

# Scalar Complexity and the Structure of Events

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## 1. Introduction

In this paper I examine the aspectual behavior of dynamic predicates, i.e. predicates that involve some “change” or potential change in one participant, including change-of-state, motion, and consumption/destruction predicates. I focus on the factors governing durativity in dynamic predicates, which I integrate into previous work on telicity to build a broader picture of their aspectual behavior. A considerable amount of recent work has argued that the telicity of dynamic predicates arises from a homomorphism between the event and some participant in the event for which the predicate supplies an explicit bound. For example, Tenny (1987, 1992, 1994) argues that events are “measured out” via a mapping between the event and one of three entities: incremental themes of what she calls incremental theme verbs (1a) (e.g. verbs of consumption), a property of an affected participant in change-of-state predicates (1b), or the path of motion verbs (1c).

- (1) a. *John ate the apple.*  
(Progress of event  $\Leftrightarrow$  apple)
- b. *John wiped the table clean.*  
(Progress of event  $\Leftrightarrow$  cleanliness of the table)
- c. *John hiked the Barton Springs trail.*  
(Progress of event  $\Leftrightarrow$  Barton Springs trail)

Telicity is derived from the “measuring out constraint” which ties the bound imposed on the event to the bound imposed on the incremental theme, property, or path (see also Krifka 1989, 1992, 1998, Dowty 1991, Jackendoff 1996, Kratzer 2004 for various similar approaches). More recently, Hay et al. (1999) and Kennedy and Levin (2001) collapse these three types of telicity under one rubric, arguing that in each case telicity derives from constraints imposed on a *scale* that measures the change undergone by the incremental theme, patient, or figure participant. For example, in (1a) the progress of

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the event is correlated with the *volume* of the apple, not the apple itself. The predicate inherently bounds this scale by the value zero, thus the event ends when the apple's volume reaches that point. Likewise, (1b,c) correlate the progress of the event with the cleanliness of the table and the position of the figure on the path respectively, for which each predicate supplies an appropriate bound. Since the homomorphism is always between the event and a scale, this approach collapses the various previously heterogeneous mappings in (1) into a single mapping.<sup>2</sup> For the remainder of the paper I assume this version of the homomorphic approach, though I recast it in different terms.

One prediction of this approach concerns which result phrases are acceptable in resultatives. Wechsler (2001, 2005), Wyngaerd (2001), and Beavers (2002) suggests that only certain kinds of scalar XPs provide appropriate scalar bounds. For example, Wechsler argues that only some adjectives ("non-gradable" and "maximal endpoint closed scale gradable" adjectives) may serve as result XPs since they describe appropriate culmination points for the relevant scales. The adjective *flat* provides an appropriate bound for the scale it describes while *long* does not (cf. the *completely* test, *completely flat/\*long*; Kennedy and McNally 1999, 2005). Thus *long* may not serve as a result XP:

(2) *John pounded the metal flat/\*long.*

Intuitively, this is because resultatives are telic and thus acceptable result XPs must provide specific enough bounds from which telicity may be determined.<sup>3</sup> However, this does not determine all of the aspectual constraints on resultatives, as shown in (3) (cf. Wechsler 2001, Beavers 2002).<sup>4</sup>

- (3)
- a. *The outlaw knocked/beat the sheriff senseless.*
  - b. *The outlaw knocked/\*beat the sheriff dead.*
  - c. *The flames will lick the room to/into a semblance of comfort.*
  - d. *Georgiana was surprised into/\*to cordiality.*

All of the result XPs in (3) are bounded adjectives or goal-marking prepositions. Yet *senseless* and *into*-PPs occur with verbs that *dead* and *to*-PPs are unacceptable with. Adopting Krifka's (1989, 1992, 1998) mereological model of telicity, Wechsler (2001, 2005) and Beavers (2002) argue that this follows from a correlation between the *durativity* of the event and the *gradability* of the scale: durative events require gradable scales, punctual events require non-gradable scales. Expressions denoting events and scales must

have compatible durativity/gradability properties. In this paper I refine and expand this analysis, making the following claims:

*Claim #1:* Durativity and gradability reflect two mereological complexity types: bipartite structures and greater than bipartite structures.

*Claim #2:* All dynamic predicates correlate durativity with gradability.

*Claim #3:* The appropriate homomorphism to explain both the scalar boundedness/telicity correlation and the gradability/durativity correlation is an abstract *movement relation* between the event and scale of change, which preserves the relevant mereological properties of each.

*Claim #4:* Movement relations are the core property of dynamic predicates.

In §2-§3 I review the findings of Wechsler (2001, 2005) and Beavers (2002) on the durativity/gradability correlation in resultatives, expanding and generalizing their results. In §4 I generalize this further, showing that this correlation is a general property of all dynamic predicates even without result phrases. In §5 I argue that this correlation is best understood as a form of abstract “motion”. I outline the relevant lexical, pragmatic, and contextual constraints on durativity and gradability and show how a generalized movement relation between events and scales explains the gradability/durativity correlation. In §6 I discuss the origins of gradability, durativity, and the correlation of the two, arguing that it is the defining feature of dynamic predicates.

## 2. Beyond Telicity - Durativity and Resultatives

I define durativity informally in terms of the “subdividability” of an event (Engelberg 1999, 2000, Beavers 2002).<sup>5</sup> Durative events have multiple discernible subparts. For instance, *build* describes an event that has a beginning point at which nothing has been built, a final point at which a full entity has been built, and a series of intermediate subevents corresponding to different degrees of being built. Thus durative predicates involve three subevents: a beginning, a middle, and an end. Punctual events have only two of these. Verbs like *notice* just describe transition events, from not noticed to noticed, thus requiring only two subevents. This definition may seem counterintuitive at first, since one might expect to define durative events as those that are subdividable (having any subevents at all) and punctual events as those that are not. But

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as discussed in Dowty (1979, pp.168-173) (following Taylor 1977) punctual events require multiple observation points to discern. For instance, an event of stepping once viewed at an instant might simply be an event of standing. It requires at least two snapshots, so to speak, to understand it as a stepping event, and more complicated events will require more snapshots. Perhaps the only situations that may be evaluated at an instant are what Dowty calls “momentary” statives, such as *the ball is on the table*, the truth of which one can evaluate on the basis of a single snapshot. In sum, punctual events are composed two subevents, a beginning and an end, and durative events additionally have medial subevents (see Dowty 1979, p.181 for a similar distinction).

Tests for durativity are less common in the aspectual literature than tests for telicity. Following Kearns (2000, p.206), I test for durativity using *for/in* temporal adverbials in combination with the future tense.<sup>6</sup> Atelic predicates acceptable with *for* adverbials as in (4a) are necessarily durative since *for* inherently imposes a duration on the event. Telic predicates occurring with *in* either have only an *after* reading (that the event occurred after *X* time) or else are ambiguous between an *after* reading and a durational reading (similar to *for* with atelic predicates). Ambiguous predicates are durational while predicates admitting only the *after* reading are punctual as in (4c,d) respectively.

- (4)
- a. *John will run for five minutes.*
  - b. *John will blink once for five minutes.*
  - c. *John will build the house in two years.* (duration/*after*)
  - d. *John will notice the painting in five minutes.* (*after*)

Some predicates are underspecified for durativity. For example, semelfactives such as *blink*, *tap*, and *stab* (Comrie 1976, Smith 1991, Beavers 2002, Rothstein 2004) can be either punctual or iterative. Likewise, some non-semelfactives allow both durative and punctual readings. The verb *cross* has a punctual or durative reading depending on the path denoted by its object:

- (5)
- a. *The settler will cross the desert in two hours.* (duration/*after*)
  - b. *The settler will cross the border in two hours.* (*after*)

With this working diagnostic for durativity, we can re-examine the resultative data in (3). I look first at the results of Wechsler (2001, 2005) on adjectival resultatives and then turn to Beavers (2002) on prepositional resultatives, in both cases summarizing and expanding the earlier results. Wechsler observed distinctions similar to the following among adjectival resultatives.<sup>7</sup>

- (6) a. *The sheriff beat/battered the outlaw senseless/black and blue.*  
 b. *The sheriff shot/??battered the outlaw dead.*

What appears to govern the unacceptability of *dead* in (6b) is durativity. Specifically, *dead* may only occur in punctual event descriptions while the other adjectives may occur in durative event descriptions, as (7) confirm:

- (7) a. *The sheriff will beat the outlaw senseless/black and blue in five minutes.* (duration/after)  
 b. *The sheriff will shoot the outlaw dead in five minutes.* (after)

By the *in* adverbial test, *dead* occurs in descriptions allowing just the *after* reading, whereas *senseless* and *black and blue* also allow durational readings. However, something not discussed by Wechsler is that adjectives occurring in durative contexts may also occur in punctual contexts:

- (8) *With one solid punch, the sheriff will knock the outlaw senseless/black and blue in five minutes.* (after)

Here *senseless* and *black and blue* are both compatible with the semelfactive *knock* on a punctual reading. So it seems that certain adjectives are sensitive to durativity while others are not. Turning to prepositional resultatives, Beavers (2002) notes similar distinctions between *to* and *into* result phrases:

- (9) a. *Kim polished the shoes into/to a sombre, unscuffed shine.*  
 b. *The gray sky dimmed into/to dusk and the snow started up again.*  
 c. *I was startled into/??to indiscretion.*  
 d. *I ducked into/\*to the cave.*

Once again durativity correlates with these distributional differences:

- (10) a. *The gray sky will dim into/to dusk in ten minutes.* (duration/after)  
 b. *I will duck into the cave in two minutes.* (after)

Thus both *to* and *into* are acceptable with durative event descriptions, whereas only *into* is also compatible with punctual event descriptions, shown in (10b).<sup>8</sup> Furthermore, something not discussed in my previous work is that some prepositions seem to require purely punctual interpretations:

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- (11) a. *John will slap the poster on the wall in five minutes.* (after)  
b. *John will roll the poster onto/??on the wall in ten seconds.*  
(duration/after)  
c. *John will push the cart at the wall in five minutes.* (after)

*On* occurs with the semelfactive *slap* only on a punctual reading and is incompatible with durative *roll*, although *onto* is acceptable here. *At* is compatible with *push* but only on a punctual reading, where John gave the cart a quick shove. Thus some prepositions behave like *dead* in requiring punctual events, while others behave like *senseless* in appearing in either durative or punctual descriptions. The curious exception is *to*, which only occurs in durative event descriptions. In fact, we see a striking contrast between *dead* and *to death* in a context with a preceding non-resultative atelic expression:

- (12) a. *After firing several shots, the sheriff finally shot the outlaw dead.*  
b. *#After firing several shots, the sheriff finally shot the outlaw to death.*

The sentence in (12a) quite felicitously means that the sheriff shot at the outlaw for a while until finally hitting and killing him, while (12b) has only the pragmatically bizarre reading that the sheriff fired several shots at the outlaw before finally firing several more shots in a genuine effort to kill him. In sum, we see the correlations in (13) between result phrases and durativity.

- (13) a. *dead, on, at* → punctual event  
b. *to* → durative event  
c. All others → durative or punctual event

In the next section I examine these scalar expressions more closely and show that these constraints are predictable from the gradability of the scale.

### 3. The Durativity/Gradability Correlation

Gradability is the subdividability of a scale, i.e. whether it is binary or multi-valued (see for example Kennedy 2001; see Sapir 1944 for an early discussion of gradability). Intuitively, *dead* describes a point on a binary scale (dead vs. not dead). *Flat* on the other hand describes a point in a multi-valued space of

flatness: there are many degrees of *flatness* other than just *flat*. An operational test for this is the acceptability of an adjective with comparative morphology (Kennedy and McNally 2005). Gradable adjectives are acceptable with comparative morphology while non-gradable adjectives generally are not:

- (14) *dirtier, wetter, straighter, more bent, more senseless, more black and blue, #deader, #more dead*

Although it has been less noted in the literature, it does appear that different classes of prepositions are also amenable to this distinction:

- (15) *This road cuts more into the woods than the highway, John walked more to/toward/across the valley than Bill, #Bill is more at the store than John, #This fly is more on the wall than that one.*

The prepositions in (15) that are unacceptable with comparative morphology are those that are largely locative and point-based in nature. The prepositions that are acceptable are those that are directional or else locative but involve comparisons of extended spatial regions. On the basis of (15) I tentatively assume that gradability is a general property of scalar expressions exhibited by both adjectives and prepositions. With this operational definition, we can re-examine the correlations in (13). Recall that *dead* is unusual among the adjectives discussed above in that it occurs only in descriptions of punctual events. Note, however, that in (14) *dead* is the only one of those that is non-gradable. On the basis of evidence like this, Wechsler proposes that non-gradable adjectives like *dead* can only occur with verbs describing punctual events. Gradable adjectives on the other hand may cooccur with either durative or punctual event descriptions as seen above. Among prepositions, *into/onto* pass the test for gradability and likewise cooccur with durative and punctual predicates. *On/at* do not pass the gradability test and only occur in punctual event descriptions. *To* is unusual in that it is gradable but strictly requires durative readings. Thus we have the following attested patterns:

- (16) a. Durative verb + gradable scalar  
 b. Punctual verb + non-gradable scalar  
 c. Punctual verb + gradable scalar except *to*

From just (16a,b) one could suppose that durativity and gradability are somehow correlated with one another as are punctuality and non-gradability.

But the peculiar case in (16c) poses problems for this clean story, where punctual verbs may also occur with gradable scalars (with the exception of *to*, another puzzle). However, (16c) may not pose much of a problem at all once we look at how gradable scalars are interpreted with durative and punctual verbs. Consider the use of the gradable adjective *flat* with *stamp*:

- (17) a. *With one quick motion, John will stamp the tulips flat in two minutes.* (after)  
 b. *John will stamp the tulips flat in two minutes.* (duration/after)

*Stamp* is semelfactive in (17a), where the context favors a punctual interpretation, and iterative in the durational context of (17b). In both cases *flat* is acceptable. However, commensurate with the punctuality in (17a), there is a non-gradable interpretation of the scale. In this context the only relevant distinction is between flat and not flat, not admitting intermediate degrees of flatness. In (17b), however, it is possible to isolate intermediate timeslices of the event at which we see intermediate degrees of flatness. We likewise see a similar correlation with *into* result phrases:

- (18) a. *With one sputter, the generator will cough into life in two minutes.* (after)  
 b. *The generator will cough into life in thirty seconds.* (duration/after)

In (18a) the generator goes from “dead” to “alive” without intermediate steps, whereas in (18b) it presumably hovers between death and life before purring completely into life. Therefore it appears that most of the purportedly gradable scalars described here are in fact underspecified for gradability: they describe either gradable or non-gradable scales, depending on context. These are distinguished from purely non-gradable scalars like *dead*, *pregnant*, and *unanimous*, which never admit a gradable reading. Likewise, we could further suppose that *to* represents a class of strictly gradable scalars which never admit a non-gradable reading. I summarize all of the possible combinations in the following table (where each cell represents the durativity/gradability of the verb/scalar combination and × indicates an ungrammatical combination):

(19)

Verb type	Scalar gradability type		
	Non-gradable	Underspecified	Gradable
Durative	×	dur/grad	dur/grad
Underspecified	punct/non-grad	dur/grad or punct/non-grad	dur/grad
Punctual	punct/non-grad	punct/non-grad	×

Almost every combination is allowed, except strictly non-gradable scalars with durative verbs and strictly gradable scalars with punctual verbs. Likewise, verbs underspecified for durativity take on durative readings with gradable scalars and punctual readings with non-gradable scalars and vice versa. Counting occurrences of different result phrases in the resultative data from the BNC collected by Boas (2003, Appendix A) further supports these conclusions. *Dead* has 429 occurrences as a result phrase, all with verbs that may describe punctual events. Likewise *to death* occurs 498 times and *to sleep* 45 times, all with verbs that allow durative readings.<sup>9</sup> Other result phrases have mixed possibilities. For example, *shut* occurred 202 times, 97 with necessarily punctual verbs, 91 with necessarily durative verbs. From this summary we can conclude that a durative interpretation of an event described by a resultative is correlated with a gradable interpretation of the result phrase and punctuality is correlated to non-gradability. In the next section I demonstrate that this generalization has consequences beyond the class of resultatives.

#### 4. Durativity and Inherent Scales of Change

Even without result phrases, dynamic predicates show durativity/gradability correlations. This can be seen by examining two kinds of data. First are sentences without result phrases but with overt scale denoting expressions (e.g. traversal objects of motion verbs), such as (5), repeated here:

- (20) a. *The settler will cross the desert in 2 hours.* (duration/after)  
 b. *The settler will cross the state line in 2 hours.* (after)

When the path is non-extended the event is understood as punctual, and when the path is extended the event is durative. Second, even when the path is not overtly expressed, for instance in a motion event with a goal-denoting object rather than a traversal object, changing the context so that the implied path must be construed as either extended or non-extended has an effect on the durative or punctual interpretation of the whole sentence:

- (21) a. [John is standing just outside the entrance of a cave]  
*John will enter the cave in 30 seconds.* (after)  
 b. [John is standing outside a tunnel leading into a cave]  
*John will enter the cave in 30 seconds.* (duration/after)

Likewise, even when the scale is not a path, the same interpretive correlation holds. Consider (22), where the same sentence is durative in one context but punctual in another depending on how the covert scale is interpreted.

- (22) a. [In a context of turning a knob that dims the lights]  
*The stagehand will lower the house lights by 3/4 in five minutes.*  
 (duration/after)
- b. [In a context of flicking a switch that cuts the lights by 3/4]  
*The stagehand will lower the house lights by 3/4 in five minutes.*  
 (after)

Thus the general conclusion for all dynamic predicates, either with overt scales of change as in resultative expressions or else covert scales of change as in inherent change-of-state, is given in (23).

(23)	Interpretation of event		Interpretation of scale
	Durative	$\leftrightarrow$	Gradable
	Punctual	$\leftrightarrow$	Non-gradable

Intuitively this is what one would expect on a truly homomorphic model of events to scales: progress of the event is determined by progress along the scale, so the complexity of one should somehow mirror the complexity of the other, at least at some level of granularity.<sup>10</sup> In the next section I integrate this into a specific model of the event-scale homomorphism.

## 5. A Complete Event Homomorphism Model

Although durativity and telicity are separate aspectual features, we can nonetheless understand the durativity/gradability and telicity/boundedness correlations in terms of the same homomorphism. In this section I argue for a particular model of the event-to-scale homomorphism based on the mereological event-to-path homomorphism defined by Krifka (1998) for motion and change-of-state descriptions. Before discussing the properties of this homomorphism, I first define durativity and gradability mereologically. I assumed above that punctual events and non-gradable scales involve just two pieces (a beginning and an end) while durative events and gradable scales involve three or more pieces (a beginning, an end, and some middle portion(s)). Following Beavers (2002), we can generalize over these two types by referring

simply to what I call “minimally complex” and “complex” objects as in (24), producing the two relevant binary distinctions for events and scales in (25).<sup>11</sup>

- (24) a. Minimally Complex Objects (*MCO*) have exactly two subparts.
- b. Complex Objects (*CO*) have at least three subparts.

(25) For event  $e$  and scale  $s$ :

<i>MCO</i> ( $e$ ):	Punctual event	<i>MCO</i> ( $s$ ):	Non-gradable scale
<i>CO</i> ( $e$ ):	Durative event	<i>CO</i> ( $s$ ):	Gradable scale

Complex objects do not necessarily have just three subparts. They only have a *minimum* of three subparts. Why are higher complexity types irrelevant? We can view this in terms of “granularity”. For any mereological entity, different subparts may be important for different contexts. One could conceive of an event of eating a sandwich as consisting of a series of bites or a series of singular chewing events (movements of the jaw). A path from San Francisco to New York could be viewed in terms of each individual mile or else in terms of just city-to-city segments, for instance the various ways different airlines calculate frequent flyer miles. Each represents a different “take” on a particular entity, at different levels of granularity. Likewise, only certain subparts or granularities may be relevant for different grammatical phenomena. Recall that on nearly any homomorphic model of telicity the endpoints of the event/scale are the most crucial for ascribing bounds; the rest of the event/scale is irrelevant. What I maintain here is that for the grammatical distinction between durative/punctual events and gradable/non-gradable scales the relevant granularity is one that separates beginnings and endings and lumps any medial subobjects together.

Turning now to the correlations between events and scales, consider first descriptions of motion. In an event described by *John walked to the store*, there is a homomorphic relationship between the event and the position of the figure on the path that can be verified visually. John’s progress is measured first by his initial departure from his starting location. He then progresses along the path, which he traverses in a spatially adjacent fashion though he may go in any direction and even backtrack. Finally he arrives at the store, designating the end of the event. Krifka (1998, (71), p.225) describes this in terms of a Movement Relation (MR) entailed by a motion verb between its event argument  $e$  and a path argument  $p$  for a figure  $x$ . Informally speaking, MRs are functions from  $e$  to  $p$  with the following properties:<sup>12</sup>

- (26)
- a. *Coextensiveness*: The initial and final subevents of  $e$  are mapped to the initial and final subpaths of  $p$  respectively.
  - b. *Adjacency*: Temporally adjacent subevents of  $e$  map to spatially adjacent subpaths of  $p$ .
  - c. *Surjective Functionhood*: All subevents of  $e$  are mapped to a single subpath of  $p$  and all subpaths of  $p$  correspond to at least one subevent of  $e$ .
  - d. *Minimality*: The event begins when  $x$  leaves the source and ends when  $x$  arrives at the goal.

Intuitively these properties capture the relationship of motion events to paths as described above. The last property, *minimality*, deserves some comment. Consider a context in which John declares his intention to walk to the store, but does not actually budge. Is the sentence *John is walking to the store* true? Clearly not. Although he may return to the house during the course of the event, the event does not begin until he leaves for the first time. Likewise, once John reaches the store, the event ends. If he reaches the store and then leaves again, one would no longer say *John is walking to the store*, at least not to describe the same event. *Minimality* is the property that ensures events begin and end promptly upon departure and arrival.

*Coextensiveness* determines telicity of motion predicates when a source and goal are specified (see Krifka 1998, p.228). But what is of interest here is what MRs say about the internal complexity of  $e$  and  $p$ . If each has just two parts then the MR maps them to one another in the expected fashion. But what if either is more complex? I examine this on a case by case basis. If  $e$  has a non-initial, non-final subevent  $e'$  then there *must* exist a non-initial, non-final subpath  $p'$  of  $p$  to which it maps. This is because MRs are *functions*, and all subevents must map to some subpath. This subpath cannot simply be either the initial or final subpath of  $p$  since  $e'$  would then map to the same subpath as either the initial or final subevent of  $e$ , violating the *minimality* of MRs. So  $p'$  must be distinct from the initial and final subpaths of  $p$ . Therefore  $p$  is also complex. Likewise, if there exists some non-initial, non-final subpath  $p'$  of  $p$  there *must* exist a non-initial, non-final subevent  $e'$  of  $e$ . This is due to the *surjectivity* of MRs, which ensures that each subpath has a corresponding subevent. This cannot be either the initial or final subevent of  $e$  since these are already mapped to the initial and final subpaths of  $p$  and each subevent may only be mapped to one subpath by the functionhood of MRs. Thus  $e$

must be complex as well. To recast this more informally, if you spend time moving between a source and a goal there must be some place you spent that time moving, and likewise if you hit any part of a path that is not the source or goal there must be some portion of the event you spent traversing it.

Thus MRs are *isomorphic up to tripartite structures with respect to mereological complexity*. This means that  $e$  has two subparts iff  $p$  has two subparts, and  $e$  has three or more subparts iff  $p$  has three or more subparts. Note that this does *not* mean that MRs are isomorphic with respect to temporal/spatial precedence, i.e. temporal precedence does not necessarily reflect spatial precedence. This allows for the fact that once a figure leaves the source point on a path, it may return to it multiple times during the course of the event before reaching the goal, in which case the figure has left the medial subpath during a medial subevent to return to the initial subpath. MRs are also not isomorphic for structures of greater than three subparts. A figure could spend a lot of time (a multi-part  $e$ ) walking back and forth along a very small  $p$  before reaching its destination. In this case there are arguably considerably more subevents than subpaths.<sup>13</sup> All MRs do is preserve isomorphy with respect to mereological complexity for bipartite and greater than bipartite structures.

But of course, this isomorphy is exactly what underlies the correlation of durativity/gradability, which therefore falls directly out of the MR:

(27) MRs are isomorphic up to tripartite mereological complexity, i.e.:

- a.  $MCO(e) \leftrightarrow MCO(p)$
- b.  $CO(e) \leftrightarrow CO(p)$

Thus MRs are responsible for the durativity/gradability correlation for motion descriptions. Recasting this in a scalar terms, the MR could be viewed instead as a homomorphism between the event and a scale of position along the path, from which the same correlations follow for the same reasons.<sup>14</sup> Of course, there is no a priori reason why the durativity/gradability correlations of other dynamic predicates amenable to a scalar analysis should not follow from the same kind of relation. For an expression like *John built a model airplane*, as John builds the (initially non-existent) airplane it progresses adjacently through different points on a scale of builtness until finally reaching completely built. Again, beyond tripartite complexity there is no one-to-one correlation between the event and scale. If the model came in three pieces, John could conceivably put two pieces together and take them apart again ad

infinitum, but the model will not be built until he snaps on the final piece. Therefore I propose that all dynamic predicates have the same general form:

- (28)  $P$  is a dynamic predicate iff  $P$  predicates over an event  $e$ , a force-recipient  $x$ , a scale of change  $s$ , and possibly other entities.<sup>15</sup>

Dynamic predicates are descriptions of an event  $e$  that relate  $e$  to a theme  $x$  which is (potentially) changed and a scale  $s$  that describes the change. The relationships of  $x$ ,  $s$ , and other participants to  $e$  are determined by what Krifka (1998) refers to as  $\theta$ -relations, relationships implied by  $P$  that relate these entities back to  $e$  (similar to Parson's 1990 thematic role relations). Following Beavers (2002), I propose that the  $\theta$ -relation relating  $s$  to  $e$  is a type of MR that relates events to scales rather than just paths, which I refer to here as a Generalized Movement Relation (GMR). What kind of dynamic predicate  $P$  is depends on the nature of the scale as discussed in §1: scales corresponding to positions along paths are appropriate for motion descriptions, scales corresponding to the extent of entities are appropriate for creation/destruction predicates, scales corresponding to non-spatial properties are appropriate for change-of-state predicates, etc.<sup>16</sup> The scale appropriate for a given expression is determined by a combination of lexical, contextual, and pragmatic factors.

Before examining how GMRs explain the data discussed in §3-§4, I briefly review where  $CO$  and  $MCO$  constraints come from. As noted above, lexemes impose complexity constraints as shown in (29) and (30).

(29) Verb	Example	Constraints Imposed
Strictly durative	<i>run, walk, drive</i>	$CO(e)$
Underspecified	<i>tap, cross, enter</i>	
Strictly punctual	<i>stun, shock, die</i>	$MCO(e)$

(30) Scalar	Example	Constraints Imposed
Strictly gradable	<i>to</i>	$CO(s)$
Underspecified	<i>dry, clean, onto</i>	
Strictly non-gradable	<i>dead, stunned, at</i>	$MCO(s)$

Presumably, these constraints are not basic but are derived from more basic properties of different classes of lexemes, something I return to in §6. Furthermore, context may determine complexity constraints:

- (31) [John is standing just outside the office]  
#*John walked to the office.*



Neither the verb nor the goal object in (34) imposes any complexity constraints on  $e$  or  $s$ . But different contexts favor different complexity constraints on  $s$  which likewise favor certain constraints on  $e$ , explaining the judgments on the *in* test. Thus the homomorphic approach explains a variety of interpretive facts about dynamic predicate. This approach also explains the grammaticality facts discussed above (the unacceptability of some verbs with some scalars) in terms of conflicting constraints. This situation is illustrated in (35).

- (35) a. \**John stunned Mary to silence.* ( $MCO(e) \wedge CO(s)$ )  
 b. \**The sheriff battered the outlaw dead.* ( $CO(e) \wedge MCO(s)$ )

*Stun* requires a bipartite event, but *to* requires a tripartite scale, thus yielding a contradiction by (27). Likewise, *batter* requires a tripartite event but *dead* requires a bipartite scale, leading to another contradiction. To see exactly where the failure is, it is helpful to view this visually:

- (36) Ungrammatical durativity/gradability correlations:
- |    |              |          |              |          |              |          |              |          |              |
|----|--------------|----------|--------------|----------|--------------|----------|--------------|----------|--------------|
| a. | $e = e'$     | $\oplus$ | $e'''$       | b.       | $e = e'$     | $\oplus$ | $e''$        | $\oplus$ | $e'''$       |
|    | $\downarrow$ |          | $\downarrow$ |          | $\downarrow$ |          | $\downarrow$ |          | $\downarrow$ |
|    | $s = s'$     | $\oplus$ | $s''$        | $\oplus$ | $s = s'$     | $\oplus$ | $s''$        |          | $s'''$       |
- (\* $V_{punct}$  + gradable scale)      (\* $V_{dur}$  + non-gradable scale)

In both cases, the condition of up to tripartite isomorphy is violated: there is either not enough scale for the event or not enough event for the scale. In (36a) it is not possible for either  $e'$  or  $e'''$  to map to  $s''$ , since this violates the condition that the GMR be a function. Likewise, in (36b),  $e''$  may not map to either  $s'$  or  $s'''$ . While in general a subscale can correspond to multiple subevents, the *minimality* of MRs ensures that nothing adjacent to  $e'$  or  $e'''$  can share a subscale with it. Thus the ungrammaticality of certain result phrases with certain predicates follows from violations of the relationship between the scale and the event. I summarize all of these conclusions in the next section and discuss the origins of the various lexical constraints assumed here.

## 6. Conclusion - The Underlying Nature of Complexity Constraints

I argued above that a homomorphism model designed to explain the nature of telicity of motion predicates (a) also explains the durativity/gradability correlation argued for by Wechsler (2001, 2005) and Beavers (2002) and expanded

on above and (b) can be generalized to cover a range of dynamic predicates following the scalar approach to telicity in Hay et al. (1999) and Kennedy and Levin (2001). Crucially, the event-to-scale homomorphism preserves complexity at exactly the level of granularity relevant for this correlation. Before concluding, I examine more closely the lexical complexity constraints discussed above and offer some tentative suggestions as to their origin, since it seems unlikely that these constraints should be basic. First is the distinction between durative and punctual predicates. Olsen (1994) proposes that durativity is a privative feature of verbs, i.e. some verbs lexically select for durative events whereas all others are underspecified. If this were true then we would have only to explain why some verbs are durative. But *prima facie*, this claim is not correct, since achievements only admit punctual readings.

- (37) a. *The art critic will notice the painting in five seconds. (after)*  
 b. *John will die in five seconds. (after)*  
 c. *John will stun Mary in five seconds. (after)*

While most punctual verbs may also be durative (such as semelfactives or path-of-motion verbs like *cross*), achievements steadfastly refuse to be durative. But notice that achievements are associated with scales that are (a) inherently non-gradable (cf. *\*more noticed*, *\*more dead*, *??more stunned*; see Kennedy and McNally 2005) and (b) non-iterable, since they entail results. This is unlike path-of-motion verbs which may have gradable scales and semelfactives which may iterate because they do not entail results. In principle, if a context were devised favoring a gradable reading of the inherent scale or iterability of the result state we might expect a durative reading of some sort. Consider a context where we might get iterability:

- (38) [In a context of Nancy suffering from acute amnesia]  
*?Sid's Mohawk will stun Nancy over and over again for five minutes.*

This (admittedly forced) context seems to allow a durative reading of *notice*. Arguably then punctuality can be derived from properties of the underlying scale. So is there no genuine punctuality? Hana Filip (p.c.) notes the unique behavior of semelfactives in the progressive:

- (39) a. *The bunny is sleeping.* (durative, non-iterative)  
 b. *The bunny is hopping.* (necessarily iterative)

In (39a) we get a regular durative reading, i.e. that the bunny is in the middle of a sleeping event. But in (39b) we necessarily have an iterative reading. This would imply that there is still something “punctual” about semelfactives such that we can only construe them durationally by stringing together lots of punctual events. But note of course that pragmatics and context play a role, since *The horse is hopping (over the fence)* may be non-iterative when the path of the hopping is long enough. This suggests that what is at play here is not a grammatical constraint of punctuality so much as a tendency to apply to shorter events. If this is the case, it might be that Olsen (1994) is indeed right and punctuality is not a lexical constraint, leaving only durativity.<sup>17</sup> But is there something we can reduce this to? Consider the data in (40).

- (40) a. *The wizard rolled down the hill (#in an instant).*  
 b. *The wizard moved down the hill (?in a flash of light).*  
 c. *The alien slurped the bowl of soup down (#in an instant).*  
 d. *The alien consumed the bowl of soup (in an instant).*

In (40a,b) there is a contrast between two verbs describing motion along the same path, where one is necessarily durative but the other allows the possibility of “instantaneous” motion given a situation involving a wizard who can move magically. Likewise in (40c,d) slurping down vs. consuming a bowl of soup in an instant (through some alien power or technology) have different durativity constraints. Although these verbs can describe the same situations, only *roll* and *slurp down* must be durative. Why is this the case? It seems that necessarily durative verbs are those with some associated manner that precludes instantaneous readings. Dowty (1979) proposes that some verbs require multiple “snapshots” to evaluate (e.g. one snapshot of walking might just be standing, two might be stepping, but three would be walking). *Roll* and *slurp down* involve manners that are sequenced in such a way that multiple “snapshots” are required to discern them as a pattern, whereas *move* and *consume* do not have manners. Thus durativity constraints may be derivative of manner, i.e. [+manner] → [+durative] in Olsen’s featural terms, suggesting that neither punctuality nor durativity is really basic to event descriptions.

Turning to scalars, the difference between non-gradable and underspecified scales is perhaps conceptually based. Certain scalars (like *dead* or *pregnant*) are lexicalized as non-gradable because they correspond to real-world binary contrasts. Other scalars however correspond to contrasts that could

be binary or have various shades. Thus gradability types are perhaps basic in the sense that they correspond to specific real world contrasts. But this leaves *to* unexplained, which is unique in being the only scalar to impose a durativity constraint. Why should this be the case? The short answer is that I have no idea. The long answer is to tentatively suggest that this is somehow correlated to the motion typology of Talmy (1975, 1985, 2000). The core of the typology is what Talmy (2000) refers to as a “framing event”, the semantic structure that defines, among other things, the aspectual and scalar structure of the event. Talmy distinguishes between verb-framed languages in which verbs define the framing event and satellite-framed languages, where satellites to the verb (e.g. particles and presumably prepositions) define the framing event. This pans out most conspicuously in expressions of motion in different languages, where manner-of-motion verbs like *saunter* and *dance* may cooccur with goal-marking satellites in satellite-framed languages but not in verb-framed languages. What is unique about *to* in English, a satellite-framed language, is that it defines framing events. Verb-framed languages (like Japanese and French) tend to lack elements with the distribution and semantics of *to*. Perhaps imposing strict gradability and boundedness, thereby providing a frame for dynamic predicates, is part and parcel of *to*'s ability to define framing events. This is not an explanation of *to*'s behavior, but merely a correlation that might offer clues into why *to* behaves as it does.<sup>18</sup>

Finally, there is the question of why dynamic predicates impose a homomorphism at all. Again I have no definitive answer, except to suggest that rather than thinking of the homomorphism as something “extra” needed to explain the durativity/gradability and telicity/boundedness correlations, we instead think of it as the defining property of dynamic verbs. That is, a homomorphism is what all dynamic predicates are about: force-dynamic relationships involving *measurable change*. Different event types are assigned to this category when they involve measurable changes, and the allegedly basic telicity/boundedness and durativity/gradability correlations follow, all under one rubric. We would of course expect further properties of dynamic predicates to fall out of the same homomorphism, a matter I leave to future work.

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## Notes

1. I would like to thank Beth Levin both for her extensive discussion and insights on this topic and also for supplying me with her hand collected database of resultatives from which my initial investigations were drawn. I would also like to thank Hana Filip, Chris Kennedy, Paul Kiparsky, Manfred Krifka, Andrew Koontz-Garboden, Chris Piñón, Ivan Sag, Judith Tonhauser, and Steve Wechsler as well as audiences at the 76th Annual LSA Meeting, the Stanford Semantics Workshop, and the Workshop on Event Structures at the University of Leipzig. This is based on my previous and currently unpublished work on prepositional resultatives (Beavers 2002). Steve Wechsler (2001, 2005) arrived at similar conclusions working primarily on adjectival resultatives, and I draw heavily on his insights even though our models differ in certain respects. However, any mistakes or deficiencies are purely my own.
2. Technically speaking, Kennedy and Levin (2001) do not assume a homomorphism between the scale and the event, just that boundedness (“quantization”) imposed on the scale determines telicity (Chris Kennedy, p.c.). For determining telicity this may well be the case, although nothing in their approach is incompatible with a homomorphism between the event and scale at all. For the aspectual properties I discuss here this homomorphism is in fact crucial, and I will assume a version of their theory involving one.
3. The claim that resultatives must be telic is modulo the effects of mass or bare plural arguments of the verb, which induce atelicity in otherwise telic predicates, an issue not particular to resultatives (Garey 1957, Verkuyl 1972, 1993, Dowty 1979). Goldberg and Jackendoff (2004) dispute the claim that resultatives must be telic on the basis of result phrases of the form *X-er and X-er* or *ever X-er*, as in *For years, Penelope wove the shawl longer and longer* (Goldberg and Jackendoff, (23c), p. 543). I ignore such examples since they necessarily require ‘resultatives’ of a highly particular morphology and thus are not indicative of the larger tendency of resultatives towards telicity.
4. Most of the data from Beavers (2002) are from a corpus of resultatives including about 1,700 with prepositional result phrases collected from various print media by Beth Levin, although some examples have been modified here for brevity or clarity.
5. Unlike telicity, which is a property of predicates, durativity is a property of events, although predicates may encode sortal constraints on durativity. Thus I refer to predicates that select for durative or punctual events as “durative predicates” and “punctual predicates” respectively.
6. This test works in the past tense as well but the future tense seems to draw out the distinction more clearly for mysterious reasons.
7. I focus here on what Wechsler (1997) calls “control” resultatives, where the verb and the result phrase share an argument, as opposed to “ECM” resultatives (involving fake objects/reflexives) where the verb is not subcategorized for the subject of the result phrase.
8. Denis et al. (2003) and Wechsler (2003) argue that *into* is only compatible with punctual contexts. However, examples like (10) as well as motion events that favor durative contexts such as *After hitting the top of the roof, the branch rolled gently into the gutter* suggest that *into* does allow durative readings, though perhaps it favors punctual readings.
9. Steve Wechsler (p.c.) points out that some examples in the BNC of *shoot to death* may

allow punctual interpretations as well as durative ones. Likewise, in Boas's corpus *to pieces* occurs more readily with strictly punctual verbs such as *break*. However, in both cases I think there is a degree of lexical idiosyncrasy with *to death* and *to pieces* due to their semi-conventionalization (e.g. both have non-literal uses as in *I love you to death* and *The review tore his symphony to pieces*). The general trend in both the BNC and of my own proprietary corpus searches have confirmed that *to*-PPs are overwhelmingly durative in nature, setting these two potential exceptions aside.

10. Evidence from English deverbal adjectives supports this general correlation (Kennedy and McNally 2005). Punctual verbs like *stun* tend to yield non-gradable deverbal adjectives while durative verbs like *build* tend to yield gradable deverbal adjectives.
11. Most of the terms and formal notions I introduce here are given more explicit model-theoretic definitions in Beavers (2002) based quite heavily on the mereological framework of Krifka (1998). For purposes of clarity and ease of presentation I keep the discussion here considerably more informal, except where needed. Although I rely here on purely mereological properties of objects, see Piñón (1997) for a formalization of punctuality (of achievement events) based on a notion of a "boundary" as a separate mereological entity. While ontologically distinct (making different predictions about sorts of punctual events), this discussion could be recast in those terms.
12. MRs are a generalization of what Krifka (1998, (69), p.224) refers to as Strict Movement Relations (SMRs). The difference is that SMRs encode motion involving constant progress with no backtracking, circles, or stopping. MRs embed SMRs but allow these extra types of motion. Note that there is a small technical difference between how I discuss paths and how Krifka defines them. For Krifka, sources and goals are limits on a path, defined as the boundaries that the initial and final subpaths of a path are adjacent to. But they are not part of the path per se. On my approach, they are the minimal (atomic/non-divisible) endpoints on a path, i.e. they are part of the path. I take this approach largely for expository purposes. It is not obvious to me that this difference is crucial or that Krifka's formal definitions would need to change in any non-trivial way.
13. The reverse is not true. If *p* is multipart it requires a separate subevent for each subpath.
14. Alternatively (or perhaps preferably) the path could be viewed as a type of scale itself.
15. "Force recipient" is the term Rappaport Hovav and Levin (2001) apply to participants in events that have potential for change.
16. The GMR thus expands Krifka's MR analysis, which he only applies to motion expressions and change-of-state predicates, to incremental theme verbs, thus implementing the scalar approach of Kennedy and Levin (2001) in Krifka's mereological framework. Wechsler (2005) argues for a similar generalization of a movement-based homomorphism, but does not discuss the nature of the homomorphism in terms of mereological complexity, which I argue must essentially and specifically be a kind of MR.
17. The one counterexample to this I have found is *step*, which steadfastly resists iteration despite not entailing a result state (cf. *\*He stepped to the office*; Beavers 2002). This may be due to a blocking effect of sorts with *walk*, which is a lexicalized iterative stepping.
18. Note that some verb-framed languages (e.g. Japanese, Korean, French, Spanish, and Turkish) permit *until*-markers to mark goals with manner-of-motion verbs. These are not goal-markers per se, having a more general semantics (occurring also as temporal, spatial, and numerical boundary markers). Interestingly, they exhibit the same complexity constraints as *to*, perhaps for similar reasons. See Beavers (2004) for further discussion.

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