Measure of Change: The Adjectival Core of Degree Achievements*

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1 Introduction

Current theories of aspect 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. Previous work has identified several sets of such verbs, including incremental theme verbs, such as *eat* and *destroy*; degree achievements, such as *cool* and *widen*; and (a)telic directed motion verbs, such as *ascend* and *descend* (see e.g., Dowty 1979; Declerck 1979; Dowty 1991; Krifka 1989, 1992; Tenny 1994; Bertinetto and Squartini 1995; Levin and Rappaport Hovav 1995; Jackendoff 1996; Ramchand 1997; Hay, Kennedy, and Levin 1999; Rothstein 2003; Borer 2005). As the diversity in descriptive labels suggests, most previous work has taken these classes to embody distinct phenomena and to have distinct lexical semantic analyses. We believe that it is possible to provide a unified analysis in which the behavior of all of these verbs stems from a single shared element of their meanings: a function that measures the degree to which an object changes relative to some scalar dimension over the course of an event. We claim that such 'measures of change' are based on the more general kinds of measure functions that are lexicalized in many languages by gradable adjectives, and that map an object to a scalar value that represents the degree to which it manifests some gradable property at a time (see Bartsch and Vennemann 1972,

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1973; Bierwisch 1989; Kennedy 1999; Piñon 2005). In this paper we focus on the analysis of degree achievements, which provide the first step towards this goal. As verbs for the most part derived from gradable adjectives, they most transparently illustrate the semantic components that we claim are involved in determining variable telicity.

We begin this paper with a detailed examination of variable telicity in degree achievements. We explore both the general role of adjective meaning in the composition of predicates that express changes along a scalar dimension and the specific effects of idiosyncratic features of adjective meaning, in particular the structure of the scale that represents the gradable property measured by the adjective. The set of facts we delineate allows us to evaluate the two major kinds of semantic analyses that have been proposed for degree achievements — what we call the 'positive' and 'comparative' analyses — and to highlight the strong and weak points of each. We then present own analysis in terms of measure of change, which represents a synthesis of the best features of the positive and comparative analyses, and show how it explains the semantic behavior of degree achievements. We conclude with a sketch of how the analysis can be extended to an account of variable telicity in the other verb classes mentioned above.

2 Variable telicity in degree achievements

2.1 Telicity and vagueness

Vendler (1957) distinguishes atelic predicates (activities) like *run* from telic predicates (accomplishments) like *run a mile* on the basis of whether they entail of an event that a 'set terminal point' has been reached. Most studies of variable telicity focus on contrasts like *run for/??in four minutes* vs. *run a mile in/??for four minutes*, because they show that compositional interactions between a verb and its argument(s) can affect the telicity of the predicate (Bach 1986; Mourelatos 1978; Verkuyl 1972; Krifka 1989). Degree achievements (DAs) present a special challenge, however, because they may have variable telicity independently of the properties of their arguments, as first observed by Dowty (1979). Consider for example the uses of *cool* in (1a-b).[1]

[1]We will focus primarily on inchoative forms of DAs in this paper, even though most have causative variants as well, as it is the semantics of the 'inchoative core' that is crucial to capturing variable telicity. That is, telicity does not correlate with causativity: if a DA shows variable telicity at all, then it shows it in both its causative and inchoative forms (Hay et al. 1999). Since for deadjectival verbs the semantics of the latter are part of the former (on standard assumptions about causative/inchoative alternations; though see Koontz-Garboden 2007), it must be the case that it is the latter on which telicity is based.

(1) a. The soup cooled in 10 minutes. (TELIC)
b. The soup cooled for 10 minutes. (ATELIC)

The acceptability of the *in*-PP in (1a) shows that *cool* can be telic, and indeed this sentence is true of an event only if it leads to an endstate in which the affected participant has come to be cool. However, the acceptable *for*-PP in (1b) shows that *cool* can also be atelic, and this example implies neither that the endstate associated with (1a) ('coolness') has been reached, nor that a sequence of distinct change of state eventualities has taken place (as in iterated achievements like *Kim discovered crabgrass in the yard for six weeks*; see Dowty 1979). Similarly, whether or not the progressive form in (2a) entails the perfect in (2b) depends on whether we understand *cool* in (2a) only as implying that the temperature of the soup is getting lower (atelic; (2b) entailed), or as implying that the temperature of the soup is moving towards an understood endstate of being cool (telic; (2b) not entailed).

(2) a. The soup is cooling.
b. The soup has cooled.

The challenge then is to identify the factors which lead to variable telicity in DAs. Building on ideas in Dowty 1979, Abusch 1986 proposes that the variable telicity of DAs (her 'vague inchoatives') is parasitic on a different kind of variability in the meanings of the expressions that describe the endstates such verbs imply (in their telic uses). Following Dowty, Abusch takes the lexical meaning of an inchoative verb to be as in (3a), where **P** is a property of individuals, with truth conditions as in (3b).[2]

(3) a. $\lambda x \lambda e.\text{BECOME}(\mathbf{P})(x)(e)$
b. $\text{BECOME}(\mathbf{P})(x)(e)$ = 1 iff $\mathbf{P}(x)(init(e))$ = 0 and $\mathbf{P}(x)(fin(e))$ = 1, where $init(e)$ and $fin(e)$ are the initial and final parts of e.

Abusch observes that what is special about DAs like *cool* is that **P** corresponds to a vague predicate: what counts as cool is a matter of context, and there will typically be some things for which it is impossible to say whether they are cool or not (so-called 'borderline cases'). Building on the analyses of vague predicates in Kamp 1975 and Klein 1980 (see also McConnell-Ginet 1973 and Fine 1975), Abusch analyzes adjectival *cool* as a function **cool** from contexts to properties of individuals, and proposes that the variability of verbal *cool* depends on whether the contextual argument of **cool** is fixed to the context of utterance, as in (4a), or is

[2] Abusch does not assume an event semantics; (3b) simply restates the interval-based semantics for BECOME that she assumes (based on Dowty 1979) in terms of an event argument; cf. Krifka 1998; Parsons 1990.

bound by an existential quantifier, as in (4b).

(4) a. $\lambda x \lambda e.\text{BECOME}(\textbf{cool}(c_u))(x)(e)$
b. $\lambda x \lambda e.\exists c[\text{BECOME}(\textbf{cool}(c))(x)(e)]$

In (4a), $\textbf{cool}(c_u)$ is the property of being cool in the context of utterance. This is the meaning of the positive (unmarked) form of the adjective, which is true of objects that are at least as cool as some contextual 'standard' of temperature. (The standard can vary both on properties of the object and on properties of the context: cool lemonade is normally cooler than cool coffee, and coffee that counts as cool relative to one's desire to drink it in the morning with a bagel is typically warmer than coffee that counts as cool relative to one's desire to pour it over ice without turning the whole thing into a watery mess.) Saturation of the individual argument x derives a property that is true of an event just in case x is not as cool as the contextual standard at the beginning of the event, and is at least as cool as the standard at the end of the event; the requirement that this transition be made renders the predicate telic.

In (4b), the context variable is existentially bound, which means that the predicate is true of an event just in case there is some context such that x is not cool relative to that context at the beginning of the event and is cool relative to the context at the end of the event, i.e., that x has a coolness that is below the standard of comparison for that context at the beginning of the event, and above it at the end. But this merely requires an increase in coolness (which amounts to a decrease in temperature, since *cool* is a 'polar negative' adjective; see Seuren 1978; Bierwisch 1989; Kennedy 2001), and there is no entailment that a particular endstate is reached. Assuming an arbitrary number of contextual interpretations of vague predicates, differing only in where along a gradable continuum they draw the line between the things they are true and false of, (4b) is true of any subevent of an event that it is true of. In other words, it has the 'subinterval property', and so is atelic (Bennett and Partee 1978).

Abusch's analysis predicts that DAs in general should behave like *cool*, having either telic or atelic interpretations depending on whether the adjectival root is analyzed in a 'positive' sense as in (4a) or a 'comparative' sense as in (4b).[3] One potential problem for this analysis comes from the fact that many DAs have default telic interpretations. Such verbs have atelic uses, but in the absence of explicit mor-

[3] Abusch's analysis of the atelic interpretation is often characterized as involving a 'comparative' semantics, and we will continue to use this label here, but with caution: this characterization is not quite accurate. Abusch's semantics is similar to e.g. Klein's (1980) analysis of comparatives in that it involves existential quantification over contextual interpretations of vague predicates, but it is crucially different in not introducing an explicit standard of comparison (the expression contributed by the *than* constituent in an English comparative construction).

phosyntactic or contextual information forcing such interpretations, they are treated as telic. This is illustrated by the examples in (5).

(5) a. The sky darkened (?but it didn't become dark).
b. The shirt dried (??but it didn't become dry).
c. The sink emptied (??but it didn't become empty).

As observed by Kearns (2007), the most natural interpretations of examples like these are ones in which the affected objects reach the endstate named by the positive form of the adjective, as illustrated by the oddity of the completions in parentheses. These completions do not result in true contradictions, showing that the telic interpretation is not obligatory, but they do result in degraded acceptability.[4] In particular, they have the feel of 'garden path effects', suggesting that the verbs in (5) have default telic positive interpretations, and the completions require reanalysis to the atelic, comparative one.

A potential explanation for this default is a pragmatic one: since the telic interpretation entails the atelic one, it is more informative and therefore stronger. In the absence of information to the contrary — which could in principle be implicit (contextual), compositional (such as modification that is consistent only with atelicity), or even lexical (word-based defaults) — the strongest meaning should be preferred, resulting in a preference for telic interpretations (cf. Dalrymple et al's (1998) analysis of interpretive variability in reciprocals).

Although we will end up adopting a version of this proposal to explain the fact that verbs like those in (5) have default telic interpretations, it is not enough to save Abusch's analysis from a more serious second problem: there are DAs which appear to have only atelic interpretations. For example, (6a-b) show that DAs derived from the dimensional adjectives *wide* and *deep* accept only durative temporal modifiers:

(6) a. The gap between the boats widened for/??in a few minutes.
b. The recession deepened for/??in several years.

In addition, entailment from the progressive to the perfect is automatic, as shown by the fact that (7a-b), unlike e.g. (8a-b), are contradictory.

[4] Kearns points out that this effect is gradient, with some verbs (like *darken*) showing it mildly and others (like *empty*) showing it quite strongly. However, even verbs like *empty* can take on atelic interpretations when the context is rich enough or other components of the sentence force such readings, as in the case of post-verbal modification by *quickly* (Kearns 2007):

(i) The sink emptied quickly (but we closed the drain before it became empty).

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

(8) a. The soup is cooling, but it hasn't cooled.
b. The shirt is drying, but it hasn't dried.

These facts are unexpected if a DA such as *widen* is ambiguous between the two meanings in (9), comparable to those for *cool* in (4).

(9) a. $\lambda x \lambda e[\text{BECOME}(\textbf{wide}(c_u))(x)(e)]$
b. $\lambda x \lambda e.\exists c[\text{BECOME}(\textbf{wide}(c))(x)(e)]$

In particular, if (9a) were an option, then *widen* should have a telic interpretation equivalent to *become wide*, i.e., 'come to have a width that is at least as great as the minimum width that counts as wide in the context of utterance'.[5] It would then be possible to simultaneously assert that something widens in the sense of (9b) while denying that it widens in the sense of (9a) (this is Zwicky and Sadock's (1975) 'test of contradiction'), since an object can increase in width without becoming wide. But this is not the case: if it were, then the examples in (7) would fail to generate a contradiction. That is, there would be an interpretation of e.g. (7a) in which the occurrence of *widen* in the perfective form is understood to mean the same as *become wide*, not *become wider*, in which case there would be no incompatibility with the progressive assertion: a gap could be increasing in width without having become wide (see note 5). We can therefore conclude that DAs like *widen* and *deepen* resist interpretations parallel to (9a), a fact that deserves explanation.[6]

A final problem with Abusch's analysis involves the interpretation of measure phrases in DAs. Consider the following examples:

(10) a. The soup cooled 17 degrees.

[5] Even if the exact value of such a width is vague or unknown (or unknowable; see Williamson 1992, 1994), it remains the case that (9a) should be semantically telic, since it imposes exactly the same kind of requirement on an event that a DA like *cool* does in its telic sense in (4a). This is confirmed by the absence of an entailment from the progressive to the perfect for *become wide*, as shown by (i).

(i) The gap is becoming wide(r), but it hasn't become wide.

Modification of *become wide* with an *in*-PP is not particularly felicitous, but this is presumably due to the vagueness of *wide*, and therefore not indicative of atelicity.

[6] While this conclusion is justifed based on the clear contrast between the examples in (7) and those in (8), we suspect that it may be possible under special circumstances and with strong contextual support to understand DAs like *widen* in a telic, 'positive' sense comparable to (8a). The analysis that we present in section 3.2 will allow for this possibility as a (highly) marked option, while at the same time explaining why the atelic 'comparative' sense is the default.

b. The gap widened 6 inches.

The measure phrases in these examples specify the amount that the respective subjects change in temperature and width as a result of participating in the event described by the verbs, and in doing so, render the predicates telic (a point to which we will return below). However, it is difficult to see how this result can be achieved given the options in (4) and (9). It might seem reasonable to modify the account so that the measure phrase and adjectival base together provide the value of the inchoative predicate, but this would predict that (10a-b) should have the meanings in (11a-b).

(11) a. ??The soup became 17 degrees cool.
b. The gap became 6 inches wide.

This prediction is obviously incorrect: *cool* is a gradable adjective that does not combine with measure phrases (see Schwarzschild 2005 and Svenonius and Kennedy 2006 for recent discussion of this issue), and (11b) does not accurately convey the meaning of (10b). Instead, (10a-b) are more accurately paraphrased by (12a-b).

(12) a. The soup became 17 degrees cooler (than it was at the beginning of the event).
b. The gap became 6 inches wider (than it was at the beginning of the event).

These paraphrases show that measure phrases in DAs express 'differential' amounts, just like measure phrases in comparatives: instead of specifying the total amount to which an object possesses some measurable gradable property (as in (12b), where *six inches* is used to describe the total/maximal width of the gap), such measure phrases convey the extent to which two objects (or the same object at different times) differ along some gradable continuum. An analysis of variable telicity in DAs that is based strictly on the vagueness of the positive form, such as Abusch's, is not equipped to convey this kind of meaning. (See von Stechow 1984 for a discussion of the problem differential measure phrases present for a semantics of comparatives based on the analysis of vagueness in Kamp 1975 and Klein 1980, on which Abusch builds her analysis of DAs.)

2.2 Telicity and scale structure

Our discussion of Abusch's work shows that any account of DAs must explain three factors: 1) the (strong) default telic/positive interpretation of verbs like *darken*, 2) the lack of a telic/positive meaning for verbs like *widen*, and 3) the differential in-

terpretation assigned to measure phrase arguments. Recent analyses of DAs have attempted to account for these factors by adopting a semantics for DAs that is more directly 'scalar', importing features from degree-based semantic analyses of gradable adjectives. We hold off on providing a full overview of scalar semantics until section 3 when we introduce our own account (which is also a scalar one); here we highlight the crucial advantages — and shortcomings — of existing scalar analyses.

The first explicitly scalar analysis of DAs, and the one on which the analysis we will present in section 3.2 is based, is provided by Hay et al. (1999). Hay et al. provide in effect a purely 'comparative' semantics for DAs, treating them as predicates of events that are true of an object if the degree to which it possesses the gradable property encoded by the source adjective at the end of the event exceeds the degree to which it possess that property at the beginning of the event by some positive degree d. The degree argument, which Hay et al. refer to as the *difference value*, is a measure of the amount that an object changes as a result of participating in the event described by a DA, and is precisely that which is overtly expressed by the measure phrases in (10) that were problematic for Abusch's analysis. The meanings assigned to these examples in the Hay et al. analysis are exactly those specified above in (12), thus solving one of the three problems.

The difference value is furthermore the crucial factor determining the telicity of the predicate. If it is such that a particular degree on the adjectival scale must be obtained in order for the predicate to be true of an event, then a terminal point for the entire event can be identified, namely that point at which the affected object attains that degree (which is equivalent to the initial degree to which it possessed the property plus the degree specified by the difference value); the result is a telic interpretation. If, however, the difference value is satisfied by any positive degree, this computation isn't possible and no terminal point can be identified; in this case, the predicate is atelic.

In some cases, such as the examples with measure phrases above, the difference value is explicit and the predicate is telic. When the difference value is implicit, contextual and lexical semantic factors determine its value and in turn the telicity of the predicate. Hay et al. take advantage of the latter to explain the different aspectual properties of DAs like *widen* and *deepen* on the one hand, and those like *darken*, *dry* and *empty* on the other. In particular, they observe that these two classes of DAs differ with respect to the structures of the scales associated with their adjectival bases: *wide*, *deep* etc. use open scales (scales that lack maximal elements); *dark*, *dry* etc. use closed ones (scales with maximal elements).

According to Hay et al., verbs derived from closed scale adjectives are default telic due to a preference for fixing the difference value in such a way as to entail that the maximal value on the scale must be reached. In effect, since the structure of the scale allows for the possibility of increase along the adjectival scale to a max-

imal degree ('maximal change'), and such a meaning is stronger than (entails) all other potential meanings, it should be selected, resulting in a telic interpretation. This explanation has obvious similarities to the account of default telicity presented above in the context of Abusch's analysis; where the Hay et al. proposal stands apart is in the explanation of obligatory atelicity for DAs derived from open scale adjectives like *widen*. Because the adjectival root *wide* uses a scale that does not have a maximal degree, there is no possibility for an interpretation involving maximal change, so the difference value is existentially closed. The result is that *widen* is true of an event and an object as long as it undergoes some increase in width, which derives an atelic interpretation.

Similar analyses have been developed by Kearns (2007) and Winter (2006), which differ slightly in detail but ultimately face a similar challenge. To set the stage for this challenge, we must first address a specific criticism of Hay et al.'s account of default telicity for verbs based on closed scale adjectives discussed in Kearns 2007. Kearns argues that the telos for such verbs need not be a maximum value on the relevant scale, but is rather the standard used by the corresponding adjective, whatever that is. As support for this claim, she presents examples like (13a-b) to show that the telic interpretations of DAs based on (unmodified) closed scale adjectives do not actually entail maximality, as indicated by the acceptability of the *not completely* continuations (numbers in square brackets refer to the example numbers in Kearns 2007).

(13) a. The sky darkened in an hour, but it wasn't completely dark. [37a]
b. The fruit ripened in five days but it wasn't completely ripe. [38a]

While we agree with Kearns' claim that the telos for verbs like *darken* and *ripen* should be identified with the standard of the corresponding adjectives (and that the Hay et al. analysis fails to adequately explain this connection), we do not agree that the data in (13) show that this value is not a maximal degree on the relevant scales. Instead, we claim that the apparent non-maximality of the adjectival standards in the second conjuncts of (13a-b) is an artifact of the fact that the definite descriptions that introduce the affected arguments in the first conjuncts can be interpreted imprecisely, allowing for the possibility that the verbs do not apply to subparts of the objects that the descriptions are used to refer to. In other words, what is being denied in the second conjunct of (13a) is that all parts of the sky are dark, not that the parts of the sky that the verb does in fact apply to fail to become maximally dark.

Evidence in favor of this interpretation of the data in (13) comes from a couple of sources. First, if we eliminate the possiblity of an imprecise interpretation of the definite in the first conjunct by making it explicit that the entire object is

affected, we get a contradiction with a *not completely* interpretation:

(14) a. #All of the sky darkened in an hour, but it wasn't completely dark.
b. #The entire fruit ripened in five days, but it wasn't completely ripe.

These examples show that the second conjunct can have an interpretation in which the adverb is in effect modifying the subject (*not all of it*) rather than picking out a maximal value on the scale, which in turn shows that Kearns' examples do not counterexemplify Hay et al.'s claims that telic DAs entail maximum degrees.

Second, if we modify the second conjunct to make it explicit that the intended interpretation is one in which a maximal degree is not achieved, we get contradiction:

(15) a. #The sky darkened in an hour, but no part of it was completely dark.
b. #The fruit ripened in five days, but no part of it was completely ripe.

These examples provide positive evidence that telic DAs like *darken* and *ripen* do in fact entail that their affected arguments achieve maximal degrees of the properties measured by the adjectives. If this were not the case, then there would be no incompatibility between the two conjuncts: the assertion that no part of the sky is completely dark in the second conjunct of (15a), for example, should be perfectly consistent with the first conjunct if the verb merely required something close to complete darkness for whatever parts of the sky (possibly all of them) are assumed to be affected.

These considerations show that telic interpretations of DAs based on closed scale adjectives do in fact entail movement to a maximal degree, contrary to Kearns's claims; however, they do not argue against her position that the telos is the 'standard endstate' associated with the adjectival form, if in fact the adjectival standard is itself a maximal degree.[7] This position is in fact argued for in detail by Rotstein and Winter (2004), Kennedy and McNally (2005) and Kennedy (in press), a point that we will discuss in detail in the next section. Although this result is not inconsistent with Hay et al.'s analysis, it is important to acknowledge that the analysis does not actually derive it in a principled way.

The problem is that Hay et al. do not provide an explicit mechanism for

[7] Kearns is correct that the DA *cool* — and presumably some others like it — has a conventionalized non-maximal endpoint. When this verb is used telically without context, as in (i), the endpoint is assumed to be room temperature, presumably because food normally can't cool further without being put in a refrigerator or in some other cold place.

(i) The soup cooled in ten minutes.

We discuss the case of *cool* in more detail below.

fixing the difference value for verbs like *darken*, *ripen* etc. in such a way as to ensure that the predicate actually entails of its argument that it becomes maximally straight, saying only that the existence of a maximal value on the scale 'provides a basis' for fixing the difference value in the appropriate way (see Piñon's contribution to this volume for detailed discussion of this point). This problem threatens to undermine the whole analysis: without a principled account of the conditions under which the difference value can and cannot correspond to particular degrees, we lose the explanation of the difference in (default) telicity between DAs derived from adjectives with open scales and those derived from adjectives with closed scales. In short, we have no explanation of why it is possible to fix the difference value to a degree that entails movement to the end of the scale in the case of the latter class of DAs, but not possible to fix the difference value to a degree that entails movement to a contextual standard in the case of the former class (see Kearns 2007 for the same criticism). Such a move would result in a telic interpretation of e.g. *widen* with a meaning comparable to *become wide*, which as we have shown is not an option (or is at best a highly marked one).

Kearns solution to this problem is to claim that the contextual standard associated with adjectives like *wide* is 'insufficiently determined' to serve as a telos. Although this explanation has intuitive appeal, it seems unlikely given the fact that *become wide* is telic (see note 5), and more generally, given the fact that speakers must have access to the contextual standard in order to assign truth conditions to sentences containing the positive form of the adjective. Winter (2006) takes a different approach: he defines the mapping from scalar adjectives to (corresponding) DAs in such a way that the verbal form has a telos based on a lexically specified adjectival standard *if one is specified*, and (building on proposals in Rotstein and Winter 2004) posits that such standards are specified only for closed scale adjectives. While this analysis achieves the desired result, it has a couple of undesirable features. First, it simply eliminates the possibility of a contextual standard by stipulation; an analysis in which this restriction follows from more general principles is preferable. Second, it predicts that DAs based on closed scale adjectives like *straighten* should have only telic interpretations, since in the Rotstein and Winter semantics for scalar adjectives, *straight* is specified as having a standard associated with the endpoint of the scale. The fact that DAs based on closed-scale adjectives can also have atelic interpretations (see note 4 and Kearns 2007) then remains unexplained.

At a more general level, Winter's analysis raises the question of why it is just the closed scale adjectives that are conventionally associated with fixed standards. If we can answer this question, and also provide an answer to the question of why fixed standards can give rise to telic interpretations of DAs while context-dependent ones (of the sort involved in the interpretation of an open scale adjective

like *wide*) cannot, then we will have the basis for a truly explanatory account of the relation between scale structure and telicity in DAs. In the next section we present an analysis of the semantics of degree achievements in which the answers to these two questions are in fact the same.

3 Measure of change

3.1 Scale structure and standard of comparison

Our analysis builds on the same core hypothesis that underlies the Dowty/Abusch analysis: the variable aspectual properties of DAs derive from the semantic properties of the adjectival part of their (decomposed) lexical meanings. However, we begin from different assumptions about how to capture the semantics of gradability and vagueness. Whereas Abusch's analysis is built on a semantics of gradable predicates in which they denote (context-dependent) properties of individuals, we start from the assumption that such expressions do not themselves express properties, but rather encode measure functions: functions that associate objects with ordered values on a scale, or degrees.[8]

In particular, we follow Bartsch and Vennemann 1972, 1973 and Kennedy 1999 and assume that gradable adjectives in English directly lexicalize measure functions.[9] We further assume following Hay et al. 1999 (cf. Piñon 2005) that such measure functions can be relativized to times (an object can have different degrees of height, weight, temperature etc. at different times), so that the adjective *cool*, for example, denotes a function **cool** from objects x and times t that returns the

[8]Following Kennedy and McNally 2005, we take scales to be triples $\langle S, R, \delta \rangle$ where S is a set of degrees, R an ordering on S, and δ a value that represents the dimension of measurement. Scales may vary along any of these parameters: the structure of S (e.g., whether it is open or closed), the ordering relation ($\prec$ for increasing, 'positive' adjectives like *warm*; $\succ$ for decreasing, 'negative' adjectives like *cool*), and the dimension (temperature, width, depth, linear extent, temporal extent, etc.). Semantic differences between gradable adjectives are primarily based on differences in the kinds of scales they use.

[9]An alternative (and more common) analysis of gradable adjectives is one in which they do not directly denote measure functions, but incorporate them as part of their meanings (see e.g. Cresswell 1977; von Stechow 1984; Heim 1985, 2000; Klein 1991). On this view, a gradable adjective like *cool* expresses the relation between degrees and individuals in (i), where **cool** is a measure function.

(i) $[\![[_{\mathrm{A}} \text{ cool }]]\!] = \lambda d \lambda x.\mathbf{cool}(x) \succeq d$

Our proposals in this paper can be made consistent with this analysis of gradable adjectives by simply assuming that measure functions correspond not directly to adjective denotations, but rather to more basic units of meaning, which are part of the lexical semantic representations of both gradable adjectives and verbs of gradual change.

temperature of x at t. A consequence of this analysis is that a gradable adjective by itself does not denote a property of individuals, but must instead be converted into one so that composition with its individual argument results in a proposition; this is the role of degree morphology: comparative morphemes, sufficiency/excess morphemes, intensifiers, and so forth.

Among the set of degree morphemes is a null degree head (or possibly a semantically equivalent type-shifting rule) that is involved in the interpretation of the so-called positive (morphologically unmarked) form, which denotes the function **pos** in (16).[10]

(16) $\textbf{pos} = \lambda g \in D_{\langle e,d\rangle} \lambda t \lambda x.g(x)(t) \succeq \textbf{stnd}(g)$

Here **stnd** is a function from gradable adjective meanings to degrees that returns a standard of comparison for the adjective in the context of utterance: the minimum degree required to 'stand out' in the context relative to the kind of measurement expressed by the adjective (Kennedy in press; Bogusławski 1975; Fara 2000; cf. Bartsch and Vennemann 1972, 1973; Cresswell 1977; von Stechow 1984). The positive form of *wide*, for example, denotes the property in (17), which is true of an object (at a time) just in case its width exceeds the standard, i.e., just in case it stands out in the context of utterance relative to the kind of measurement represented by the measure function **wide** ('linear extent in a horizontal direction perpendicular to the perspective of reference', or something like that).

(17) $\textbf{pos}(\textbf{wide}) = \lambda t \lambda x.\textbf{wide}(x)(t) \succeq \textbf{stnd}(\textbf{wide})$

The truth of a predication involving the positive form of a gradable adjective thus depends on two factors: the degree to which it manifests the gradable property measured by the adjective (in this case, its width), and the actual value of the standard of comparison in the context (here the degree returned by **stnd**(**wide**)). The latter value is a function both of (possibly variable) features of the conventional meaning of the adjective (such as its domain, which may be contextually or explicitly restricted to a particular comparison class; see Klein 1980; Kennedy in press), and of features of the context (such as the domain of discourse, the interests/expectations of the participants in the discourse, and so forth).

However, there is an asymmetry in the relative contributions of conventional (lexical) and contextual information to the determination of the standard of comparison. Rotstein and Winter (2004), Kennedy and McNally (2005), and Kennedy (in

[10] At the risk of confusion, we follow descriptive tradition and use 'positive form' to refer to the morphologically unmarked use of a predicative or attributive adjective. This sense of 'positive' is distinct from the one used to refer to adjectival polarity, e.g. the characterization of *warm* as a (polar) positive adjective and *cool* as a (polar) negative one.

press) provide extensive empirical arguments that when an adjective uses a closed scale (a feature of its conventional meaning), the standard of comparison invariably corresponds to an endpoint of the scale: the minimum in some cases (*bent, open, impure*, etc.) and the maximum in others (*straight, closed, pure*, etc.). In other words, the standards of comparison of closed-scale adjectives are not context-dependent.

Kennedy (in press) argues that this distinction follows from the semantics of the positive form; specifically from the fact that the standard represents the minimum degree required to stand out relative to the kind of measure encoded by the adjective. The difference between adjectives that use closed measurement scales and those that use open ones is that the former come with 'natural transitions': the transition from a zero to a non-zero degree on the scale (from not having any degree of the measured property to having some of it) in the case of an an adjective with a lower closed scale, or the transition from a non-maximal to a maximal degree (from having an arbitrary degree of the measured property to having a maximal degree of it) in the case of an adjective with an upper closed scale. Kennedy proposes that what it means to 'stand out' relative to a property measured by a closed scale adjective is to be on the upper end of one of these transitions. In the case of adjectives with lower closed scales like *wet, impure* and so forth, this means having a non-zero degree of the measured property; in the case of adjectives with upper closed scales like *dry* and *pure*, this means having a maximal degree of the measured property.[11]

Scale structure explains why the endpoints of closed-scale adjectives are potential standards (only closed scale adjectives have scales with endpoints), but it does not explain why they are the actual standards. There is nothing inherently incompatibile between a closed scale and a context dependent, non-endpoint oriented standard, so the fact that closed scale adjectives default to endpoint-oriented standards must follow from some other constraint. According to Kennedy, this constraint is the principle of Interpretive Economy stated in (18).

(18) *Interpretive Economy*
Maximize the contribution of the conventional meanings of the elements of a sentence to the computation of its truth conditions.

The effect of Interpretive Economy is to make a contextual standard a 'last resort': since the natural transitions provided by the endpoints of a closed scale provide a basis for fixing the standard of comparison strictly on the basis of the conventional (lexical) meaning of a closed scale adjective, they should always be favored over

[11] Adjectives with totally closed scales are somewhat more complicated: some can have either maximum or minimum standards (e.g., *opaque*), which is expected given the considerations articulated above, but others have only maximum standards (e.g., *full*). See Kennedy (in press) for discussion.

a context-dependent standard. In contrast, nothing inherent to the meaning of an open-scale adjective beyond its dimension of measurement (e.g., width vs. depth) provides a basis for fixing the standard. This means that contextual factors such as the domain of discourse, the interests and expectations of the discourse participants, and so forth must be taken into consideration when determining how much of the measured property is enough to stand out, resulting in the familar context dependent, vague positive form interpretations of adjectives like *wide* and *deep*.

3.2 The semantics of scalar change

The assumptions outlined in the previous section (or something very much like them) are necessary to account for the semantics of the positive form, given a degree-based analysis of gradable adjectives.[12] They are not sufficient on their own, however, to explain the semantic properties of DAs in terms of the semantic properties of the adjectival parts of their meanings. To implement this hypothesis directly — essentially providing a scalar version of the Dowty/Abusch analysis — we would posit (19) as the meaning of a DA based on a gradable adjective **g**.

(19) $\lambda x \lambda e.\textsc{become}(\textbf{pos}(\textbf{g}))(x)(e)$

Here $\textbf{pos}(\textbf{g})$ is equivalent to the meaning of the positive form of a gradable adjective **g**. In the case of DAs based on adjectives whose positive forms make use of maximal standards (adjectives with upper closed scales), such as *straight*, *dry* and *dark*, we almost get the right results. The DA *straighten*, for example, would have the denotation in (20).

(20) $\lambda x \lambda e.\textsc{become}(\textbf{pos}(\textbf{straight}))(x)(e)$

(20) is true of an individual x and an event e just in case $\textbf{pos}(\textbf{straight})$ is false of x at the beginning of e and true of x at the end of e. Since the measure function **straight** uses a scale with a maximum value, $\textbf{pos}(\textbf{straight})$ is true of x just in case it has maximal straightness, which in turn means that (20) holds of an event just in case x undergoes a change from non-maximal to maximal straightness. (20) fails to hold of subevents in which x ends up less than completely straight, and so is correctly predicted to be telic. However, this analysis will run into the same problems as Winter's account: it predicts that *straighten* is never atelic, contrary to fact.

This simple implementation fares even worse for DAs based on adjectives that do not have upper closed scales and maximum standards, however. Consider

[12] This is true regardless of whether we assume that such adjectives are of type $\langle e, d\rangle$ or type $\langle d, \langle e, t\rangle\rangle$, as described in note 9. The latter approach also requires a null positive morpheme, type-shifting rule, or saturation principle to map a function of type $\langle d, \langle e, t\rangle\rangle$ to a property of individuals.

the case of *widen*, based on the open scale adjective *wide*, which should have the denotation in (21) according to (19).

(21) $\lambda x \lambda e.\text{BECOME}(\textbf{pos}(\textbf{wide}))(x)(e)$

The problem is essentially the same as the problem discussed in section 2.1: **pos**(**wide**) denotes the property of having a width that exceeds the standard of comparison for the context of utterance (whatever amount is enough to stand out relative to the measure function **wide**), so *widen* should have a meaning equivalent to *become wide* (which it doesn't) and it should be telic (which it isn't.) For the same reason, a DA like *cool* is predicted to have only a telic interpretation equivalent to *become cool*; (19) does not provide a means of deriving the atelic intepretation parallel to *become cooler*.

One response to these problems would be to instead assume a version of Abusch's 'comparative' semantics as in (22).

(22) $\lambda x \lambda e.\text{BECOME}(\textbf{more}(\textbf{g}))(x)(e)$

Strictly speaking, **more** in (22) cannot encode exactly the same meaning as the morpheme involved in comparative constructions, since the latter needs to combine with both an adjective and a standard of comparison (provided by the *than*-constituent in English) in order to derive a property of individuals. Instead, the **more** in (22) should really be thought of as shorthand for something that leaves us with a property that is true of an object x and an event e just in case x ends up being 'more **g** at the end of e than it was at the beginning'; this is essentially the analysis of DAs proposed in Hay et al. 1999 and Winter 2006 (minus the culmination stipulation in the latter). (22) correctly captures the atelic interpretations of *widen* and *cool*, but fails to adequately account for the telic interpretation of the latter or to adequately explain why DAs like *straighten* and *darken* have default telic interpretations.

It appears, then, that basing the semantics of DAs on a degree semantics of gradable adjectives fares no better than the Dowty/Abusch analysis. If we assume that DAs have only 'positive' meanings like (19), we fail to account for atelic interpretations of *widen*, *cool*, *straighten* and so forth. If we assume that DAs have only 'comparative' meanings like (22) (essentially the position taken in e.g. Hay et al. 1999), we fail to derive the telic interpretations of *straighten*, *darken*, etc. Finally, if we assume that DAs are ambiguous between (19) and (22), the fact that *widen*, etc. do not have both atelic and telic interpretations (absent a measure phrase) becomes mysterious.

As a solution to this apparent paradox, we present a kind of synthesis of the 'positive' and 'comparative' analyses, which differs from both the Dowty/Abusch approach and the analyses of Hay et al. 1999, Kearns (2007) and Winter 2006 in

the following crucial respect: instead of treating the adjectival part of the meaning of a DA as identical to the meaning of the adjectival base (a vague property for Abusch and Dowty; a measure function or the equivalent for Hay et al., Kearns and Winter), we propose that the adjectival core of a DA is a special kind of derived measure function that measures the degree to which an object changes along a scalar dimension as the result of participating in an event.

Our analysis builds on a non-standard semantics of comparatives discussed in Kennedy and McNally 2005 (see also Faller 2000; Neeleman, van de Koot, and Doetjes 2004; Rotstein and Winter 2004 and Svenonius and Kennedy 2006; see Schwarzschild 2005 for a similar idea).[13] Noting that comparatives and deverbal adjectives with lower closed scales accept the same kinds of degree morphemes (e.g., both can be modified by *much*, as in *much taller* and *much appreciated*, which is indicative of a lower closed scale), Kennedy and McNally propose that comparatives should be analyzed as derived measure functions, which are just like the functions expressed by the base adjective except that they use scales whose minimum values are determined by the denotation of the *than*-constituent — the 'comparative standard'. Generalizing this idea, we can define for any measure function **m** a corresponding DIFFERENCE FUNCTION $\mathbf{m}^{\uparrow}_{d}$ that is just like **m** except that the degrees it returns for objects in its domain represent the difference between the object's projection on the scale and an arbitrary degree d (the comparative standard): a positive value when there is a positive difference, and zero otherwise. This idea is made explicit in (23).

(23) *Difference functions*
For any measure function **m** from objects and times to degrees on a scale S, and for any $d \in S$, $\mathbf{m}^{\uparrow}_{d}$ is a function just like **m** except that:
i. its range is $\{d' \in S \mid d \preceq d'\}$, and
ii. for any x, t in the domain of **m**, if $\mathbf{m}(x)(t) \preceq d$ then $\mathbf{m}^{\uparrow}_{d}(x)(t) = d$.

In the case of comparatives, the hypothesis is that the comparative morphology turns a basic measure function into a difference function with a scale whose minimal element — the 'derived zero' — corresponds to the degree introduced by the comparative standard. So if *wide* denotes the measure function **wide**, *wider than the carpet* denotes the difference function $\mathbf{wide}^{\uparrow}_{\mathbf{wide}(\mathbf{c})}$, which returns values that represent the degree to which an object's width exceeds that of the carpet (represented here as $\mathbf{wide}(\mathbf{c})$, which suppresses the temporal argument for perspicuity): positive values if the argument's width is greater than that of the carpet, and zero

[13] The 'standard' semantics for comparatives is one in which *more than X* is a quantifier over degrees that targets the degree argument of a gradable adjective; see Heim 2000 for a representative implementation.

(relative to the derived scale) otherwise.[14] A consequence of this analysis is that like morphologically bare adjectives, comparative adjectives are of type $\langle e, d\rangle$ and so need to combine with **pos** to derive a property of individuals. The denotation of the bracketed comparative predicate in (24a) is (24b), which is an abbreviation for the property in (24c) (which spells out the result of composition with **pos**).

(24) a. The table is [wider than the carpet].
b. $\textbf{pos}(\textbf{wide}^{\uparrow}_{\textbf{wide}(\textbf{c})})$
c. $\lambda x \lambda t.\textbf{wide}^{\uparrow}_{\textbf{wide}(\textbf{c})}(x)(t) \succeq \textbf{stnd}(\textbf{wide}^{\uparrow}_{\textbf{wide}(\textbf{c})})$

Given the semantics of the positive form discussed in the previous section, in particular the meaning contributed by **stnd**, (24c) is a property that is true of an individual if it stands out relative to the kind of measurement expressed by the difference function $\textbf{wide}^{\uparrow}_{\textbf{wide}(\textbf{c})}$. Crucially, for any measure function **m**, a difference function $\textbf{m}^{\uparrow}_{d}$ based on **m** always uses a lower closed scale: one whose minimal element is d. Since measure functions with lower closed scales are systematically associated with minimum standards when they combine with **pos**, as discussed in section 3.1, the result is that (24b) denotes a property that is true of an object x if the degree we get by applying the difference function to x is non-zero relative to the scale of the difference function, i.e. is greater than $\textbf{wide}(\textbf{c})$. In other words, *wider than the carpet* is true of an object just in case its width exceeds the width of the carpet, which is exactly what we want.

Returning now to the semantics of DAs, we propose that the adjectival core of a degree achievement is a special kind of difference function: one that measures the amount that an object changes along a scalar dimension as a result of participating in an event. We make this idea explicit in (25), which defines for any measure function **m** from objects and times to degrees on a scale S a new MEASURE OF CHANGE function $\textbf{m}_{\Delta}$. (Here *init* and *fin* return the initial and final temporal intervals of an event.)

(25) *Measure of change*
For any measure function **m**, $\textbf{m}_{\Delta} = \lambda x \lambda e.\textbf{m}^{\uparrow}_{\textbf{m}(x)(\mathit{init}(e))}(x)(\mathit{fin}(e))$

In prose, a measure of change function $\textbf{m}_{\Delta}$ takes an object x and an event e and returns the degree that represents the amount that x changes in the property measured by **m** as a result of participating in e. It does this by mapping its individual

[14] We do not address here the question of how this degree is derived compositionally, though we see no obstacles to adapting any of a number of current proposals for the syntax and semantics of the comparative clause. Most analyses agree that the comparative clause denotes some sort of maximal degree (see e.g., von Stechow 1984; Rullmann 1995; Heim 2000; Bhatt and Pancheva 2004), which is all that we need to build the derived scale.

argument x onto a derived scale whose minimal element is the degree to which x measures **m** at the initiation of e. The output is a degree that represents the positive difference between the degree to which x measures **m** at the beginning of e and the degree to which it measures **m** at the end of e; if there is no positive difference, it returns zero.

Like other measure functions, a measure of change must combine with some degree morphology (or undergo a type shift) in order to ensure that we ultimately end up with a property of events. We will consider overt instances of such morphology below; in order to complete the semantic analysis of DAs we follow Piñon 2005 and posit a verbal positive form morpheme $\textbf{pos}_v$ with the semantic properties stated in (26). (Here D_{m_Δ} represents the domain of measure of change functions — functions from individuals to functions from events to degrees.)

(26) $\quad \textbf{pos}_v = \lambda g \in D_{m_\Delta} \lambda x \lambda e . g(x)(e) \succeq \textbf{stnd}(g)$

Combining $\textbf{pos}_v$ with a measure of change function returns (27), which we claim represents the core (inchoative) meaning of a DA: a DA based on a measure of change function $\textbf{m}_\Delta$ is true of an object x and an event e just in the degree to which x changes as a result of participating in e exceeds the standard of comparison for $\textbf{m}_\Delta$.

(27) $\quad \textbf{pos}_v(\textbf{m}_\Delta) = \lambda x \lambda e . \textbf{m}_\Delta(x)(e) \succeq \textbf{stnd}(\textbf{m}_\Delta)$

Before showing how this analysis derives the facts discussed in section 2, we want to elaborate on two intuitions that underlie our proposal that DAs are based on measure of change functions, rather than basic measure functions encoded by (noncomparative) gradable adjectives. The first is that any change necessarily entails a shift along some dimension, and that when that dimension is a scalar one, the change corresponds to a difference in degree. In this sense, a measure of change function generalizes (and directly encodes) the 'transition' feature of Dowty's BECOME operator (where the shift from 0 to 1 represented by BECOME is just the limiting case where the scale has no intermediate values). The second is that a fundamental part of what it means to make an adjective 'verbal' is to introduce an event argument. Thus the difference between a pure measure function or a comparative difference function (both adjectival roots) and a measure of change function (a verbal root) involves a difference in domain: the former are functions from objects and times to degrees; the latter is a function from objects and events to degrees. In the next section, we will show that this analysis both captures the truth conditions of DAs and accounts for their observed patterns of telicity in terms of the scalar properties of the measure of change function.

3.3 Capturing (a)telicity

Recall from the discussion in section 3.1 that the standard of comparison involved in the truth conditions of the positive form of a gradable predicate — the value returned by applying the standard-identifying function **stnd** to a measure function **m** in a context of utterance — represents the minimum degree required to stand out relative to the kind of measurement encoded by **m**. This value is further regulated by the principle of Interpretive Economy which requires truth conditions to be based on the conventional meanings of the constituents of a sentence whenever possible, allowing for context dependent truth conditions only as a last resort. A consequence of this principle is that when **m** is a function to a closed scale, the standard of comparison must be endpoint oriented. In particular, the positive form of an adjective with a lower closed scale is true of an object just in case it has a non-zero degree of the measured property, and the positive form of an adjective with an upper closed scale is true of an object just in case it has a maximal degree of the measured property. Context dependent standards are available only for the positive form of adjectives that denote measure functions to open scales (or perhaps also when contextual information is strong enough to force such a result as a marked reading for a closed scale adjective).

These considerations form the basis of our account of variable telicity in degree achievements. According to the semantic analysis outlined in the previous section, an (unmodified) DA is a kind of positive form gradable verb whose meaning is based on a measure of change function. Crucially, since a measure of change function is a special kind of difference function, and since all difference functions use scales with minimum elements (see the discussion of adjectival comparatives above), our analysis predicts that a DA should always permit a minimum standard interpretation whereby it is true of an object and an event as long as the measure of change function the DA encodes returns a non-zero degree when applied to the object and event; i.e., as long as the object undergoes some positive change in the measured property as a result of participating in the event. In other words, all DAs are predicted to allow 'comparative' truth conditions, in which all that is required is that the affected argument undergo some increase in the measured property as a result of participating in the event. As we have already shown, such truth conditions correspond to atelic predications, so all DAs are predicted to allow atelic interpretations, which is in fact the case.

At the same time, some DAs encode measure of change functions that make use of scales with maximal as well as minimal elements. In particular, given the definition of measure of change functions in (25), this will be the case for any DA whose corresponding adjectival form uses a scale with a maximum element, such as *straighten, darken, fill, empty* and so forth. Since the scale for the measure of

change function is derived from the scale for the adjectival measure function, it will always 'inherit' a maximal element if there is one; the crucial difference between the adjectival measure function and the verbal measure of change function involves the obligatory presence of a (derived) minimum value in the latter. For example, the scale for the measure of change function $\textbf{straight}_{\Delta}$, on which the DA *straighten* is based, is that subpart of the **straight** scale whose minimum value is the degree to which the (internal) individual argument of the verb is straight at the beginning of the event. But since the **straight** scale has a maximum element (the degree that represents complete straightness), the $\textbf{straight}_{\Delta}$ scale does too.

Importantly, on the analysis proposed here, the availability of the maximum standard/telic interpretation is a consequence of more general principles governing the interpretation of the positive form, which apply equally to a gradable adjectives like *straight* and a DA like *straighten*. In the case of the DA, there are two potential standards of comparison that are consistent with Interpretive Economy: one based on the minimal element of the derived scale, resulting in the 'comparative' truth conditions described above and an atelic predicate, and one based on the maximal element of the scale, resulting in truth conditions that are similar to the 'positive' interpretation discussed in section 2. On this latter interpretation, a DA like *straighten* is true of an object and an event just in case the value returned by applying the measure of change function $\textbf{straight}_{\Delta}$ to the object and the event equals the maximal degree of the $\textbf{straight}_{\Delta}$ scale, i.e., just in case the object ends up completely straight. As we have already seen, this results in a telic predicate. As in the Dowty/Abusch analysis, the preference for a telic interpretation can be explained in terms of pragmatic principles: since the maximum standard, telic interpretation of *straighten* entails the minimum standard, atelic one, it is more informative, and is therefore preferred unless there are contextual, compositional, or lexical reasons to avoid it.[15]

This account of default telicity of DAs based on closed-scale adjectives is an improvement over the analysis in Hay et al. 1999, where the telic interpretation of the DA has no direct connection to the maximum standard interpretation of the adjective. It is also an improvement over the analysis in Winter 2006, where the

[15]A question that arises from this analysis is why comparative forms of closed scale adjectives, such as *straighter*, do not have maximum standard interpretations as well as their minimum standard ones. (Recall for a comparative like *straighter than this rod*, a minimum standard meaning requires positive (non-minimal) straightness relative to the subpart of the **straight** scale whose (derived) minimal value is *this rod*'s straightness.) A plausible explanation for this is that if the comparative form were assigned a maximum standard interpretation, it would have identical truth conditions to the positive form (maximal straightness); since the comparative is more complex than the positive, this interpretation is blocked. In the case of DAs, however, there is no competing form, so both the maximum and minimum standard interpretations are accessible.

culmination requirement of DAs based on closed scale adjectives is stipulated. Finally, our analysis directly captures Kearns' (2007) intuition that the telos of the verb equals the standard of the adjective. While we disagree with Kearns about where on the scale the standard falls (she denies that it is a maximal degree, though we feel that the evidence in section 2.2, together with an account of imprecision, supports the position that it is one), we agree completely that the adjective/verb pairs like *straight* and *straighten* should pattern together. Our analysis derives this result because the two forms have the same core meaning: one that involves a relation to a standard based on the maximal element of the **straight**/**straight**$_{\Delta}$ scale, which is the same value. The DA differs from the adjective in using a scale with a derived minimum value, which allows for the possibility of a minimum standard, 'comparative', atelic interpretation alongside the — preferred — maximum standard 'positive', telic interpretation.

Turning now to the case of *widen*, our analysis explains both why this verb and others like it have only atelic interpretations, and why true context dependent positive interpretations (equivalent to *become wide*) are impossible (or at least highly marked). The crucial fact is that such DAs are related to adjectives that denote measure functions to open scales; this is why the positive form of *wide* has a context dependent standard of comparison. However, according to our analysis the DA *widen* is not based on the open scale measure function **wide**, but on the measure of change function **wide**$_{\Delta}$. There is no maximal degree on the **wide** scale, so there is no maximal degree on the **wide**$_{\Delta}$ scale, eliminating the possibility of a maximum standard/telic interpretation. However, there is a minimum value on the **wide**$_{\Delta}$ scale: the degree to which the affected argument is wide at the beginning of the event. This value supports a minimum standard, atelic interpretation on the basis of the lexical semantic (scalar) properties of the verb; Interpretive Economy then rules out the possibility of a contextual standard (which is the only option for the adjective) and an interpretation equivalent to *become wide*.

In short, Interpretive Economy rules out a telic, 'positive' interpretation of DAs like *widen*, because given the option of a conventionalized, scale-based standard and a contextual, norm-based one, it forces the former to be chosen. What is crucial, though, is the conventional/contextual distinction, rather than the scale/norm distinction per se. The structure of the scale used by a measure function is one aspect of conventional meaning that can be used to fix a standard, but our analysis allows for the possibility that some adjectives/verbs and the measure functions they encode could, as a matter of conventional meaning, identify particular values on their scales as standards of comparison. This, we assume, is what happens in the case of *cool*: in addition to a norm-based meaning that requires its argument to have a temperature below some contextual standard, it has a purely conventionalized meaning along the lines of 'has a stabilized temperature' or 'at

room temperature'. It is the availability of this conventionalized but non-scale based standard that licenses a telic interpretation of *cool*, albeit one that does not entail movement to a scalar maximum, unlike what we see with DAs based on true closed scale adjectives (Kearns 2007).[16]

We conclude the presentation of our analysis by showing how it accounts for examples involving measure phrases like (28a-b), as well as examples with various kinds of degree modifiers such as (29a-b).

(28) a. The soup cooled 17 degrees (in 30 minutes).
b. The gap widened 6 inches (in 1 hour).

(29) a. The basin filled completely/halfway/by one third (in 10 minutes).
b. The basin filled partially/a bit/slightly (??in 10 minutes).

As noted in section 2.1, the fact that examples like (28a-b) are telic is unsurprising given their truth conditions: (29a), for example, entails that the soup undergoes a decrease in temperature of 17 degrees; the event description will fail to hold of subevents in which the soup cools less than this, resulting in a telic interpretation. The question that we need to answer is whether our analysis of DAs fares any better than Abusch's analysis in deriving this meaning.

In particular, recall from the discussion in section 2.1 that examples like (28a-b) posed a problem for Abusch's account because it was not clear how to ensure that the measure phrases are interpreted as differential terms, measuring the change in temperature/width that the affected objects undergo, rather than their 'absolute' temperature/width. Since our semantics of DAs is based on a measure of change function, it avoids this problem (the degrees returned by the measure of change function are differential measures); but it faces another one: how do we compositionally integrate the measure terms into the semantics of the verb?

Our solution to this problem builds on the analysis of measure phrases in Svenonius and Kennedy 2006. According to Svenonius and Kennedy, measure phrases saturate degree arguments that are introduced by a special degree morpheme μ, which combines with a measure function to produce a relation between degrees and individuals, as shown in (30).

(30) $[\![\mu]\!] = \lambda g \in D_{\langle e,d\rangle} \lambda d \lambda x \lambda t . g(x)(t) \succeq d$

On this view, the interpretation of the phrase in (31a) (which by hypothesis contains

[16] The existence of adjectives and verbs like *cool*, which have conventionalized but non-scale based standards, is not unexpected in the general approach to the semantics of the positive form articulated in Kennedy in press, which we have adopted here. That said, such cases appear to be rare: we know of no other adjectives/verbs that are like *cool* in this respect, though presumably there are some.

the degree head μ) is (31b), which is true of an object if its height is at least as great as 2 meters. (Here we assume for simplicity that measure phrases denote degrees, though the analysis is consistent with alternative assumptions in which they are quantifiers over degrees or predicates of degrees.)

(31) a. $[_{\mathrm{DegP}}$ 2 meters μ $[_{\mathrm{A}}$ tall]]
b. $[\![\mu]\!]([\![\text{tall}]\!])([\![\text{2 meters}]\!]) = \lambda x.\textbf{tall}(x) \succeq \textbf{2 meters}$

Svenonius and Kennedy motivate this analysis by showing that it provides a means of accounting for cross-linguistic and language internal restrictions on adjective/measure phrase combinations, via the selectional restrictions on μ. One of the general properties of this morpheme, however, is that it can always combine with difference functions.[17] Since the measure of change functions that underlie DAs on our analysis represent a special type of difference function, the only move we need to make to extend our account to cover examples like those in (28) is to assume that there is a verbal version of μ to go along with the verbal version of **pos** that we posited above, with the denotation in (32).

(32) $[\![\mu_v]\!] = \lambda g \in D_{m_\Delta} \lambda d \lambda x \lambda e.g(x)(e) \succeq d$

Given these assumptions, an example like (28a) will express the event description in (33), which has exactly the properties we want: it is true of an event e if the degree returned by applying the measure of change function $\textbf{cool}_\Delta$ to *the soup* and e, which represents the amount that the soup decreases in temperature as a result of participating in the event, is at least as great as 17 degrees.

(33) $\lambda e.\textbf{cool}_\Delta(\textbf{the soup})(e) \succeq \textbf{17 degrees}$

Finally, the contribution of adverbs such as those in (29) can be incorporated into our analysis if we follow Piñon 2005 and treat these on a par with **pos** and μ, i.e. as degree modifiers that have both 'adjectival' and 'verbal' denotations (so that we can handle *completely/slightly/... full* along with *fill completely/slightly/...*). The denotation assigned to an arbitrary verbal degree modifier mod_v will in general be one that relates the degree returned by applying the measure function encoded by verb to its individual and event arguments to some arbitrary standard determined by the modifier (cf. Kennedy and McNally's (2005) analysis of adjectival degree modifiers). For example, $completely_v$ should have a denotation along the lines of

[17] Svenonius and Kennedy suggest that this is precisely because such functions use scales with (derived) minimal elements. This feature of μ accounts for the fact that cross-linguistically, even languages that do not permit measure phrases with unmarked adjectives (such as we find in the English example in (31a)) do permit them with comparatives, which denote difference functions. See Schwarzschild 2005 for detailed discussion of this point and an alternative analysis.

(34a), where **max** is a function that returns the maximal element of the scale used by its measure function argument, and *slightly*$_v$ should have a denotation like (34b), where **min** returns the minimum value on the measure function's scale and **small** is a context-dependent function that returns a low degree on the scale.

(34) a. $[\![\text{completely}_v]\!] = \lambda g \in D_{m_\Delta} \lambda d \lambda x \lambda e.g(x)(e) = \mathbf{max}(g)$
b. $[\![\text{slightly}_v]\!] = \lambda g \in D_{m_\Delta} \lambda d \lambda x \lambda e.\mathbf{min}(g) \succ g(x)(e) \succeq \mathbf{small}(g)$

Whether a particular adverb results in a telic interpretation or not is dependent on the kind of relation it encodes: given the denotations in (34), *completely*$_v$ *V* will be a telic predicate, while *slightly*$_v$ *V* will be an atelic one, which is exactly what we want.

4 Looking ahead

This paper has presented an analysis of variable telicity in degree achievements that is similar to the analysis originally proposed by Dowty and Abusch (and advocated more recently in a different form by Kearns and Winter) in that it links telicity to the semantic properties of the gradable adjective meanings on which the verbs are based, in particular to the calculation of a standard of comparison. It differs from the Dowty/Abusch analysis in adopting a scalar semantics for gradable adjectives, and it differs from previous scalar analyses in assuming that the adjectival meanings that underlie DAs are measure of change functions, rather than the more general kinds of measure functions involved in (non-comparative) adjectival forms. The latter move allows us to provide an explanation of the relation between the scalar properties of a measure of change function and the telicity of the corresponding DA that is based on exactly the same semantic and pragmatic principles that determine the standard of comparison for an adjectival predicate as a function of the scalar properties of the measure function it encodes, as described in Kennedy (in press).

The account presented here leaves a number of important questions unanswered, however. First, we have said nothing about the morphosyntax of DAs and the larger verbal projections in which they appear, something which should be part of a fully comprehensive analysis. However, it is worth pointing out one interesting morphological property of DAs that our analysis may provide an explanation for. Based on a survey of roughly twenty languages, Bobaljik (2006) has identified the following generalization about the form of DAs (his 'change-of-state verbs'):

(35) If the comparative degree of an adjective is built on a suppletive root, then the basic corresponding change-of-state verb (inchoative or causative) will also be suppletive.

In our analysis, there is a direct link between comparatives and DAs: both are based on difference functions, rather than on the more general measure functions that are involved in (non-comparative) adjectival predications. While it remains to be shown how our semantic analysis connects to a theory of the morphosyntax of adjectives, comparatives, and DAs, the fact that our analysis relates comparatives and DAs in terms of such a basic notion — the kind of measure function they encode — suggests that it can provide the basis for an explanation of Bobaljik's generalization.

Second, although we started out this paper with the broad aim of providing an account of variable telicity in several different classes of verbs — 'classic' incremental theme verbs, verbs of directed motion, and degree achievements — we have thus far only provided a detailed analysis of the latter. It therefore remains to be shown that our proposals will extend to the other classes of verbs as well. In the case of directed motion verbs like *ascend*, *raise* and so forth, we believe that the account we have presented here carries over entirely: such verbs encode measure of change functions over scales that measure directed movement along a path. While they do not always have corresponding adjectival forms, the kinds of meanings they express are identical to the kind of meanings we have described here for verbs directly related to gradable adjectives.

Incremental theme verbs are not so simple. The analysis of the meanings of these verbs proposed by Rappaport Hovav (2006) suggests that many — if not all — of these verbs do not themselves lexicalize a measure of change, but rather the measure of change is introduced compositionally by the objects of these verbs. (This proposal is consistent with Rappaport Hovav and Levin's (2005) study, which shows that these verbs behave differently from change of state verbs, including degree achievements.) Nevertheless, once introduced, the measure of change function will give rise to meanings comparable to those postulated here for degree achievements. Assuming that the referential properties of the arguments that introduce the measure of change function determine the scalar properties of the measure of change function (in the spirit of Krifka 1989, 1992), our account of variable telicity in DAs should carry over directly. Demonstrating that this is the case, and exploring further extensions of our proposals, will be the focus of future work.

In closing, we draw attention to one feature of our analysis of degree achievements that bears on the analysis of verb meaning and verb behavior more generally. Although we have provided a general account of degree achievements, it is one that accommodates differences among the degree achievements that reflect differences in the scale structure of the adjectives themselves. The observation that the meaning of individual lexical items has a part to play in the explanation of their properties is consistent with what Rappaport Hovav and Levin have noticed in other verbal domains: a lexical item's so-called 'root' or 'core' meaning contributes to its be-

havior, though within the behavioral confines defined by the verb's semantic class specific meaning.

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