A SEMANTIC ANALYSIS OF ACCOMPLISHMENTS
ON THE BASIS OF EVENT SEMANTICS

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The aim of this paper is to semantically clarify the internal structures
of various types of accomplishments. In doing so, the present theory
assumes that an accomplishment event is made up of the corresponding
activity event and the corresponding achievement event, and that the
achievement event is constructed with an argument which plays the role
of a measuring parameter for the event. Based on these assumptions,
the paper will show that the aspectual distinction between accomplish-
ments and activities can be represented in terms of their logical forms.
Moreover, this paper will make it clear that the semantic incremental
relationships which different types of accomplishments semantically imply
are elucidated in a parallel manner.*

Keywords: aspect, two-event analysis, aspectual presupposition, measure
function, measuring argument, incremental relationship

1. Introduction

This paper will show how aspectual features are represented in the
logical form; in particular, we will show how an aspectual distinction
between accomplishments and activities is presented in the logical form.

When representing accomplishments in the logical form, we will
adopt an analysis with two events instead of an analysis with a single
event. In order to do so, we will first show that, when analyzing
accomplishments, some problems posed by the analysis with a single
event (a single-event analysis) are properly dealt with by the analysis
with two events (two-event analysis). The idea of two-event analysis is

* I am grateful to an anonymous reviewer for several comments and advice. They were very helpful to improve this paper. I would also like to thank George Manolovich for suggesting stylistic improvements and some useful comments. Needless to say, all remaining inadequacies are my own.
originally attributed to Dowty (1979). Though his theory does not use the notion of event as a primitive notion, Dowty divides an accomplishment into the causing activity and the caused achievement. This paper will make an event-semantic theory on the basis of Dowty’s idea. In other words, the present theory reproduces his idea on the basis of the notion of event. Therefore, the present theory analyzes an accomplishment event into two events, namely, the corresponding activity (cor-Act) event and the corresponding achievement (cor-Ach) event. However, the present theory is different from Dowty’s theory in that this theory adopts the manner in which the cor-Ach event is constructed on the basis of the notion of measuring parameter; that is, the present theory assumes that the cor-Ach event is made of the argument that plays the role of measuring the event. Also, since this theory is based on two events, it is different from Krifka’s theory (1992, 1998) which is based on a single event.

The first problem this paper will tackle is the one that a single-event analysis raises.

(1)  
  a. John ate an apple.  
  \[\exists x, e, t [\text{Apple}(x) & \text{Eating}(e) & \text{Agent}(e, j) & \text{Theme}(e, x) & \text{Cul}(e, t)]\]  
  b. John built a hut.  
  \[\exists x, e, t [\text{Hut}(x) & \text{Building}(e) & \text{Agent}(e, j) & \text{Theme}(e, x) & \text{Cul}(e, t)]\]  
  c. John painted a wall.  
  \[\exists x, e, t [\text{Wall}(x) & \text{Painting}(e) & \text{Agent}(e, j) & \text{Theme}(e, x) & \text{Cul}(e, t)]\]

Each sentence has a unique meaning for its internal argument: (1a) means that an apple goes out of existence at the culmination, (1b) means that a hut comes into existence at the culmination, and (1c) means that a wall exists all through the unfolding of the event. But when these sentences are analyzed on the basis of a single event, they are transformed into the quite same type of logical form as \[\exists x, e, t [\ldots]\], as shown in (1a'), (1b') and (1c'). In other words, though each sentence has its own meaning, the same type of logical form is assigned to each sentence. This sameness is problematic in the logical representation for a single-event analysis. That is, a single-event analysis cannot properly represent their meaning differences in the logical form that sentences (1a), (1b) and (1c) produce. Thus, the issue is how the semantic differences are represented in the logical form. In particular,
each logical form should represent the following difference in meaning; a hut appears when John's activity of building culminates and an apple disappears when John's activity culminates. Therefore, this paper will treat the problem of what kind of logical form is assigned to each sentence in order to represent the unique meanings which sentences (1a), (1b) and (1c) yield. This paper will show that this problem is properly solved by means of the analysis based on two events.

The second problem with which this paper will grapple is the one that Krifka's analysis based on a single-event poses.

(2)  
a. John walked some distance.  
b. John walked.

According to Krifka, sentence (2a) is interpreted as telic whereas sentence (2b) is as atelic. But his theory assigns the same logical form to these sentences, which means that we cannot distinguish accomplishments and activities from the point of view of logical form. This problem will be discussed in more detail in chapter 2. Moreover, when the aspectuality in sentence (2a) is calculated along the lines of Krifka's theory, it turns out not to be telic, which is problematic. This problem is pointed out by Zicchi and White (2001). This problem will also be discussed in detail in chapter 2, and it will be shown how these problems are solved by means of the present theory based on the two-event analysis in chapter 3.

The third problem with which this paper deals is how the present theory can describe, in terms of two-event analysis, the incremental relationship that Krifka's theory clarifies in terms of a single event.

When this paper deals with the problems mentioned above, the analysis of the present theory is based on two important schemes:

(3) (i) One is Dowty's idea in which an accomplishment is analyzed into the corresponding activity (cor-Act) and the corresponding achievement (cor-Ach).

(ii) The other is Tenny's idea (1994), namely, a measuring parameter which plays the role of measuring out an event.

Also, this paper will grapple with the problems of how a measuring parameter is analyzed and what kind of logical form is assigned to it. Before tackling all the problems mentioned above, we will discuss them in a little more detail in the next chapter.
2. Some Problems

2.1. A Single-Event Analysis

To begin with, let us look at a few defects that a single-event analysis of accomplishments causes. To do so, we will focus on the difference between the meanings of the following two sentences and the difference between their logical forms which are assigned to them on the basis of a single-event analysis.

(4) a. John built a hut.

   b. John ate an apple.

What sentence (4a) implies is that when John started his activity, there didn’t exist a hut yet, but when he finished it, a hut came into existence. And when the sentence is represented as the following logical form in (5) on the basis of a single-event, the logical form seems to appropriately represent its own meaning of sentence (4a): it represents the existence of a hut at the time of culmination, as shown in (5).

(5) \[ \exists x, e, t [\text{Hut}(x) & \text{Building}(e) & \text{Agent}(e, j) & \text{Theme}(e, x) & \text{Cul}(e, t)] \]

On the other hand, sentence (4b) means that when John started his activity, there was a complete apple, and when he finished his activity of eating, the apple went out of existence. This situation is quite opposite to the one described by sentence (4a). However, when sentence (4b) is symbolized in the logical form on the basis of a single event, the same type of logical form as in (5) would be assigned to it, namely, logical form (6).

(6) \[ \exists x, e, t [\text{Apple}(x) & \text{Eating}(e) & \text{Agent}(e, j) & \text{Theme}(e, x) & \text{Cul}(e, t)] \]

As opposed to the case of (5), what the logical form in (6) denotes seems peculiar: it is because it represents the existence of an apple though the apple goes out of existence at the culmination. In other words, it seems unsuitable that the same type of logical form is used to represent sentences (4a) and (4b), since the meaning of (4a) is completely opposite to the one of (4b) at the time of the event culmination. The problem is, therefore, how the situation in which an entity disappears at the event culmination is appropriately represented in the logical form.\(^1\) Moreover, since it is more appropriate in the semantic analysis

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\(^1\) The analysis in which a logical form like (6) is assigned to sentence (4b) can be proved to be unsuitable as follows:
that we can deal with sentences (4a) and (4b) in a parallel way, the issue is how the two sentences are analyzed in the same manner. We will give a solution to the problem in chapter 3.

Here, we will define the two notions of culmination and starting point from the point of view of event as follows:

(7) a. Since an event culmination takes place at the final subevent of the event, we will identify the culmination with the final subevent. The final subevent $e'$ of an event $e$ is represented as $\text{FIN}(e', e)$.

$$\text{FIN}(e', e) \iff \forall e'' [ e'' \subseteq e \rightarrow e'' < e']$$

b. Since the starting point of an event is associated with the initial subevent of the event, we will identify the starting point with the initial subevent. The initial subevent $e'$ of an event $e$ is represented as $\text{INI}(e', e)$.

$$\text{INI}(e', e) \iff \forall e'' [ e'' \subseteq e \rightarrow e' < e'']$$

2.2. Defects in Krifka’s Analysis

Let us next look at the problems that Krifka’s theory (1992) poses. According to his theory, the aspectual distinction between atelic and telic is made on the basis of semantic properties like cumulativity and quantization, which are represented as (8a') and (8b'), respectively.

(8) a. When an internal argument has a semantic property like cumulativity and the main verb is cumulative, the corresponding VP has the semantic property cumulativity. That means that the VP is interpreted as atelic.

$$\text{Cumulative}(P) \iff \forall x, y [P(x) \& P(y) \rightarrow P(x \cup y)]$$

b. When an internal argument has a semantic property such as quantization, the corresponding VP is interpreted as telic.

$$\text{Quantized}(P) \iff \forall x, y [P(x) \& P(y) \rightarrow \neg y \subseteq x]$$

These semantic properties guarantee that a sentence like (9a) is inter-
preted as atelic whereas one like (9b) is telic.

(9) a. John ate apples.
   b. John ate an apple.
The NP apples has the semantic property cumulativity; thus, the VP eat apples is interpreted as atelic. On the other hand, the NP an apple has the semantic property quatization, and so the VP eat an apple is interpreted as telic.

But this analysis of Krifka’s has a defect with respect to aspectual calculation, which is pointed out by Zucchi and White (2001).

(10) a. John walked.
   b. John walked some distance.
It is generally acknowledged that sentence (10a) is interpreted as atelic whereas sentence (10b) is telic. Krifka’s analysis, however, contradicts this interpretation. The contradiction is proven, according to Zucchi and White, as follows:

(11) Proof: Since a part of some distance is some distance, the NP some distance is not a quantized NP but a cumulative NP. So, the VP walk some distance has the semantic property cumulativity. Thus, the VP is interpreted as atelic and sentence (10b) cannot be telic.

Another problem in Krifka’s analysis is about the logical representation with a path argument. In Krifka (1998: 224), in which path arguments are introduced, sentence (12a) and sentence (12b) are transformed into logical forms (12a’) and (12b’), respectively.

(12) a. Mary wrote something.
   ⇒ a’. ∃z,e[WRITE(m, z, e)]
   b. Mary hiked.
   ⇒ b’. ∃x,e[HIKE(m, x, e)]
   where the variables z and x are path arguments.

When the sentence John walked is analyzed along the lines of the analysis of (12b’), the sentence is transformed into the logical form as follows:

(13) a. John walked.
   ⇒ a’. ∃x,e[WALK(j, x, e)]

Also, the sentence John walked some distance is symbolized, following the analysis of (12a’), as follows:

(14) a. John walked some distance.
   ⇒ a’. ∃x,e[WALK(j, z, e)]

When the sentences in (13a) and (14a) are analyzed along the lines of
Krifka's theory as shown above, we cannot aspectually distinguish one from the other in terms of their logical forms. In other words, once sentences (13a) and (14a) are symbolized in the logical form, the same logical form is assigned to them; thus, we cannot aspectually distinguish them from the point of view of logical form. In the following chapter, we will try to solve the problems posed in this chapter.

3. The Framework in the Present Theory

3.1. Two-Event Analysis

As shown above, the aspectual distinction in the logical form between the sentences John walked some distance and John walked disappears when they are symbolized in the logical forms along the lines of Krifka (1998) in which path arguments are introduced.

In order to make the aspectual difference between them, this paper will adopt an analysis which is based on two events when analyzing accomplishments. As mentioned in Introduction, this idea owes its origin to the aspectual analysis in Dowty (1979) in which he divides an accomplishment into the cor-Act and the cor-Ach. By reproducing his theory on the basis of the notion of event, the position that this theory takes is that an accomplishment event is divided into the cor-Act event and the cor-Ach event. This method is illustrated as follows:

(15) When A stands for the predicate of an accomplishment event, it is symbolized in the logical form consisting of two events.

\[ \exists e [A(e) \Leftrightarrow \exists e',e''[P(e') \& R(e'') \& \text{CAUSE}(e', e'')]] \]

where P stands for the predicate of the cor-Act event and R for the predicate of the cor-Ach event.

Thus, the present theory characterizes accomplishments and activities, respectively, as follows:

(16) a. When a sentence is interpreted as an accomplishment, it is analyzed as an event consisting of two events, namely, the cor-Act event and the cor-Ach event.

b. When a sentence is interpreted as an activity, it is analyzed as an event consisting of a single event.

We will, first of all, tackle the problem of how an accomplishment is divided into two events. In order to do so, let us focus on a difference in the function of the internal argument between sentences (17a) and (17b).
(17)  
  a. John painted a wall.
  b. John drew a circle.
  c. John ate an apple.

As to (17a), the wall exists from INI(e', e) of John’s painting to FIN(e', e). This paper will describe the situation of the wall as follows: the existence of the wall is aspectually presupposed all through the unfolding of the event. We will define the notion of aspectual presupposition on an internal argument as follows:

(18) Aspectual Presupposition on Internal Argument (AP):
  a. When the entity x described by an internal argument R exists from INI(e', e) to FIN(e'', e), the x is aspectually presupposed in the event e, AP(x, e).

\[ \text{AP}(x, e) \iff \forall e, e', x, x'[\theta(e, x) \land \theta(e', x') \land e' \leq e \rightarrow x = x'] \]

b. When the x is aspectually presupposed in the event e, it is represented in the logical form as \( \exists x[R(x) \land \exists e[... \land \text{Theme}(e, x) \land ...]] \).

Now, let us return to sentence (17a). The sentence denotes that a wall is wholly painted at FIN(e', e) although it is not painted at INI(e', e) at all.

On the other hand, as to (17b), what exists at INI(e', e) is not a circle, but only a dot or nothing. And when John finishes his activity, namely, at FIN(e', e), a circle comes into existence; a circle is not aspectually presupposed all through the unfolding of the event. Thus, the changes which (17a) and (17b) describe respectively are roughly illustrated as follows:

(19)  
  a. a wall is not painted—BECOME \( \rightarrow \) a wall is painted
  b. x is not a circle—BECOME \( \rightarrow \) x is a circle

These changes are assumed to represent the achievement events that sentences (17a) and (17b) imply, respectively. Thus, each change is roughly represented in the logical form as follows:

(20)  
  a. BECOME (Be-painted)(a wall)
  b. \( \exists x[\text{BECOME}(	ext{Circle})(x)] \)

When rewriting the above representations on the basis of event semantics, they are represented as the following logical forms in (21a) and (21b):

(21)  
  a. \( \exists e[\text{BECOME}(\text{Be-painted})(e) \land \text{Theme}(e, \text{a wall})] \)
  b. \( \exists x \exists e[\text{BECOME}(	ext{Circle})(e) \land \text{Theme}(e, x)] \)
  c. \( \exists x[\text{Wall}(x) \land \exists e[\text{BECOME}(\text{Be-painted})(e) \land ...]] \)
Moreover, logical representation (21a) is rewritten by means of (18) as (21c).

Also, when representing in the same manner the event in which an apple goes out of existence, namely, the event which sentence (17c) denotes, the event is illustrated and symbolized along the lines shown above as follows:

\[
\begin{align*}
\text{(22) a. } & x \text{ is an apple} \quad \text{become} \rightarrow x \text{ is not an apple} \\
\text{b. } & \exists x [\text{become}(-\text{Apple})(x)] \\
\text{c. } & \exists x, e [\text{become}(-\text{Apple})(e) \& \text{theme}(e, x)]^2
\end{align*}
\]

In the case of (17c), since the spatial change of an apple is identified with a change of the internal structure of an apple, this paper will refer to the object as an internal affected object, IN-AFF object. The object of painting, on the other hand, which is aspectually presupposed all through the unfolding of the event, undergoes an external change of state, the object will be, therefore, referred to as an external affected object, EX-AFF object.

From the above discussion, when analyzing sentence (17c) in a manner as shown above, the sentence is divided into the cor-Act event rep-

\footnote{It was pointed out with regard to the analysis in (22) by an anonymous reviewer that there is a difference in meaning between (i) the notion of the non-existence of an apple and (ii) the notion of the loss of an apple-property. In a strict sense the indication is true. This paper, however, regards the former notion and the latter notion as semantically connected with each other in the interpretation of a sentence like \textit{John ate an apple}. Let us explain in a little more detail the semantic connection between the two notions, and why the corresponding achievement part which the sentence implies is represented as \text{become}(-\text{Apple}).}

Suppose (iii) John broke a vase into pieces. When John broke a vase into pieces, we see that two situations simultaneously happen: one is that the vase goes out of existence, which corresponds to the notion in (i), and the other is that a lot of fragments of the broken vase come into existence. We can, therefore, assume that sentence (iii) implies the transition from being a vase to being fragments. Since the fragments do not have the property of being a vase any longer, which corresponds to the notion in (ii), the transition can be viewed as the transition from the property of being a vase to the property of not being a vase, which is logically represented as \text{become}(-\text{Vase}). The two notions are closely connected with each other in the meanings of sentences like \textit{John ate an apple} and \textit{John broke a vase}. Thus, this paper assumes that since sentence (iii) yields the two situations, which are simultaneous, the corresponding achievement event which the sentence implies is described as \text{become}(-R), in which $R$ denotes the nominal predicate represented by the internal argument of a destructive or consumptive verb.
resented as $\exists x [\text{Eating}(e) \& \text{Agent}(e, j)]$ and the cor-Ach event represented as (22c). Thus, the present theory represents the logical form of sentence (17c) as follows:

$$(23) \quad \exists e [\text{Eating}(e) \& \text{Agent}(e, j) \& \exists e', x [[\text{BECOME}(-\text{Apple})(e') \& \text{Theme}(e', x)] \& \text{CAUSE}(e, e')]]$$

Also, sentence (17a) and (17b) are represented as follows:

$$
(24) \quad \text{a.} \quad \exists e [\text{Painting}(e) \& \text{Agent}(e, j) \& \exists x [[\text{Wall}(x) \& \exists e' [\text{BECOME}(-\text{Be-painted})(e') \& \text{Theme}(e', x)] \& \text{CAUSE}(e, e')]]
$$

$$
\text{b.} \quad \exists e [\text{Drawing}(e) \& \text{Agent}(e, j) \& \exists x \exists e' [[\text{BECOME}(-\text{Circle})(e') \& \text{Theme}(e', x)] \& \text{CAUSE}(e, e')]]
$$

From these logical forms, we can recognize what is aspectually presupposed. We can also explain an intriguing fact, depending on whether an internal argument is aspectually presupposed; the same activity can exert the influence repeatedly on the object that is aspectually presupposed, whereas it cannot in the alternative situation. Thus, an aspectual ambiguity arises in the former case; that is, sentences like John painted the wall for/in an hour, John climbed the ladder for/in an hour and John baked the potato for/in 5 minutes can have both the iterative interpretation without a notion of measuring and the telic interpretation with a notion of measuring. But in the latter case, such an ambiguity does not arise in the interpretation: John ate an apple in/*for a minute, John painted a picture in/*for a month, and John baked the cake in/*for 5 minutes. We will discuss the ambiguity in more detail in the next section.

### 3.2. Measuring Argument

When the following sentence in (25) is semantically analyzed as having two events, namely, the cor-Act event and the cor-Ach event, the problem we will encounter concerns the logical form assigned to each event.

$$
(25) \quad \text{John walked some distance.}
$$

Although the cor-Act event which sentence (25) implies is clearly described by the main verb walk, the problem is how the cor-Ach event is represented. In order to solve this problem, an important notion should be introduced into the present theory: namely, a measure function. According to Krifka (1998: 200), it is defined as follows:

$$
(26) \quad \text{A measure function } m \text{ relates an empirical relation to a numeral function.}
$$
In other words, \( m \) is a function from a set of entities to a set of positive real numbers.

Moreover, following Tenny (1994), the present theory takes the following position: when a sentence is interpreted as telic, it necessarily has an argument that plays the role of measuring out the event. We will refer to the argument as a measuring argument. Thus, the present theory assumes that an achievement is characterized as follows:

\[
(27) \text{ The event, which a measuring argument measures out, is an achievement event. In other words, an achievement event is made of a measuring argument.}
\]

The relationship between a measuring function and a measuring argument is described as follows: given a measuring argument, the spatial length (or extent) of the measuring argument is determined by the measure function. For example, when a measuring argument is represented by an NP, \( \alpha \), the length (or extent) is defined by the measure function \( m \) as follows:

\[
(28) \quad m(\alpha) = n, \text{ which means that } \alpha \text{ has a length (or extent) of } n.
\]

Also, when \( \alpha \) stands for a measuring argument and \( R \) stands for the predicate describing the event which is measured out by \( \alpha \), this paper represents the achievement event as \( \text{ACH}(\alpha, R) \). And the present theory defines \( \text{ACH}(\alpha, R) \) as follows:

\[
(29) \quad \text{ACH}(\alpha, R) \equiv \exists e', n [\text{BECOME}(R)(e') \& m(\alpha) = n \& \text{Theme}(e', n)]
\]

The notation in (29) roughly means that \( R \) represents the predicate described by the event which is measured out by the spatial extent of \( \alpha \). Note here that the achievement event which a measuring argument measures out is in general not an instantaneous event.

Though discussed in more detail below, a semantic mutual relationship between a part and its whole, which is referred to as an incremental relationship, will be clarified by means of a measuring function and a measuring argument.

We will return to the problem of analyzing sentence (25). When analyzing the sentence, we can easily find the cor-Act event, which is described by the main verb; it is represented as \( \exists e [\text{Walking}(e) \& \text{Agent}(e, j)] \).

We encounter a difficulty, however, in determining how the cor-Ach event is represented in the logical form; that is, the issue is what kind of change is described by the cor-Ach event. In order to get over this difficulty, this theory needs to find what plays the role of the measuring
parameter. In this case, we find that the cor-Ach event which sentence (25) expresses is measured out by the NP *some distance*. In other words, we can say that the changes of state in the achievement event are represented by the argument. That means that the cor-Ach will be constructed with the measuring argument on the basis of (27). Also, when the measuring argument is measured by means of a measure function, the cor-Ach event is measured out by the n-length of the path that John travels. The cor-Ach event is, therefore, symbolized by means of $\text{ACH}(\alpha, R)$ as follows:

\[(30) \ \exists e', n[\text{BECOME}(\text{Be-traveled})(e') \land m(\text{some distance}) = n \land \text{Theme}(e', n)]\]

As a consequence, the sentence is represented by means of the present theory based on two-event analysis as follows:

\[(31) \ \text{John walked some distance.} \Rightarrow \exists e[\text{Walking}(e) \land \text{Agent}(e, j) \land \exists e', n[\text{BECOME}(\text{Be-traveled})(e') \land m(\text{some distance}) = n \land \text{Theme}(e', n)] \land \text{CAUSE}(e, e')]]\]

On the other hand, sentence (32a), the sentence with no measuring argument, is transformed into logical form (32b).

\[(32) \ a. \ \text{John walked.} \Rightarrow b. \ \exists e[\text{Walking}(e) \land \text{Agent}(e, j)]\]

As shown in (31) and (32), the present theory can show that an aspectual distinction is made between an activity event and an accomplishment event in terms of their logical forms. In other words, an aspectual distinction between (31) and (32) depends on whether a measuring argument is found in the corresponding sentence or not. When a measuring argument is found in the sentence, which implicitly or explicitly includes an activity event, the sentence is analyzed into two events. On the other hand, when no measuring argument is found, it is analyzed into a single event.

Let us next consider an ambiguous sentence like (33a), in which the entity described by an internal argument is aspectually presupposed. And consider how it is analyzed and what kind of logical form is assigned to each interpretation.

\[(33) \ a. \ \text{John painted the wall.} \ b. \ \text{John painted the wall in an hour.} \ c. \ \text{John painted the wall for an hour.}\]

This paper has assumed that an accomplishment event is composed of the cor-Act event and the cor-Ach event which is constructed by means
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of $\text{ACH}(\alpha, R)$. Thus, when sentence (33a) should be interpreted as an accomplishment, the first step is to find what plays the role of a measuring parameter. It is because this theory assumes that the achievement event is made of a measuring argument. In the interpretation of (33b), it is not the wall itself but the spatial extent of the wall that measures out the event. In other words, the issue is whether the whole spatial extent of the wall is painted. What plays the role of a measuring parameter is, therefore, the spatial extent of the wall. We can represent the spatial extent by means of a measure function $m$. It is shown as follows:

$$(34) \quad m(\text{the wall}) = n$$

Notation (34) means that the wall has a spatial extent of $n$. Thus, the achievement event is constructed by means of $\text{ACH}(\alpha, R)$ and is represented as follows:

$$(35) \quad \exists!x[\text{Wall}(x) \land \exists e', n[\text{BECOME}(\text{Be-painted})(e') \land m(x) = n \land \text{Theme}(e', n)]]$$

where the notation $\exists!x[...]$ represents a definite description. When sentence (33a) is to be interpreted as an accomplishment, it is represented as the following logical form with two events:

$$(36) \quad \exists e[\text{Painting}(e) \land \text{Agent}(e, j) \land \exists!x[[\text{Wall}(x) \land \exists e'[\text{BECOME}(\text{Be-painted})(e') \land m(x) = n \land \text{Theme}(e', n)]] \land \text{CAUSE}(e, e')]]$$

While an accomplishment event is interpreted with two events, an activity event is interpreted with a single event. It is because an activity event does not include the notion of a measuring parameter with which an achievement event is constructed. Therefore, when sentence (33a) is to be interpreted as an activity, the NP the wall is not regarded as a measuring argument, but as merely an object undergoing the influence of an activity; thus, it is represented as follows:

$$(37) \quad \exists!x[\text{Wall}(x) \land \exists e[\text{Painting}(e) \land \text{Agent}(e, j) \land \text{Theme}(e, x)]]$$

Note here that logical form (36) contains the notion of measuring whereas the logical form introduced in section 3.1, namely, (24a), does not. The cor-Ach event which is represented as (35) is constructed on the basis of the notion of measuring parameter, namely, by means of $\text{ACH}(\alpha, R)$, whereas the logical form in (24a) is not. It will be shown in the next chapter that the notion of measuring parameter plays the very important role in clarifying a semantic incremental relationship an accomplishment event describes.

Next, we will take up the following sentences and examine how they...
are analyzed in the present theory.

(38)  
   b. John sank the boat.

When sentence (38a) is to be interpreted as an accomplishment, the problem is to find what plays the role of a measuring parameter: what is the measuring argument that measures out the cor-Ach event of the accomplishment? As to (38a), since the NP a book is assumed to exert the influence on the event, which is measured out by the NP, we assume that the NP plays the role of a measuring parameter. Also, in this case, what the cor-Ach event should describe is whether the whole pages of the book are read or not. Thus, since the spatial extent of the measuring argument is represented by means of a measure function as (39a), the cor-Ach event is symbolized by means of ACH(α, R) as (39b).

(39)  
   a. m(a book) = n
   b. $\exists x [\text{Book}(x) \land \exists e, n [\text{BECOME(Be-read)}(e) \land m(x) = n \land \text{Theme}(e, n)]]$

Notation (39a) denotes that a book consists of n pages, and logical form (39b) means that n pages are read. Since the whole sentence in (38a) is composed of the cor-Ach event represented by (39b) and the cor-Act represented by John’s reading, the sentence is represented as follows:

(40) $\exists e [\text{Reading}(e) \land \text{Agent}(e, j) \land \exists x [[\text{Book}(x) \land \exists e', n [\text{BECOME(Be-read)}(e') \land m(x) = n \land \text{Theme}(e', n)] \land \text{CAUSE}(e, e')]]$

Proceeding along the lines of the analysis as shown above, sentence (38b) is also represented as follows:

(41) John sank the boat.

$\Rightarrow \exists e [\text{DO(P)}(e) \land \text{Agent}(e, j) \land \exists !x [[\text{Boat}(x) \land \exists e', n [\text{BECOME(Be-sunken)}(e') \land m(x) = n \land \text{Theme}(e', n)] \land \text{CAUSE}(e, e')]]$

In the case of (41), n stands for the spatial extent of the boat that represents the measuring parameter for the event, and DO(P) means an unidentified activity.

Before closing this section, we will deal with a sentence with a prepositional phrase (PP) like (42a) and a sentence with a secondary predicate like (42b).

(42)  
   a. John pushed a cart to the store.
   b. John painted the wall red.
The problem here is how to analyze the PP to the store; that is, what kind of logical form is assigned to it, when the PP is combined with a motion verb like walk or a motion verb phrase like push a cart?

In solving the problem, this paper assumes, following Tenny (1994), that where there is a goal there is a path, and that, following Krifka (1992, 1998), the measuring parameter of a goal phrase is described as the length of the path. Thus, when the path to the goal is represented as Path-to-the store(y), and the distance to the goal, which is defined by a measure function m, is represented as m(y)=n, the goal phrase to the store is symbolized by means of ACH(α, R) as follows:

(43) to the store ⇒ ∃y[Path-to-the store(y) & ∃e',n[BECOME (Be-traveled)(e') & m(y) = n & Theme(e', n)]]

When such an analysis as in (43) is assigned to the goal phrase to the store, we can assign the following logical form in (44b) to sentence (44a).

(44) a. John pushed a cart to the store.
⇒ b. ∃x[Cart(x) & ∃e[Pushing(e) & Agent(e, j) & Theme(e, x) & ∃y[[Path-to-the store(y) & ∃e',n[BECOME(Be-traveled)(e') & m(y) = n & Theme(e', n)]] & CAUSE(e, e')]]]

Logical form (44b) means the following: the event e denotes a certain amount of the activity of John’s pushing a cart, and the event e causes the event e’ which represents that the path to the store with a length of n is wholly traveled.

Let us return to sentence (42b). This paper assumes that the secondary predicate red in (42b) also semantically represents a goal. This means that there is a path to the goal. In the case of (42b), the path is an abstract one, which describes the process leading to a state of being wholly red. Thus, when the path is represented as Path-to-a state of being red(y), the secondary predicate will be analyzed in the same manner as the goal phrase to the store. That is, the cor-Ach event which the secondary predicate red stands for in the sentence (42b) is represented by means of ACH(α, R) as follows:

(45) red ⇒ ∃y[Path-to-a state of being red(y) & ∃e',n [BECOME(Be-traveled)(e') & m(y) = n & Theme(e', n)]]

The whole sentence in (46a) will be, therefore, represented as (46a').

(46) a. John painted the wall red.
⇒ a'. ∃!x[Wall(x) & ∃e[Painting(e) & Agent(e, j) &
The present analysis has an advantage in that the difference between accomplishment sentences (46a) and (46c) can be shown in terms of logical forms (46a') and (46c'), which clearly show by what the events are respectively measured out.

4. Incremental Relationships

4.1. Path Verbs and Changing-State Verbs

In this chapter, we will tackle the problem of the incremental relationship between an event and its measuring argument, and how to represent this relationship within the framework of the present analysis. We will, first of all, have to solve the problem of how the incremental relationship between the causing event and the caused event is represented, since the present theory takes the position that an accomplishment is divided into the two events. This is shown as (47).

(47) When an accomplishment event \( e \) is represented as \( \exists e \ [A(e)] \), the event is divided into \( P(e_1) \) and \( R(e_2) \), which is represented as follows:

\[
\exists e [A(e)] \iff \exists e_1,e_2 [P(e_1) \land R(e_2) \land \text{CAUSE}(e_1,e_2)]
\]

When an accomplishment event is divided into two events, \( e_1 \) and \( e_2 \), the present theory assumes that an incremental relationship holds between \( e_1 \) and \( e_2 \). We will refer to the relationship as Graduality, which is represented as follows:

(48) \( \text{Gradual}(e_1, e_2) \iff \forall e_1 \forall e_2 \forall e'1 [[P(e_1) \land R(e_2) \land \text{CAUSE}(e_1,e_2) \land e'1 \subseteq e_1] \to \exists e'2 [e'2 \subseteq e_2 \land \text{CAUSE}(e'1,e'2)]] \)

where \( P(e_1) \) denotes a predicate represented by an activity event and \( R(e_2) \) is a predicate of an achievement event.

The next problem concerns the incremental relationship obtained be-
tween the measuring argument and the cor-Ach event. In order to examine this relationship, we will consider the following sentences.

(49)  
   a. John painted the wall (in an hour).
   b. John painted the wall white.
   c. John pushed a cart to the store.

As shown in chapter 3, the cor-Ach events are represented, respectively, as follows:

(50)  
   a. \( \exists x [\text{Wall}(x) \land \exists e, n[\text{BECOME}(\text{Be-painted})(e) \land m(x) = n \land \text{Theme}(e, n)]] \)
   b. \( \exists y [\text{Path-to-a state of being white}(y) \land \exists e, n[\text{BECOME}(\text{Be-traveled})(e) \land m(y) = n \land \text{Theme}(e, n)]] \)
   c. \( \exists x [\text{Path-to-the store}(x) \land \exists e, n[\text{BECOME}(\text{Be-traveled})(e) \land m(x) = n \land \text{Theme}(e, n)]] \)

The present theory assumes that an incremental relationship holds between each achievement event (Ach) and each measuring argument (MA). We will represent this incremental relationship as \( \text{INCR}(\text{Ach}, \text{MA}) \), which is defined in (51).

(51) \( \text{INCR}(\text{Ach}, \text{MA}) \Leftrightarrow \forall R \forall x \forall e \forall e' \forall n[\text{BECOME}(R)(e) \land m(x) = n \land \text{Theme}(e, n) \land e' \subseteq e \Rightarrow \exists n'[n' \subseteq n \land \text{Theme}(e', n')]] \)

To sum up what we have seen so far, when sentence (49a), repeated here as (52a), is analyzed by means of the present theory as (52b), the incremental relationships \text{Graduality} and \( \text{INCR}(\text{Ach}, \text{MA}) \) among the causing event, the caused event, and the measuring argument are represented as in (52c) and in (52d).

(52)  
   a. John painted the wall (in an hour).
   \( \Rightarrow \) b. \( \exists e_1[\text{Painting}(e_1) \land \text{Agent}(e_1, j) \land \exists x[[\text{Wall}(x) \land \exists e_2[\text{BECOME}(\text{Be-painted})(e_2) \land \text{Theme}(e_2, x)] \land \text{CAUSE}(e_1, e_2)]] \)
   \( \Rightarrow \) c. \( \text{Gradual}(e_1, e_2) \Leftrightarrow \forall e'1[e'1 \subseteq e1 \Rightarrow \exists e'2[e'2 \subseteq e2 \land \text{CAUSE}(e'1, e'2)] \)
   \( \Rightarrow \) d. \( \text{INCR}(\text{Ach}, \text{MA}) \Leftrightarrow \forall e'2[e'2 \subseteq e2 \rightarrow \exists n'[n' \subseteq n \land \text{Theme}(e'2, n')] \)

The incremental relationships above describe the following: when \( e_1 \) stands for the cor-Act event, \( e_2 \) represents the cor-Ach event, and \( n \) denotes the spatial extent (or length) of the measuring argument \( x \), for every subevent \( e'1 \), there is a subevent \( e'2 \) such that \( e'1 \) stands in the \text{CAUSE} relation to \( e'2 \), which \text{Graduality} means, and for every \( e'2 \),
there is a subpart $n'$ such that $n'$ stands in a thematic relation to $e'2$, which $INCR(Ach, MA)$ denotes. In other words, for every activity subevent $e'1(\subset e1)$, there is a subpart $n'(\subset n)$ such that $n'$ is semantically associated with $e'1$ via $e'2(\subset e2)$ which $e'1$ causes.

4.2. Consumptive Verbs and Creative Verbs

We will in this section consider how the incremental relationship is represented in the case of an IN-AFF object like an apple in the following sentence.

(53) John ate an apple.

The logical form of sentence (53), which was introduced in section 3.1, is the following one, repeated here as (54).

\[
(54) \exists e [Eating(e) \& Agent(e, j) \& \exists x, e' [\text{BECOME}(\neg \text{Apple})(e') \& \text{Theme}(e', x) \& \text{CAUSE}(e, e')]]
\]

In order to define the incremental relationship, we must incorporate a notion of measuring into logical representation (54). To do so, we should find what plays the role of a measuring parameter for the co-Ach event. What the variable $x$ in (54) stands for cannot be viewed as a measurable argument for the co-Ach event. It is because the variable does not represent at $FIN(e', e)$ a complete apple but something like a core of the apple. That means that the variable cannot play the role of a measuring parameter. Therefore, we cannot easily represent the incremental relationship of sentence (53), since the sentence does not have the same incremental relationship as the one in the sentence John painted the wall in an hour. In the case of (53), it is a whole apple that we regard as a measuring parameter for the cor-Ach event. The problem here is how we should represent the whole apple which goes out of existence at $FIN(e', e)$; that is, how should we represent the original spatial extent of the disappeared apple?

This paper will introduce two tools in order to solve the problem. The one tool that we should invoke is a materialization function $h$, which is explained in detail in Link (1983) and Bach (1986). According to Bach, it is defined as follows:

\[
(55) \exists x \text{a materialization function } h \text{ is a function mapping from individuals to the stuff of which they are composed.}
\]

The other tool to which the present theory resorts is the one by means of which a material part is restored to its original complete entity with the help of the materialization function $h$. The present theory refers to this tool as RESTORE, which is defined as follows:
(56) \( \text{RESTORE}(x, u) \Leftrightarrow \forall R \forall x \forall e [\text{BECOME}(\neg R)(e, x) \rightarrow \exists e' \exists u [\text{INI}(e', e) \& h(x) \subseteq h(u) \& R(e', u)]] \)

The notation \( \text{RESTORE}(x, u) \) denotes that \( u \) is the original complete entity of \( x \) such that \( x \) is a material part of an entity \( u \) and the \( u \) has a semantic property of \( R \) at \( \text{INI}(e', e) \). For example, when \( x \) means a core of an apple, \( \text{RESTORE}(x, u) \) denotes that \( u \) is an whole apple with the core as its material part.

Consequently, the present theory assumes that the spatial extent of a measuring argument of sentence (53) is represented as follows:

(57) \( m(\text{RESTORE}(x, u)) = n \)

Notation (57) denotes that the spatial extent of the original whole apple \( u \) of \( x \) is measured as \( n \).

When the measuring argument of sentence (53) is defined as (57), we have to rewrite the representation in (22c), which is repeated here as (58), since it does not take the notion of measuring into consideration.

(58) \( \exists x \exists e [\text{BECOME}(\neg \text{Apple})(e) \& \text{Theme}(e, x)] \)

When the present theory takes the notion of measuring into consideration, the representation of the achievement event should be rewritten by means of \( \text{RESTORE}(x, u) \) and \( \text{ACH}(\alpha, R) \) as follows:

(59) \( \exists x \exists e [\text{BECOME}(\neg \text{Apple})(e) \& \text{Theme}(e, x) \& \exists u \exists n [m(\text{RESTORE}(x, u)) = n \& \text{Theme}(e, n)]] \)

The logical form in (59) roughly denotes this: there is something \( x \) such that \( x \) becomes not an apple and the spatial extent of the original whole entity of \( x \) stands in the thematic relation to the event \( \text{BECOME}(\neg \text{Apple})(e) \).

By analyzing the achievement event as logical form (59), we are in a position to depict the incrementality of (53) in the same manner as other cases; we can show on the basis of \( \text{INCR(Ach, MA)} \) the incremental relationship which sentence (53) implies.

(60) \( \text{INCR(Ach, MA)} \) in (53): \( \forall e' [\text{BECOME}(\neg R)(e, x) \& m(\text{RESTORE}(x, u)) = n \& \text{Theme}(e, n) \& e' \subseteq e \rightarrow \exists n' [n' \subseteq n \& \text{Theme}(e', n')]] \)

Next, we will analyze a sentence like (61), in which the verb \textit{draw} is referred to as creative verbs.

(61) John drew a circle.

The event \( e \) which \textit{draw} describes is this: nothing or only a dot exists at \( \text{INI}(e', e) \). This event contrasts with the event of eating in which a complete entity exists at \( \text{INI}(e', e) \). That is, the entity that the event of drawing creates does not exist during the unfolding of the event, which
means that the entity is not aspectually presupposed. But when the event reaches $FIN(e', e)$, a complete entity comes into existence. Thus, the notion of RESTORE is unnecessary to represent sentence (61) in the logical form, because a complete entity, which measures out the event, exists at $FIN(e', e)$. What is left is to incorporate the notion of measuring into the logical form without the notion of measuring, which was introduced in section 3.1. In the case of (61), since the measuring argument is represented as the variable $x$, which means a complete circle, the achievement event is represented only by means of $ACH(\alpha, R)$ as follows:

$$\exists e \exists x [\text{BECOME(Circle)}(e) \land \text{Theme}(e, x) \land \exists n [m(x) = n \land \text{Theme}(e, n)]]$$

Logical form (62) denotes that there is an event in which $x$ becomes a circle with a length of $n$. Sentence (61) is, therefore, transformed into the following logical form:

$$\exists e [\text{Drawing}(e) \land \text{Agent}(e, j) \land \exists e' \exists x [\text{BECOME(Circle)}(e') \land \text{Theme}(e', x) \land \exists n [m(x) = n \land \text{Theme}(e', n)] \land \text{CAUSE}(e, e')]]$$

As a consequence, the incremental relationship between the measuring argument and the event $\text{BECOME(Circle)}(e)$ can be roughly represented on the basis of $INCR(Ach, MA)$ as follows:

$$\forall e' [\text{BECOME(Circle)}(e, x) \land m(x) = n \land \text{Theme}(e, n) \land e \subseteq e' \rightarrow \exists n' [n' \subseteq n \land \text{Theme}(e', n')]]$$

To sum up, the incremental relationships among the causing activity events, the caused achievement events, and the measuring arguments are roughly represented as follows:

$$\begin{align*}
\text{(65)} & \quad \text{a. When } CR(e1) \text{ stands for the predicate of the activity event which a creative verb implies, and } R \text{ stands for the object of the creative verb, the logical form is represented as follows: } \\
& \quad \exists e1 [CR(e1) \land \text{Agent}(e1, y) \land \exists x \exists e2 [\text{BECOME(R)}(e2) \land \text{Theme}(e2, x) \land \text{CAUSE}(e1, e2)]] \\
& \quad \Rightarrow \text{Graduality: } \forall e1 [e1 \subseteq e1 \rightarrow \exists e'2 [e'2 \subseteq e2 \land \text{CAUSE}(e1, e'2)]] \\
& \quad \Rightarrow \text{INCR(Ach, MA): } \forall e'2, n [\text{BECOME(R)}(e2, x) \land m(x) = n \land \text{Theme}(e2, n) \land e'2 \subseteq e2 \rightarrow \exists n' [n' \subseteq n \land \text{Theme}(e'2, n')]]
\end{align*}$$

$$\begin{align*}
\text{b. When } CO(e1) \text{ stands for the predicate of the activity event which a consumptive verb implies, and } R \text{ stands for its object, the logical form is represented as follows: }
\end{align*}$$
As illustrated above, the present theory shows that a part of a measuring argument is related to a causing activity subevent via a caused achievement subevent. The essence of this theory is the assumption that an accomplishment is divided into its activity event and its achievement event, and that the achievement event is made of a measuring argument. Therefore, the present theory is clearly different from Krifka's theory since his theory is based on a single event. However, the present theory can also show the semantic properties which Krifka's theory clarifies; the incremental relationship $\text{INCR}(\text{Ach}, \text{MA})$ is the one which corresponds to the Krifka's semantic property mapping to objects.

Moreover, this theory has an advantage over Krifka's theory with regard to the incremental relationship.

(66) John filled the balloon with helium. As to (66), the mapping to objects in Krifka's theory predicts that there is a part of the balloon such that it is filled with some helium. Giorgi and Pianesi (2001: 245) point out, however, that it is not clear what such balloon-parts would be. They also point out the following problem of Krifka's: a given quantity of helium does not occupy a fixed portion of the potential volume of the balloon but disperses uniformly into the whole volume.

On the other hand, the present theory, into which the notion of measuring is incorporated, does not encounter such a problem as they point out. According to this theory, in the case of (66), it is not the balloon itself but the size of space of the balloon that plays the role of a measuring parameter for the event. In other words, the incremental relationship that this theory predicts is not associated with a part of the balloon nor a fixed portion of the balloon volume, but with a change of the spatial size of the balloon. The co-Ach event that sentence (66) implies is, therefore, symbolized by means of $\text{Ach}(\alpha, R)$ as follows:

(67) $\exists!x[\text{Balloon}(x) \& \exists e[\text{BECOME}(\text{Be-filled-with-helium})(e) \& m(x) = n \& \text{Theme}(e, n)]]$

The logical form in (67) means that when the balloon is filled with
helium, the balloon swells up and results in the volume of $n$; in other words, the positive real number $n$ denotes a size of space of the balloon. In this case, the incremental relationship in this theory is, therefore, represented as the relationship holding between a change of the event of being filled with helium and a change of the spatial size of the balloon. For example, when the balloon is filled with helium halfway, the balloon half swells and the size of space of the balloon is represented as a half of $n$. This can be shown by the $INCR(Ach, MA)$ represented as (68a), which is constructed on the basis of (67). And the whole sentence in (66) is symbolized as (68b).

(68) a. $\forall e', n[BECOME(Be\text{-}filled\text{-}with\ helium) (e) \& m(\text{the balloon}) = n \& Theme(e, n) \& e' \subseteq e \rightarrow \exists n'[n' \subseteq n \& Theme(e', n')]]$

b. $\exists e[DO(e) \& Agent(e, j) \& \exists x[\text{Balloon}(x) \& \exists e'[BECOME(Be\text{-}filled\text{-}with\helium)(e') \& m(x) = n \& Theme(e', n)] \& CAUSE(e, e')]]$

4.3. The Difference Between Some Apples and Apples

Let us finally consider on the basis of $RESTORE$ and $ACH(A, R)$ how the present theory makes an aspectual distinction between the following two sentences in terms of logical form:

(69) a. John ate some apples.

b. John ate apples.

What we first notice is this: the number of apples that the NP $\text{some apples}$ denotes cannot be clearly identified, but the number is finite, whereas the bare plural noun $\text{apples}$ denotes that the number is not identified nor finite. In other words, when some apples eaten by John are restored to their original entities by means of $RESTORE$, they can be counted since the number of apples is delimited. Thus, the entity which the NP $\text{some apples}$ denotes can play the role of a measuring parameter.

(70) When $x$ denotes some apples, $m(RESTORE(x, u)) = \text{finite} = n$.

In this case, we can consider $n$ to represent either the spatial extent of the sum of apples or the number of apples. Thus, since the NP $\text{some apples}$ can be viewed as a measuring argument, an achievement event is constructed with the measuring argument by means of $ACH(\alpha, R)$; that is, sentence (69a) is interpreted as an accomplishment.

On the other hand, the number of apples that the bare plural noun
apples denotes cannot be determined; thus, they cannot be viewed as a measuring argument. In other words, the positive real number of the spatial extent of the sum of apples cannot be given in the case of (69b).

(71) When x denotes apples, m(RESTORE(x, u)) is not determined; that is, a positive real number is not given.

This means that the bare plural noun apples cannot measure out the event; thus, it cannot be viewed as playing the role of a measuring parameter. As a consequence, sentence (69b) is interpreted as an activity because there is not a measuring argument of which an achievement event is made by means of ACH(α, R).

Also, the aspectual distinction between the following sentences will be made on the basis of the present theory.

(72)  
   a. John ran to the church.
   b. John ran toward the church.

In the case of (72a), the distance to the church is finite and so it is represented as follows:

(73) \[ m(\text{Path-to-the church}) = \text{finite} = n \]

Thus, an achievement event is constructed with the measuring argument by means of ACH(α, R); that means that sentence (72a) is interpreted as an accomplishment.

On the other hand, the distance that the PP toward the church denotes cannot be determined since the goal is not definitely fixed in the meaning of the PP; thus, the PP cannot be viewed as playing the role of a measuring parameter. In other words, since there is not a measuring argument of which an achievement event is made by means of ACH(α, R), the sentence is not interpreted as an accomplishment but as an activity.

(74) \[ m(\text{Path-toward-the church}) = \text{the real positive number is not given.} \]

4. Conclusion

The present theory is mainly based on two important schemes:

(75)  
   a. Two-Event Analysis: an accomplishment event is composed of the corresponding activity event (cor-Act event) and the corresponding achievement event (cor-Ach event).
   b. ACH(α, R): the corresponding achievement event is
made of a measuring argument.

Based on these schemes, we can more clearly and easily distinguish the aspectuality of (76a) from the one of (76b), and represent the aspec
tual difference in terms of logical form.

(76) a. John walked some distance.
   b. John walked.

Sentence (76a) has a measuring argument like some distance, which constructs an achievement event by means of \( ACH(\alpha, R) \); thus, it is interpreted as an accomplishment event. On the other hand, sentence (76b) does not have such a measuring argument; thus, it is interpreted as an activity event. The semantic distinction between an accomplishment and an activity event can be made, depending on whether there is a constituent representing the notion of measuring in the predication.

Also, the present theory can depict by means of \( INCR(Ach, MA) \) the same incremental relationships as a semantic property like mapping to objects in Krifka’s theory. But the present theory is different from Krifka’s in that this theory make clear the incremental relationship on the basis of two events, one of which is constructed with a measuring argument, while his theory does it on the basis of a single event. Thus, this theory cannot interpret a sentence without a measuring argument as an accomplishment. Also, since accomplishments are analyzed as the logical forms with two events and activities are the ones with a single event, the present analysis can definitely distinguish accomplishments and activities from the point of view of logical form.

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