Paths and Scalar Change

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Consider the sentences in (1):

(1) a. The fog extended (from the pier to the point).
b. The crack widened (from the north tower to the gate.)
c. The storm front zigzagged (through the entire state of Colorado)
d. Snow covered the mountain (from the valley floor to the summit).

Each of sentences (1a)-(1d) is ambiguous between an event reading and a stative reading. For example, on what I'll call the *event reading* of sentence (1a), a body of fog beginning in the vicinity of the pier moves pointwards, and on the other, stative reading, which I'll call an *extent* reading, the mass of fog sits over the entire region between pier and point. The event reading entails movement. The extent reading entails extension, the occupation of a region of space. Similarly, there is a reading of (1b) describing a crack-widening event, as well as a reading describing the dimensions of the crack, increasing in width along an axis extending from the north tower to the gate; and readings of (c) and (d) describing movement events as well as readings describing the configuration of the storm front and the snow respectively.

Building on the Hay et al. (1999), Gawron (2006) proposes an analysis of the first 3 cases assuming the lexical semantics of each predicate includes a *state function*, a function from indices to a state space. In the case of *widen* and *zigzag* this is a function to degrees, and in the case of the *extend* and *cover* a function to locations. The distinction between event and extent readings depends on whether the domain of the function is the time axis (event reading) or some contextually provided spatial axis (extent readings). Call this the GHKL analysis. The central claim of the GHKL analysis is that extent predicates are not just simple statives, but may show aspectual properties such as gradual change and telicity, but along a spatial axis. Thus, for example, there are both spatial accomplishments and spatial activities, as shown in (2).

(2) a. The crack widened nearly half an inch in ten meters.
b. The crack widened for 100 yards.

The fact noted by Jackendoff (1990), that predicates exhibiting this ambiguity take path-phrase modifiers on both readings, is due to the fact that **path** is the only semantic component available to introduce the spatial axis, and path-phrases the only way to describe orientation of the axis.

Missing from Gawron (2006) is an articulation of how extent predicates fit in with a general account of state functions and telicity such as the one outlined in Kennedy and Levin (2001). This paper seeks to identify the specific properties making a predicate an extent predicate, locate them with respect to other verbs of gradual change, and to account for some of the variation in the aspectual nature of extent predicates, including the important case of cover/fill verbs as in (1d), unanalyzed in Gawron (2006).

Two diagnostics of aspectual structure are examined. First I look at the compatibility of the adverb *gradually* with extent readings:

(3) Graduality

[- Grad]	(a)	The fog gradually covered the peninsula
	(b)	The fog gradually extended to the point.
[+ Grad]	(c)	The crack gradually widened from the tower on.
	(d)	The stormfront gradually zigzagged to the border.

[- Grad] means non gradual on the extent reading. The sentences marked [- Grad] have event readings; sentences marked [+ Grad] have both event and extent readings. Second, I look at whether path is really an incremental theme (Dowty 1991) in event readings; that is, do the truth conditions require that the path covered grow homomorphically with the event, with the location identified in the *from* phrase overlapped at the beginning of the event, and the location identified in the *to*-phrase overlapped at the end?

(4) Incrementality

[+ Incr]	(a)	A storm front zigzagged from Prescott to the border.
	(b)	The fog extended from the pier to the point.
[- Incr]	(c)	The crack widened from the tower to the north gate.
	(d)	Fog covered the peninsula from the pier to the point

For the cases marked [- Incr], the answer is no. In particular, on the non-incremental event reading of (c) the progression of the crack's widening may be in any order, say, from gate to tower, as long as the event concludes with a widening that covers that span; and in (d) the fog's progress may be in any order as long as in the end a span between pier and point is covered.

These contrasts have fairly natural accounts under the GHKL approach. First, for graduality, we may assume that graduality requires that a predicate's state function be increasing (Pinon 2000). Next, for incrementality, if the filler of the path role is a state function returning locations (Verkuyl 1993, Gawron 2006), then path-incrementality for a predicate entails that its state function is either the path function (motion predicates) or a property of the path-function (*zigag* and other path-shape verbs). Thus, extent predicates may be arranged in the following grid:

(5) Aspect of Extent Predicates

	state function increasing	state function nonincreasing
path-property	zigzag	extend
not a path-property	widen	cover

These ideas are both descriptions of the facts; however they leave unexplained certain basic asymmetries.

First, incrementality of theme is a concept that makes sense for both spatial and temporal axes of change. In (1b), for example, on the extent reading, the path-phrases do impose a directionality on the change; the crack must get wider as we move in the direction from the tower to the gate, not the other way. Thus, on extent readings the path phrase of *widen* IS incremental, yet on event readings it is not. How is this possible if the semantics of the two readings is basically the same, except for the axes used? Similarly, for the predicates marked [- Grad], the lack of an increasing

change function can apply only with extent readings, since *gradually* is perfectly compatible with event readings. Again, a key semantic property changes between event and extent readings.

The answer I propose follows many of the ideas of Jackendoff (1996), though with somewhat different implementations. All the predicates in (1) are predicates with spatially indexed paths; however they differ in whether those paths alternate with temporally undexed paths and whether the spatial paths are tied to an axis of change. I assume a predicate can have at most one axis of change and therefore the HKL INCREASE operator, which adds either a spatial (INCREASE_S) or temporal (INCREASE_T) axis of change, can apply only to predicates with no axis of change. In particular, INCREASE_T can apply to *wide*$_\text{S}$ or *cover*$_\text{S}$, which have spatial paths and no axes of change, and produce temporal change predicates with spatial paths independent of the axis of change. On the other hand, I will argue that motion predicates like *zigzag* and *extend* already have an axis of change, and that their temporally indexed paths are necessarily tied to the axis of change, resulting in path incrementality for both event and extent readings.

Constraints on graduality follow from the properties of state functions. I will argue that *gradually* applies only to verbs of gradual change, and the domain of the state function of a verb of gradual change must be what I will call a **non-trivial mereology**, a class of semi-lattices that includes degrees. I will show that INCREASE_S applies to *wide*$_\text{S}$ because the range of its state function (a set of degrees) is ordered, but cannot apply to *cover*, because the range of the resulting state function is not. In contrast, when an axis is added, that is, when INCREASE_T applies to *cover*, an ordered state function results. Thus, the contrast in graduality between event and extent readings of *cover* can be explained. Further support for this analysis of *cover* is that it immediately derives the the insights of Dowty (1991) that *cover*-verbs have two incremental themes, under the assumptions about closed scales and state-functions in HKL.

Consistent with HKL, this analysis follows a trend in recent analyses of lexical aspect in which the classic Vendlerian aspectual categories have no uniform account in the lexical decomposition, contra Dowty (1979), pro Levin (2000). Rather, telicity depends on whether the semantics entails bounded change. HKL associate the bounding of change with state functions which take as values degrees on some closed scale. The present analysis makes use of state functions whose range is not scalar, in particular state functions associated with paths. I will conclude with some general remarks about the utility of such state functions, show how boundedness nevertheless arises, and argue that with a small amendment, the generalization to non-trivial mereologies, this analysis is essentially compatible with the proposal of Kennedy and Levin (2001), that all verbs of gradual change have degreeable properties as semantic components.

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