is not the case for Dowty's theory. The desired interpretation of sentences with inchoatives and causatives follows from the semantics of such verbs and from that of time adverbials.

¹¹ Lauri Carlson (1981), for example, takes the punctual time adverbial *at* ("momentaneous" in his terms), as a criterion for classifying momentaneous verbs. He has observed that some verbs may take both *at* and the durative time adverbial *for*. He names this class "Dynamics" and provides as an example the verb *stand*. It seems that comparative inchoatives fall into his class of dynamics, since they take both momentaneous and durative adverbs.

References

- Abusch, D. 1985. *On Verbs and Times*. Doctoral dissertation, University of Massachusetts, Amherst (distributed by the GLSA).
- Bennet, M. and B. Partee. 1978. *Toward the Logic of Tense and Aspect in English*. Indiana University, Linguistics Club.
- Carlson, G. 1977a. *Reference to Kinds in English*. Doctoral dissertation, University of Massachusetts, Amherst (distributed by the GLSA).
- Carlson, G. 1977b. A Unified Analysis of the English Bare Plural. *Linguistics and Philosophy* 1.3:413-456.
- Carlson, L. 1981. Aspect and Quantification. In P. Tedeschi and A. Zaenen (Eds.) *Syntax and Semantics* 14:31-64.
- Dowty, D. 1979. *Word Meaning and Montague Grammar*. Dordrecht: D. Reidel Publishing Company.
- Hoepelman, J. 1982. *Action, Comparison and Change*. Unpublished manuscript.
- Kamp, J. A. W. 1975. Two Theories about Adjectives. In E. Keenan (Ed.) *Semantics from Different Point of View*. Berlin: Springer-Verlag.
- Kenney, A. 1963. *Action, Emotion and Will*. London: Routledge and Kegan Paul.
- Klein, E. 1980. A Semantics for Positives and Comparative Adjectives. *Linguistics and Philosophy* 4.1:1-45.
- Lewis, D. 1973. Causation. *Journal of Philosophy* 70:556-567.
- Ryle, G. 1947. *The Concept of Mind*. London: Barnes and Noble.
- Vendler, Z. 1967. *Linguistics in Philosophy*. Ithaca: Cornell University Press.
- Wright, G. H. von. 1963. *Norm and Action*. Humanity Press.