4

The composition of incremental change

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4.1 Introduction

Current theories of aspectual composition acknowledge the pervasiveness of verbs of variable telicity, and are designed to account both for why these verbs show such variability and for the complex conditions that give rise to telic and atelic interpretations. Much of the literature on this topic has focused on the relation between nominal and verbal reference in so-called INCREMENTAL THEME verbs such as those in the following examples, which describe eventualties in which the internal argument of the verb undergoes an incremental change over the course of the event: incremental creation in (4.1a,b), incremental consumption in (4.2a,b), and incremental affect in (4.3a,b) (see e.g., Vendler 1967; Dowty 1979,1991; Declerck 1979; Krifka 1989,1992; Tenny 1994; Bertinetto and Squartini 1995; Levin and Rappaport Hovav 1995; Jackendoff 1996; Ramchand 1997; Filip 1999; Hay *et al.* 1999; Rothstein 2003, this volume; Borer 2005; Piñon 2005,2008).[1]

(4.1) a. Lee wrote a poem in/??for an hour.   Telic
       b. Lee wrote poetry for/??in an hour.   Atelic

(4.2) a. Kim drank a glass of beer in/??for an hour.   Telic
       b. Kim drank beer for/??in an hour.   Atelic

[1] I will primarily use *in* and *for* adverbials to illustrate (a)telicity in this paper, but this is meant to be shorthand for the whole set of aspectual class diagnostics (ambiguity with *almost*, entailment from progressive to perfective, the *take n-time to* test, etc.), which largely agree on the classification of the predicates in question.

(4.3)   a. Lee painted the house in/?for two weeks.   Telic
         b. Lee painted houses for/??in two weeks.   Atelic

As shown by these examples, when the internal argument—the incremental theme—
is introduced by a nominal constituent that holds of a specified quantity of stuff,
either because it includes an explicit quantity term (as in (4.2a)) or because it is
referential (as in (4.3a)), the resulting predicate is telic.[2] In contrast, when the
nominal does not impose any constraints on the quantity or extent of the argument,
as in the (b) sentences, the resulting event description is atelic.

   One of the most comprehensive accounts of the relation between the referential
properties of the incremental theme argument and the telicity of the verbal event
description comes from the work of Manfred Krifka (1989,1992). Krifka accounts for
facts like those in (4.1)–(4.3) in terms of the thematic role system, arguing that it is a
definitional feature of the set of incremental theme roles (Krifka's GRADUAL PATIENT
roles) that the part structure of an object which bears such a role stands in a
homomorphic relation to the progress of the event introduced by the corresponding
verb. As a result, when the nominal that introduces the incremental theme argument
picks out a specified quantity of stuff as in (4.1a)–(4.3a) (when it has quantized
reference), the event description does not hold of subevents (which necessarily
involve smaller quantities of stuff) and so is telic. In contrast, when the nominal
holds of arbitrary quantities of stuff as in (4.1b)–(4.3b) (when it has cumulative
reference), the event-argument homomorphism ensures that the event description
also holds of subevents, and so is atelic (Bennett and Partee 1978).

   Despite its success at capturing the basic pattern of variable telicity in incremental
theme verbs, there are reasons to believe that Krifka's analysis is not sufficiently
general. As pointed out by Ramchand (1997), this analysis does not directly extend to
motion verbs like (4.4) and (so-called) "degree achievements" like (4.5), which also
show variable telicity and intuitively share with incremental theme verbs the property
of describing events of incremental change, but which do not include true incremen-
tal theme arguments.

(4.4)   a. Kim walked from the bank to the store in/??for an hour.
         b. Kim walked for/??in an hour.

(4.5)   a. The canyon widened 30 kilometers in/??for one million years.
         b. The canyon widened for/??in one million years.

That is, in neither (4.4) nor (4.5) is it the case that the "theme" argument undergoes
the sort of change in mereological constitution that we see in (4.1)–(4.3); instead, as

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[2] However, in the latter cases the atelic interpretation is often available as well, possibly to different
degrees of acceptability (the *for*-PP in (4.3a) is arguably more acceptable than it is in the other examples),
a point stressed by Piñón(2008). I return to this point in Section 4.3.2.

Ramchand observes, this argument is related to a different, more abstract scale: a movement path in (4.4) and a property scale in (4.5).

Ramchand goes on to define new mapping rules to explain the patterns of variable telicity for these verbs in a way that is parallel to Krifka's account of incremental theme verbs. However, in multiplying the set of argument–event mapping relations, there is a sense that a generalization is being missed, namely the generalization that all verbs of variable telicity describe events in which some argument changes along some dimension as a result of participation in the event: a mereological dimension in the case of the true incremental verbs, a path in the case of motion verbs, and an arbitrary scalar dimension in the case of degree achievements.

Kennedy and Levin (2008), building on earlier work by Hay *et al.* (1999), develop an analysis of variable telicity in degree achievements that makes this intuition explicit, showing that telicity is a function of the scalar properties of a particular element of the meaning of degree achievements: a function that measures the degree to which an object changes as a result of its participation in an event. They suggest that their account can be extended to verbs of motion and incremental theme verbs as well, but do not provide any actual details of how exactly this can be done. And indeed, although it should be fairly straightforward to provide a scalar account of motion verbs, given the formal correspondence between property scales and paths (see e.g. Zwarts and Winter 1997; Faller 2000; Zwarts 2000; Winter 2005), it is not at all obvious how the scalar account can be extended to the class of incremental theme verbs. The problem is that there is a fundamental difference between degree achievements and motion verbs on the one hand, and incremental theme verbs on the other, as pointed out by Piñón(2008): it is only in the latter that nominal reference makes a difference. It is therefore crucial that a fully general theory of variable telicity that is stated in terms of general features of scalar change not only explain the role of abstract scalar features in deriving (a)telicity, but also the role of nominal reference, in those cases (like incremental theme verbs) where nominal reference plays an important role.

The goal of the current paper is to outline the basic structure of a theory that does exactly this. I begin by reviewing the analysis of degree achievements in Kennedy and Levin (2008), showing how (a)telicity is explained in terms of the scalar properties of the verb, and outlining some predictions about composition with degree expressions that this kind of theory makes. I then turn to incremental theme verbs, showing that they do not compose with degree expressions in the same way as degree achievements, concluding with Gawron (2007), Rappaport Hovav (2008), and Levin and Rappaport Hovav (2010) that they do not lexicalize change scales. I then show that Kennedy and Levin's analysis of degree achievements can be extended to an account of variable telicity in incremental theme verbs if we assume that the change scale comes from a measure function associated with the incremental theme argument itself, something that is independently necessary to account for the distribution of

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Filepath:d:/womat-filecopy/0001482109.3D

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quantity expressions inside DP (Krifka 1989,1992; Schwarzschild 2006). In this way, the analysis derives Krifka's mapping relations from a semantic feature that is already inherent in English nouns, plus the hypothesis that measure functions can in general be converted into measures of change.

4.2 Measures of change

4.2.1 *Variable telicity in degree achievements*

This section provides an overview of the semantic analysis of deadjectival degree achievements (DAs) proposed in Kennedy and Levin (2008), which is designed both to explain variable telicity in DAs, and to provide a general semantic framework for characterizing scalar change. In the interest of space, I will not reproduce here all the arguments that Kennedy and Levin present in favor of their analysis and against alternatives, but will focus on a presentation of the core semantic features of the analysis that will be carried over to the analysis of incremental theme verbs to be developed in the next section. I begin with a more detailed discussion of the facts that these features were initially designed to explain: variable telicity in DAs.

First and foremost, as noted above, most DAs can have both telic and atelic interpretations, as shown by examples such as (4.5) above and by the sentences in (4.6).

(4.6)   a. A balloon ascended/descended in/for 20 minutes.
          b. Kim raised the volume for 15 seconds.
          c. Kim raised the blinds in 5 seconds.

Sometimes the plausibility of a particular reading depends on semantic/pragmatic features that are related to the argument that undergoes the scalar change: the atelic interpretation is more natural in (4.6b), and the telic reading in (4.6c), thanks to general knowledge about volume-raising versus blind-raising (the latter is more likely to involve a fixed amount of change). But the distinction is not linked to the mereological properties of the argument in the way that we saw earlier for incremental theme verbs.

Instead, the telicity of a particular DA shows a much greater sensitivity to a semantic feature of the gradable adjective that provides its lexical source: the structure of the scale relative to which it orders the objects in its domain. I will have more to say about scales below; what is important to observe at the moment is that some gradable adjectives order objects according to scales that have maximum values, and others make use of scales without maxima. This distinction affects the acceptability of adjectival modifiers that make reference to endpoints: expressions like *completely, 100 percent,* and *almost* are acceptable with adjectives that use scales with maximum values, but not with adjectives that don't:

Comp. by: PG1891   Stage : Proof   ChapterID: 0001482109   Date:7/12/11   Time:12:25:29
Filepath:d:/womat-filecopy/0001482109.3D

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(4.7)   a. The shirt is completely/100%/almost dry.
      b. The sink is completely/100%/almost empty.

(4.8)   a. ??The canyon is completely/100%/almost wide.
        (cf. *really/very/incredibly wide*)
      b. ??The recession is completely/100%/almost deep.
        (cf. *really/very/incredibly deep*)

Returning to DAs, scale structure interacts with telicity in two ways. First, DAs based on adjectives that use scales with maximum values have default telic interpretations. The continuations in (4.9a, b), while not impossible, have a 'garden path' feel, because the initial assumption upon hearing the first part of the sentences is that the shirt is dry and the sink empty, respectively.

(4.9)   a. The shirt dried (??but it didn't become dry).
      b. The sink emptied (??but it didn't become empty).

However, these DAs are not incompatible with atelic interpretations, and indeed the addition of a *for*-PP forces such readings:

(4.10)   a. The shirt dried on the line for a few minutes (but was then soaked by a passing shower).
       b. The sink emptied for 15 seconds (but we closed the drain before it became empty).

The telic interpretation of DAs based on maximum-scale adjectives is thus the default interpretation, but is not obligatory.

    Second, DAs based on adjectives that use scales without maximum values typically have only atelic interpretations, in the absence of explicit information about a telos. This is shown by the unacceptability of *in*-PPs with verbs and the entailment from progressive to perfective with DAs like *widen* and *deepen*:

(4.11)   a. The canyon widened for/??in one million years.
       b. The recession deepened for/??in several years.

(4.12)   a. #The canyon is widening, but it hasn't widened.
       b. #The recession is deepening, but it hasn't deepened.

Such DAs can be assigned telic interpretations, but only through the addition of something that explicitly indicates a bound for the scalar change. The most common way of providing such a bound is through the use of a measure phrase, as in (4.13a-,b).

(4.13)   a. The canyon widened 30 kilometers in/??for one million years.
       b. The shadow lengthened 10 cm in/?? 15 minutes.

It is important to note that the measure phrases in these examples are understood as providing *differential* measures: (4.13a, b) are understood as in (4.14), not as in (4.15).

(4.14)   a. The canyon became 30 km wider (than it was).
        b. The shadow became 10 cm longer (than it was).

(4.15)   a. The canyon became 30 km wide.
        b. The shadow became 10 cm long.

As indicated by the paraphrases in (4.14), the semantics of DAs shares important features with the semantics of comparative constructions. Kennedy and Levin's analysis makes this connection explicit, by hypothesizing that the core function of a DA is to measure the difference between the degree to which an object possesses some scalar property at the beginning and end of an event, much as a comparative like *The shadow is 10 cm longer than the carpet* measures the difference between the degree to which two objects possess a scalar property.

4.2.2. *Scale structure, standard of comparison, and telicity*

The starting point for the analysis is the intuition stated above: verbs that describe events in which one argument undergoes an incremental change have a scalar element as a basic component of their meaning, whose function is to represent the degree to which the object changes along a relevant dimension as a result of its participation in the event. Degree achievements provide the most transparent illustration of this intuition, since most of these verbs are derived from adjectives which make the the relevant scale explicit: *widen* describes changes in width, *lengthen* describes changes in length, *darken* describes changes in illumination, and so forth. An important feature of the analysis, however, is that the "adjectival" component of the meaning of a DA is not the meaning that is expressed by the predicative form of the corresponding adjective: *widen*, for example, does not include the property of being wide as a component of its meaning.[3] Instead, the DA meaning is based on a more abstract conception of gradable adjective meanings as expressions that encode situation-dependent measure functions: relations between objects x and situations (parts of worlds) s to the degree d which represents the extent to which x manifests the property measured by the adjective in s.

This basic idea is implemented in two different ways by researchers working on the semantics of gradable predicates. On one view, the denotation of the predicate is just the measure function (Bartsch and Vennemann 1972,1973; Kennedy 1999), so that for example *wide* denotes the type $<e, <s,d>>$ function in (4.16a) (where s is the type of situations). On another view, the denotation is a relation between

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[3] This is shown both by the fact that (4.5b) does not entail that the canyon became wide, and by the fact that the measure term *30 kilometers* in (4.5a) has a differential meaning: this sentence means that the canyon became 30 kilometers wider, not that it became 30 kilometers wide.

Comp. by: PG1891   Stage : Proof   ChapterID: 0001482109   Date:7/12/11   Time:12:25:29
Filepath:d:/womat-filecopy/0001482109.3D

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degrees and individuals that includes the measure function (Seuren 1973; Cresswell 1976; von Stechow 1984; Heim 1985; and many others), so that *wide* denotes the type $<d, <e, <s, t >>>$ expression in (4.16b).

(4.16)   a. **wide**
        b. $\lambda d\lambda x\lambda s.\textbf{wide}(x)(s) \succeq d$

For the purpose of this paper, I will work with the latter implementation, because it will keep the syntax a bit simpler. However, since all of the crucial proposals involve the measure function component of scalar predicate meaning, the analysis could just as well involve the former implementation (which is in fact the approach taken in Kennedy and Levin 2008).

According to Kennedy and Levin, the core meaning of a degree achievement is a special kind of measure function, which they refer to as a MEASURE OF CHANGE function. The difference between a regular measure function and a measure of change function is that the former measures the "absolute" degree to which an object manifests some scalar property (in a situation), while the latter measures the difference between the degree to which an object manifests a property at the beginning and end of an event. Kennedy and Levin show how measure of change functions can be derived from basic measure functions in a way that is related to the semantics of comparison; for our purposes in this paper, the illustrations in (4.17) and (4.18) suffice to give the basic idea. (I use $\textbf{m}_\triangle$ to represent the measure of change function based on a measure function $\textbf{m}$.)

(4.17) $[[\text{wide}_A]] = \lambda d\lambda x\lambda s.\textbf{wide}(x)(s) \succeq d$, where **wide** is a function from individuals **wide** and situations s to:

$$(\text{WIDTH} \quad 0 \ \longrightarrow)$$

where the value returned by $\textbf{wide}(x)(s)$ is the width of x in s.

(4.18) $[[\text{widen}_V]] = \lambda d\lambda x\lambda e.\textbf{wide}_\triangle(x)(s) \succeq d$, where $\textbf{wide}_\triangle$ is a function from individuals x and events e to the non-dashed part of:

$$(\text{WIDTH} \quad 0 \ - - - - - -_{\textbf{wide}(x)(\textit{beg}\ (e))} \bullet \ \longrightarrow)$$

Where the value returned is wide $(x)(end(e))$, the width of x in the situation holding at the end of e, and the minimum element of the derived scale is wide $(x)(beg(e))$, the width of x in the situation hodling a the beginning of e.

A crucial feature of Kennedy and Levin's analysis is the fact that measure of change functions map objects onto subparts of the scale used by the source measure function: that part of the scale whose minimal element is the degree to which the object possesses the relevant property at the beginning of the event. Otherwise, the scale is identical to that of the source adjective. These properties of measure of

change functions play a crucial role in the analysis of variable telicity in DAs but, to see how, we need to first consider how expressions that encode measure functions are converted into properties.

If degree achievements encode measure of change functions and, like gradable adjectives, include degree arguments, then this argument must be saturated in order to eventually derive an event description. This is parallel to the case of gradable adjectives, which must have their degree arguments saturated in order to be converted into properties of individuals. In the latter case, it is generally assumed that the degree argument is saturated either through composition with degree morphology (such as English *-er/more, as, too, how, so,* etc.), or, in the case of the unmarked, "positive" form, by the rule in (4.19) (which could just as well be the meaning of a null degree morpheme; see Kennedy and McNally 2005; Kennedy 2007 and Grano to apper for general discussion). Here **stnd** is a function that identifies the degree argument of the adjective with an appropriate STANDARD OF COMPARISON for the kind of measurement encoded by the adjective.[4]

(4.19) $[\lambda d\lambda x\lambda s.\mathbf{m}(x)(s) \succeq d] \rightarrow_{pos} \lambda x\lambda s.\exists d [\mathbf{stnd}(d) \wedge \mathbf{m}(x)(s) \succeq d]$

The positive form of, for example, *wide* thus denotes the property in (4.20), which is true of an object just in case it has a width that is at least as great as the standard of comparison for the kind of measurement that the **wide** function encodes.

(4.20) $[[\text{wide}_{pos}]] = \lambda x\lambda s.\exists d[\mathbf{stnd}(d) \wedge \mathbf{wide}\,(x)(s) \succeq d]$

Kennedy and Levin (2008) propose that unmodified degree achievements are mapped onto properties of events in the same way as adjectives, by a variant of the rule in (4.19) which derives the following denotations for DAs along the lines of the ones in (4.21a, b) for *widen* and (verbal) *dry* (see also Piñon 2005, 2008).

(4.21)   a. $[[\text{wide}_{pos}]] = \lambda x\lambda e.\exists d[\mathbf{stnd}(d) \wedge \mathbf{wide}_\Delta\,(x)(e) \succeq d]$
          b. $[[\text{dry}_{pos}]] = \lambda x\lambda e.\exists d[\mathbf{stnd}(d) \wedge \mathbf{dry}_\Delta\,(x)(e) \succeq d]$

According to this analysis, *widen* is true of an object, and an event, just in case the degree to which the object changes in width meets the standard of comparison for **wide$_\Delta$** in the context, and verbal *dry* is true of an object, and an event, just in case the degree to which the object changes in dryness meets the standard of comparison for **dry$_\Delta$** in the context.[5]

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[4] Strictly speaking, the denotation of the source gradable predicate should also be an input to the **stnd** function, since, as described below, the computation of the standard of comparison is sensitive to features of the meaning of the predicate. To keep the notation simple, I will omit this information from the logical representations, but they should be understood in this way. See Kennedy (2007) for extensive discussion of this issue.
[5] Given the way that Kennedy and Levin define measure of change functions, "changes" always correspond to increases in the property, relative to the polarity of the source adjective. So a non-zero change as measured by **wide$_\Delta$** always corresponds to an increase in width; a decrease in width would be reflected by a non-zero change as measured by **narrow$_\Delta$**.

Standards of comparison can in general be either context dependent or linked to fixed points on scales, in particular to minimum or maximum values (Paradis 2001; Rotstein and Winter 2004; Kennedy and McNally 2005; Kennedy 2007). Whether the latter option is possible depends on the scalar properties of the gradable predicate: whether the measure function it encodes maps its arguments onto an open scale (no maximal/minimal values) or a closed one (minimum value, maximum value, or both). However, it is generally the case that if a scale has a minimum or maximum value, then the standard of comparison is set to this fixed point, rather than to a contextual degree (Kennedy and McNally 2005; Kennedy 2007). This property of standards of comparison plays in important role in Kennedy and Levin's analysis of variable telicity in DAs.

Specifically, since DAs encode measure of change functions, their scales necessarily include minimum degrees: the degree corresponding to the position of the internal argument on the property scale at the beginning of the event. This means that DAs can always express relations to minimum standards, the resulting truth conditions make the verb true of an object and an event as long as that object undergoes some change relative to the scalar dimension encoded by the DA, that is as long as its degree of the relevant property is greater at the end of the event than it was at the beginning. This derives the atelic interpretation.

Some DAs encode measure of change functions whose scales also include maximal degrees. If this is the case, then the **stnd** function can fix the standard to the scalar maximum, deriving an event description that is true of an object and an event just in case the object undergoes a maximal change relative to the scalar dimension encoded by the DA. This results in a telic interpretation. Moreover, for those DAs that allow this option, the maximum standard/telic interpretation entails the minimum standard/atelic one, so the fact that it is a default can be explained in terms of something like Dalrymple et al.'s (1998) "Strongest Meaning Hypothesis."

Crucially, whether a particular DA uses a scale with a maximum value depends on the scale used by the source adjective. Adjectives like *dry* and *empty* use scales with a maximum degree, as we saw in the previous section, but adjectives like *wide* and *deep* do not. Consequently, degree achievements based on the former adjectives can have maximum standards and telic interpretations, but DAs based on the latter cannot. However, such DAs can be assigned telic interpretations by fixing their standards in such a way as to require a specific degree of change. This is what happens in examples like (4.22a), where the measure phrase saturates the verb's degree argument, deriving (4.22b) as the denotation of the event description (ignoring tense and binding of the event argument).[6]

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[6] We also want to say that the measure phrase maximizes over this argument, effectively turning the "$\succeq$" relation into an "=" relation. I leave out the details of this, but it can be written into an appropriate denotation for measure terms; see Koenig (1991); Kennedy (2011).

Comp. by: PG1891   Stage : Proof   ChapterID: 0001482109   Date:7/12/11   Time:12:25:30
Filepath:d:/womat-filecopy/0001482109.3D

OUP UNCORRECTED PROOF – FIRST PROOF, 7/12/2011, SPi

112   *C. Kennedy*

(4.22)   a. The canyon widened *30 kilometers* (in/??for one million years).
          b. $\lambda e.\textbf{wide}_\triangle$ (c)(e) = **30km**

Note also that since the "zero point" of a measure of change scale is the degree to which the individual argument of the verb possesses the scalar property at the beginning of the event, we also correctly derive the differential interpretation of the measure phrase: *30 kilometers* measures the change in the canyon's width, not its actual width.

In sum, Kennedy and Levin's scalar semantics for degree achievements hypothesizes that such verbs encode functions which measure the degree to which an object changes along a scalar dimension over the course of an event. Whether an event description based on a DA is telic or not is a function of the standard of comparison against which the change is measured: if it is minimal, merely requiring some amount of change, the event description is atelic; if it requires a change that reaches a fixed point on the scale, either because it is maximal or because it is set by a measure phrase, the event description is telic. The telicity of a DA is thus fully linked to the semantic properties of its scalar core, not to the referential properties of the nominal expression that introduces the object that undergoes the change.

4.2.3 *Composition with degree morphology*

Before showing how the scalar analysis of DAs can be extended to an account of variable telicity in incremental theme verbs, I want to make note of a set of facts that both support the scalar analysis of DAs, and provide a kind of general "test" for verbal degree meanings. The facts build on the observation that if DAs lexicalize measure of change functions, they should combine with degree morphosyntax (Gawron 2007). In particular, given the similarity in meaning between measure of change functions and the kinds of meanings encoded by comparative constructions (both measure differences), we should see morphosyntactic and semantic parallels between DAs and comparatives. The following set of examples confirm this prediction.

(4.23)   a. She warmed the soup *10 degrees*.
          b. She warmed the soup *less than the coffee*.
          c. She warmed the soup *as much as you did*.
          d. She warmed the soup *too much*.
          e. She warmed the soup *so much that she can't eat it*.

(4.24)   a. Her soup is *10 degrees* warmer than mine.
          b. Her soup is *less* warmer than mine *than yours is*.
          c. Her soup isn't *as much* warmer than mine *as yours is*.
          d. Her soup is *too much* warmer than mine.
          e. Her soup is *so much* warmer than mine *that she can't eat it*.

Sentences (4.23a–e) show that DAs can combine with measure phrases (as we have already seen), as well as the full range of comparative/degree constructions. Examples (4.24a–d) further show that the interpretations of the degree constructions in the DA examples are parallel to the interpretations they have with comparatives: they impose constraints on differential degrees. In DAs, these degrees represent the difference between the object undergoing the change at the beginning and end of the event (the measure of change); in the case of comparatives, these degrees represent the difference between two objects on a scale. Assuming that the various degree constructions shown here saturate the degree argument of the DA (see the discussion of (4.22) above), these are exactly the meanings that we expect to derive.

4.3 The composition of incremental change

4.3.1 *Incremental theme verbs do not encode measures of change*

In order to extend the scalar analysis of variable telicity in DAs to incremental theme verbs we need to do two things. First, we need to identify the source of the measure of change function. Second, we need to explain the way that nominal reference plays a role in aspectual composition. The most natural hypothesis about the source of the measure of change function is that it is in the verb itself, that is that verbs like *write, drink*, and *paint* encode measures of how much their "incremental theme" arguments change according to a measure of how much they are eaten, drunk, or painted. This approach is advocated by Kennedy and Levin (2002) and taken up by Caudal and Nicolas (2004) and Piñón (2008), though as Piñón shows, it turns out to be difficult to adequately capture the role of nominal reference if incremental verbs lexicalize measure of change functions.

Independent of these concerns, however, there is evidence that incremental verbs in English at least do not lexicalize measure of change functions. The evidence comes from two sources. The first comes from work by Rappaport Hovav (2008) (see also Levin and Rappaport Hovav 2010), who argues that the basic meaning of an incremental theme verb is that of a simple property of events, and although such properties may characterize events that are inherently associated with some sort of scale (cf. Beavers 2011), the actual meaning of the verb does not introduce the scale. Rappaport Hovav provides several pieces of data in support for her claims.

First, incremental theme verbs can be supplemented with scales in the form of resultative secondary predicates:

(4.25)   a. We steamed the clothes dry/clean/stiff.
         b. Cinderella scrubbed her knees sore/the dirt off the table/the table clean.
         c. Jones read us all to sleep/read herself blind.

This would be unexpected if these verbs already introduced scales as a matter of lexical meaning, and in fact resultative predicates are in general unacceptable with degree achievements (which, following Hay *et al.* 1999 Rappaport-Hovav takes to be examples of verbs that do introduce scales):

(4.26)   *Jones dimmed/cooled/cleared the room empty.

Second, incremental theme verbs have a weaker attachment to their direct objects than degree achievements. For example, they can be used intransitively and they support *out*-prefixation, neither of which is possible with DAs:

(4.27)   a. All last night Cinderella scrubbed/read/ate/drank/wiped and wiped.
          b. All last night we cooled/warmed *(the house with the air conditioner/
              heater).

(4.28)   a. Jones outread/outate/outdrank Smith.
          b. *Jones outdimmed/outcooled/outflattened Smith.

These facts lead Rappaport Hovav to conclude that the basic denotation of an incremental theme verb is a simple property of events, describing a certain kind of activity that may be canonically associated with certain kinds of changes, but which does not actually select for an object and map that object to a measure of scalar change.

The second kind of evidence that incremental theme verbs do not lexically encode measure of change functions comes from the relation between incremental theme verbs and the kinds of verbal degree constructions that we looked at in Section 4.2.3. As shown by Gawron (2007) and by the examples in (4.29), verbs like *write, drink*, etc. do not combine with degree constructions in the same way as degree achievements.

(4.29)   a. ??Jones wrote the paper more than Smith did.
          b. ??Jones didn't write the paper as much as Smith did.
          c. ??Jones wrote the paper too much.
          d. ??Jones wrote the paper two sections.
          e. ??Jones wrote the paper so much that Smith barely had to do anything.

Some of these examples marginally support a "comparison of events" reading, but none of them are particularly acceptable ways of comparing the degree to which the paper gets written to some other degree, which is what we would expect if *write* had the same sort of meaning as a DA like *widen*. Instead, when we want to convey this kind of meaning, the degree construction must combine directly with the incremental theme argument:

(4.30)   a. Jones wrote more of the paper than Smith did.
         b. Jones didn't write as much of the paper as Smith did.
         c. Jones wrote too much of the paper.
         d. Jones wrote two sections of the paper.
         e. Jones wrote so much of the paper that Smith barely had to do anything.

The usual semantics for nominal comparison would assign meanings to the constructions in (4.30) in which the various degree terms pick out a certain quantity/part of the object denoted by *the paper*, and this part would then be provided as the theme argument of the verb, as paraphrased in (4.31a) for the sentence in (4.30d) (which is the simplest to deal with). However, it is also possible to think of the information conveyed by these sentences in a different way, as paraphrased in (4.31b), in which the degree constructions provide information about a degree of change.

(4.31)   a. There is a part of the paper which measures two sections and that part underwent an incremental increase in extent as part of a writing event whose agent was Jones.
         b. The paper underwent an incremental increase in extent as part of a writing event whose agent was Jones, and the amount of this increase was two sections.

This second way of characterizing the meanings of the sentences in (4.30) is what we would expect if Kennedy and Levin's scalar analysis of DAs can be extended to incremental theme verbs. However, the fact that it is associated with the syntactic forms in (4.30) and not the ones in (4.29) indicates that the measure of change function must be somehow associated with the incremental theme *argument*, rather than the incremental theme *verb*. This is the conclusion drawn by Rappaport Hovav (2008) and Levin and Rappaport Hovav (2010); the question is how to work it out compositionally in a way that accounts for the role of nominal reference in aspectual composition. The next section provides an answer to this question.

4.3.2 *From nominal measure functions to nominal measures of change*

The idea, in a nutshell, is that the verb phrase in a sentence such as (4.32a) has a denotation along the lines of (4.32b), and the verb phrase in a sentence like (4.33a) has one like (33b) (these will be refined below), where $\mathbf{m}_\triangle$ is a mereological measure function that measures the extent to which the quantity of dumplings changes over the course of an event (of eating, in this case). (Here and elsewhere I assume that external arguments are introduced separately from the verb, by voice morphology, as in Kratzer 1996.)

(4.32)   a. Kim ate ten dumplings (in/??for 30 seconds).
         b. $\lambda e.\exists x[\mathbf{eat}(e) \wedge \mathbf{dumplings}\,(x) \wedge \mathbf{m}_\triangle(x)(e) =$10]

Comp. by: PG1891   Stage : Proof   ChapterID: 0001482109   Date:7/12/11   Time:12:25:30
Filepath:d:/womat-filecopy/0001482109.3D

OUP UNCORRECTED PROOF – FIRST PROOF, 7/12/2011, SPi

116   *C. Kennedy*

(4.33)   a. Kim ate dumplings (for/??in 30 seconds).
          b. $\lambda e.\exists x[\mathbf{eat}(e) \wedge \mathbf{dumplings}\,(x) \wedge \mathbf{m}_\Delta(x)(e) \succ 0]$

Example (4.32b) is true of events of dumpling eating in which the total amount of
dumplings changes in a way consistent with the type of event—which in the case of
eating, means a decrease—by the amount denoted by the numeral *ten*; this is a telic
event description. Example (4.33b), on the other hand, is true of events of dumpling
eating in which some quantity of dumplings decreases by some amount. Such an
event description is atelic.

The trick, of course, is to say where m_Δ comes from, why it involves the particular
kinds of measurement that it does, and how we end up with the particular truth
conditions that I have shown in (4.32) and (4.33). In recent work, Stensrud (2009)
proposes that the measure of change function associated with incremental theme
verbs (or more accurately, verbal predicates headed by such verbs) is introduced by a
functional head that combines with the incremental theme argument.[7] Here I would
like to propose a deeper connection between the measure of change function and the
incremental theme argument: it comes from the semantics of the nominal itself.

My proposal builds on the hypothesis that English nominals, like gradable adjec-
tives, incorporate measure functions as part of their meanings and have degree
arguments, an idea that appears in Cresswell (1976) and in (Krifka 1989,1992), and
has been recently pushed in a new direction by Schwarzschild (2006). Here I will
make use of Krifka's analysis, which assigns the denotation in (4.34) to the (count)
noun *dumpling(s)*, where NU is a parameterized measure function that measures
things according to "natural units" based on the intension of the noun. (For Krifka,
there is no difference in meaning between the singular and plural forms.) As with
gradable adjectives, I assume that such measure functions are relativized to situa-
tions, indicated by the ==variable in== (4.34).

(4.34) $[[\mathrm{dumpling(s)}]] = \lambda d\lambda x\lambda s.\,\mathbf{dumplings}(x) \wedge \mathrm{NU}(\mathbf{dumplings})(x)(s) = d$

According to (4.34), the noun *dumpling(s)* is true of a quantity of stuff x and a degree
d in a situation just s in case x is dumpling stuff and the measure of x relative to
dumpling-units in s equals d. The degree argument may be saturated by a numeral, it

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[7] Stensrud's analysis is based on her approach to resultatives, in which the overt resultative predicate in
an example like (ia) is taken to encode not the adjectival measure function **flat**, but the verbal measure of
change function $\mathbf{flat}_\Delta$, as shown in (ib).

(i)   a. Kim hammered the metal flat.
       b. $\lambda e.\exists d[\mathbf{hammer}(e) \wedge \mathbf{stnd}(d) \wedge \mathbf{flat}_\Delta(\mathbf{m})(e)) \succeq d]$

Example (ib) is true of an event if it is a hammering and the metal changes in flatness to a degree that meets
the standard for $\mathbf{flat}_\Delta$, which Stensrud takes to be (obligatorily) a maximal one. Whether this is the right
analysis of resultatives or not is indepedent of the hypothesis that incremental arguments introduce measure
of change functions.

may be existentially bound (in e.g. the case of a bare plural), or it may be fixed to a default value of "1" (in the case of determiners that quantify over atoms).

What is crucial to observe about Krifka's analysis is that NU(**dumplings**) is a measure function, so the noun *dumpling* has the same semantic type as the gradable adjectives that are converted into measure of change functions in degree achievements. My proposal is that "incremental themes" are just nominals that have undergone exactly the same conversion. Specifically, if we assume that measure functions can in general be converted into measure of change functions, then the basic meaning of *dumpling(s)* in (4.34) can be turned into the "incremental" meaning in (4.35).

(4.35) $[[\text{dumpling(s)}_{inc}]] = \lambda d \lambda x \lambda e.\textbf{dumplings}(x) \wedge \text{NU}_\Delta (\textbf{dumplings})(x)(e) = d$

Example (4.35) holds of a quantity d, some stuff x, and an event e iff x is dumpling stuff and the degree to which x changes in NU-dumpling-measures over the course of e equals d. Having this kind of meaning, I claim, is what it means to be an incremental theme.

Let us further assume with Krifka and Cresswell that the degree argument of the noun can be directly saturated by a numeral, and that in a bare plural it is saturated by a default existential quantifier over degrees. (I indicate the latter in the logical representation as a ">0" requirement for the output of the measure of change function.) We then derive the denotations in (4.36) as the incremental denotations of *ten dumplings* and *dumplings*, respectively.

(4.36)   a. $[[[_{DP} \text{ten dumplings}]]] = \lambda x \lambda e. \textbf{dumplings}(x) \wedge \text{NU}_\Delta (\textbf{dumplings})(x)(e) = 10$
          b. $[[[_{DP} \text{dumplings}]]] = \lambda x \lambda e. \textbf{dumplings}(x) \wedge \text{NU}_\Delta (\textbf{dumplings})(x)(e) > 0$

Assuming that Rappaport Hovav (2008) and Levin and Rappaport Hovav (2010) are correct that incremental verbs like *eat* denote simple properties of events, composition of the incremental DPs in (4.36) with the verb can be effected using Kratzer's (1996: 122) rule of Event Identification, defined in (4.37).

(4.37)   **Event Identification**
          If α is a constituent with daughters β,γ, such that $[[\beta]]$ is type $\langle \varepsilon, t \rangle$ and $[[\gamma]]$ is type $\langle e \langle \varepsilon, t \rangle \rangle$ (ε the type of events), then $[[\alpha]] = \lambda x \lambda e [[\beta]](e) \wedge [[\gamma]](x)(e)$.

Existential closure over the individual argument then gives us the denotations in (4.38a, b) as the meanings of the VPs *eat 10 dumplings* and *eat dumplings*.

(4.38)   a. $[[[_{VP} \text{eat ten dumplings}]]]$
              $= \lambda e.\exists x[\textbf{eat}(e) \wedge \textbf{dumplings}(x) \wedge \text{NU}_\Delta (\textbf{dumplings})(x)(e) = 10]$
          b. $[[[_{VP} \text{eat ten dumplings}]]]$
              $= \lambda e.\exists x[\textbf{eat}(e) \wedge \textbf{dumplings}(x) \wedge \text{NU}_\Delta (\textbf{dumplings})(x)(e) > 0]$

These denotations are essentially more detailed versions of (4.32)–(4.33), and have the same truth conditions. In particular, (4.38a) is telic because the numeral term makes

the description true only of events in which 10 dumplings are consumed, and (4.38b) is atelic because it is true of any event of (some amount) of dumpling eating.

The analysis of noun meaning in (4.34) corresponds to Krifka's analysis of English count nouns; he assumes that mass nouns just denote quantities of stuff, and a measure function is introduced externally to the head noun. Cresswell, on the other hand, also treats mass nouns as having degree arguments. Either way, the overall analysis of aspectual composition with bare versus quantized mass nouns, such as *eat sushi* and *eat two pieces of sushi*, respectively, will end up looking exactly the same as the analysis presented above—existential closure of the degree argument in the first case; saturation by the measure phrase *two pieces* for the latter—given the assumption that measure functions can in general be mapped to measures of change.[8]

Somewhat more complicated are examples in which the incremental argument is individual-denoting, which I take to be the case when it is introduced by a quantifier, as in *eat every dumpling* (assuming that Quantifier Raising or the equivalent supplies an individual-denoting variable as the argument of the verb), or by a referential DP, as in *eat that piece of eel* or *eat Mr. Unagi*. (Let us assume for the sake of exposition that "Mr Unagi" is the name of a particularly large specimen of Anguilla japonica.) In these cases, it is not plausible to assume that the DP itself (the trace/variable or the name) introduces a measure function, so this part of the meaning must come from somewhere other than the noun. Instead, building on proposals in Bochnak (2010, to appear) and Stensrud (2009), I will hypothesize that it comes from a partitive head that is present in expressions such as the following (and may or may not be the element that is pronounced *of*):

(4.39)   a. some of Mr Unagi
          b. half of Mr Unagi
          c. four cm^3 of Mr Unagi

Specifically, I assume that individual-denoting DPs may in general combine with a partitive head PART that has the denotation in (4.40). This denotation differs from the standard semantics for the <mark>partitives</mark> morpheme by analyzing it in terms of a parameterized, closed-scale measure function **partof**, which provides a measure of the degree to which a quantity of stuff y constitutes a part of an individual x in a situation s.[9]

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[8] If Krifka is correct that mass nouns do not include measure functions, it should be possible to handle them in terms of the partitive semantics I adopt below for individual-denoting incremental arguments, given the assumption that mass terms are names of substances or kinds (Chierchia 1998).

[9] The <mark>partof</mark> function in (4.40) is meant to be a combination of the standard material-part meaning of the partitive from Ladusaw (1982) with a monotonic measure function. Schwarzschild (2006) and Bochnak (2010) hypothesize that the measure function component of a partitive is projected separately, above the partitive head (which introduces the Ladusovian material part relation); my idea here is that the partitive head *is* the measure function.

(4.40) $[[\text{PART}]] = \lambda x \lambda d \lambda y \lambda s.\mathbf{partof}(x)(y)(s) = d$

Assuming that *some*, *half*, and *four cm*^{3} saturate the degree argument of PART (though not necessarily in exactly the same way), the phrases in (4.39) will introduce descriptions of appropriately sized quantities of Mr. Unagi-parts. Example (4.39c), for example, has the denotation in (4.41), which is true of those parts of Mr. Unagi that measure four cubic centimeters.

(4.41) $[[\text{PART}]]([[\text{Mr Unagi}])([4\text{ cm}^3])) = \lambda y \lambda s\ \mathbf{partof}\ (\mathbf{mr\ unagi})(y)(s) = 4\mathbf{cm}^3$

To handle incremental readings, I assume as above that measure functions can in general be converted into measures of change. This means that in addition to the basic meaning of the partitive morpheme in (4.40), we also have the incremental variant in (4.42).

(4.42) $[[\text{PART}_{inc}]] = \lambda x \lambda d \lambda y \lambda e.\mathbf{partof}_\triangle\ (x)(y)(e) = d$

This morpheme takes an individual x and returns an expression that measures the degree to which a portion of its constitutive parts change (increase or decrease) as a result of participation in an event e. This is the kind of meaning that Stensrud (2009) and Bochnak (to appear) hypothesize for a special functional head associated with incremental theme arguments; my claim is that it is just the meaning we get by converting the measure function associated with the regular partitive morphology into a measure of change function.

We now consider two kinds of cases: one in which PART$_{inc}$ combines with an individual-denoting DP and then with an explicit degree term, and one in which the degree argument is fixed to an implicit standard of comparison. Example (4.43) shows the first case, for the VP pronounced *eat four cm^3 of Mr Unagi*.

(4.43) $[[_{V P}\text{ eat four cm}^3\text{PART}_{inc}\text{ Mr Unagi}]] =$
            $\lambda e.\exists x[\mathbf{eat}(e) \wedge \mathbf{partof}_\triangle\ (\mathbf{mr\ unagi})(x)(e) = 4\mathbf{cm}^3]$

Example (4.43) is true of an event if it is an eating event in which there is a change in the constitution of Mr Unagi-parts that measures four cubic centimeters, which, given that this is an eating event, should involve the disappearance of those parts into another entity's (the agent's) body.

When there is no overt expression to saturate the degree argument of the incremental partitive, I assume that it is set to an appropriate standard of comparison, as we saw for degree achievements and gradable adjectives. Since the scale used by the **part of**$_\triangle$ function is a totally closed one—it is a measurement of the degree to which a quantity of stuff y constitutes a part of the individual x—there should be two options: a maximum standard interpretation and a minimum standard interpretation. These are shown in (4.44a) and (4.44b), respectively, where I represent the maximum

standard interpretation with "= 1" and the minimum standard interpretation with "$\succ$ 0" for perspicuity.

(4.44) $[[[_{V P}$ eat PART$_{inc}$ Mr Unagi]] =
     a. $\lambda e.\exists x[\mathbf{eat}(e) \wedge \mathbf{partof}_\Delta\ (\mathbf{mr\ unagi})(x)(e) = 1]$
     b. $\lambda e.\exists x[\mathbf{eat}(e) \wedge \mathbf{partof}_\Delta\ (\mathbf{mr\ unagi})(x)(e) \succ 0]$

Example(4.44a) is true only of events in which all of Mr Unagi is eaten, and so is telic. Example(4.44b), on the other hand, is true of events in which some part of Mr Unagi is eaten, and so is atelic. The analysis thus predicts that *eat Mr Unagi* is ambiguous between a telic and an atelic interpretation, though the former is stronger and should therefore be preferred, as we saw with closed-scale degree achievements like (verbal) *empty* and *dry*. And indeed, this seems to be the case: *eat Mr Unagi* can, in appropriate contexts, be understood atelically.

(4.45)   a. I ate Mr Unagi in 30 seconds flat.
     b. I ate Mr Unagi for a few minutes, then decided to switch to tofu.

4.4 Conclusion

To summarize, I have proposed that the scalar component of the meaning of verb phrases head by (so-called) incremental theme verbs comes from a scalar element inherent to the semantics of the incremental theme argument, which can either be part of the meaning of a noun or a separate partitive head. Either way, these expressions are independently required to account for the semantics of quantity expressions (numerals, partitives, etc.) in the nominal projection; the new proposal is simply a generalization of the core idea in Kennedy and Levin (2008) that measure functions can in general be mapped onto measure of change functions.

In locating the scalar component of the meaning of incremental predicates in the incremental object, this analysis is in line with the evidence presented by Gawron (2007), Rappaport Hovav (2008), and Levin and Rappaport Hovav (2010) that incremental verbs do not themselves lexicalize scales. At the same time, this analysis also provides an explanation of the role of nominal reference in aspectual composition with incremental verbs. As in Kennedy and Levin's analysis of variable telicity in degree achievements, variable telicity of incremental theme verbs is a function of the standard of comparison relative to which incremental change is measured: whether it merely has to meet a minimum standard (some amount of incremental change; atelic interpretation), or whether it has to reach a maximum standard or a standard specified by a measure phrase (a specified amount of incremental change; telic interpretation). As the derivations we looked at demonstrated, it is precisely the referential properties of the incremental theme argument that fix the standard, since

Comp. by: PG1891   Stage : Proof   ChapterID: 0001482109   Date:7/12/11   Time:12:25:31
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these features determine how the quantity argument inside the nominal projection gets valued.

There are a number of significant questions about the analysis which still need to be answered, of course, and their answers will bear greatly on the overall success of the analysis and the assessment of whether it is an improvement over previous accounts. The most central question is the following: how do we ensure that nominals only get mapped to measure of change functions in the right contexts? Ideally, this would follow purely from principles of composition: the incremental type-shift occurs just for verbs that do not lexically select for internal arguments, as a way of making composition possible, possibly subject to further combinatoric constraints based on lexical considerations of the sort suggested by Beavers (2011) and Stensrud (2009). Alternatively, it may be necessary to assume a lexical/syntactic role for the verbs in question, such that they subcategorize for objects that have undergone the incremental type-shift. Finally, important questions about cross-linguistic variation need to be addressed, with particular attention to the interaction of telicity and VP-internal morphosyntax (e.g. the role of particles, affixes, and case alternations).