# Scales in Lexical Decomposition: The Role of the Root

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## 1 Introduction

- What are the building blocks of verb meanings, and how do they compose together?
- A common assumption is that verb meanings consist partly of an "event structure" built from (a) a template of basic eventive predicates (e.g. *v*s; Marantz 1997) and (b) idiosyncratic roots filling in real world meanings (e.g. manner, state; Rappaport Hovav and Levin 1998) (Dowty 1979, Ramchand 2008, Alexiadou et al. 2015, Beavers and Koontz-Garboden 2020).
- Change of state verbs are a classic case study, where the root contributes a state and functional heads form a template introducing (caused) change:

(1) a. John flattened the rug ≈ [$_{v\text{P}}$ John [$_{v'}$ $v_{\text{cause}}$ [$_{v\text{P}}$ the rug [ *-en*$_{v_{\text{become}}}$ $\sqrt{\text{FLAT}}$ ] ] ] ]
b. Kim cracked a vase ≈ [$_{v\text{P}}$ Kim [$_{v'}$ $v_{\text{cause}}$ [$_{v\text{P}}$ a vase [$_{v'}$ $v_{\text{become}}$ $\sqrt{\text{CRACK}}$ ] ] ] ]

- An approach like this explains why words with shared roots entail the same states.
- Yet change of state is nowadays assumed to be scalar, rooted mostly in work on adjectives (e.g. Krifka 1998, Hay et al. 1999, Kennedy and Levin 2008, Rappaport Hovav 2008, Beavers 2008, 2012a, Koontz-Garboden 2010, Beavers and Koontz-Garboden 2020).

(2) a. The road is wide. ≈ The road has an above standard degree of width.
b. The road widened ≈ The road has increased in its degree of width.

- Scales provide a way to analyze a range of lexical aspectual facts:

(3) a. Specific scalar endpoints factor into telicity (Hay et al. 1999, Beavers 2011).
b. Different types of scales lead to variable telicity (Kennedy and Levin 2008).
c. Scalar complexity factors into durativity (Beavers 2008, 2012a).

- On scalar approaches that have decomposed word meanings (qua event structures), the assumption is that the root is a measure function returning a degree (Kennedy 2007), whereas functional heads introduce comparison to the relevant standard that creates a predicate.

(4) a. The road is wide ≈ [ The road is [ *pos* [ *adj* $\sqrt{\text{WIDE}}$ ] ] ]
b. The road widened ≈ [ The road [ $v_{\text{become}}$ $\sqrt{\text{WIDE}}$ ] ]

#1 We suggest based on evidence primarily from sublexical modifiers that (a) roots denote stative predicates (cf. Wellwood 2015) and (b) they contain a notion of comparison in them.

#2 Functional heads clarify the standard of comparison, but do not introduce comparison. They do, however, introduce other forms of comparison, including measures of change and quality.

∴ Altogether, we suggest that traditional event structural approaches can be combined with scalar approaches in ways that preserve the advantages of both.

- This also suggests roots can entail things like comparison that are usually thought to be templatic in nature, as per Beavers and Koontz-Garboden (2020) and Beavers et al. (2021).

## 2 Evidence for Event Decompositions and the Need for Theories of Root Meaning

- We start with a basic description of standard decompositional approaches to change-of-state verbs, where roots are treated as stative predicates and change is the coming about of a state that did not hold before (Dowty 1979). The primary ingredients we need are:

(5) a. $[\![ \sqrt{\text{OPEN}} ]\!] = \lambda x \lambda s[\mathbf{open}'(x, s)]$ ("A state of openness $s$ holds of $x$.")

b. $[\![ v_{\text{become}} ]\!] = \lambda P \lambda x \lambda e \exists s[become'(s, e) \wedge P(x, s)]$
("A state $s$ of type $P$ holds for individudal $x$ and came about in event $e$.")

c. $[\![ v_{\text{cause}} ]\!] = \lambda Q \lambda y \lambda v \exists e[effector'(y, v) \wedge cause'(v, e) \wedge Q(e)]$
("Event $v$ with $y$ as its effector causes an event $e$ of type $Q$.")

- This yields the following for causative and inchoative verbs, capturing the classic fact that by and large the causative entails the inchoative:

(6) a. The door opened. $[\![ [_{vP}$ the door $[_{v'}\ v_{\text{become}}$ [ $\sqrt{\text{OPEN}}$ ] ] ]$]\!]$
$= \exists e \exists s[become'(s, e) \wedge \mathbf{open}'(\mathbf{door}', s)]$

b. Kim opened the door. $[\![ [_{vP}$ Kim $[_{v'}\ v_{\text{cause}}$ $[_{vP}$ the door $[_{v'}\ v_{\text{become}}$ [ $\sqrt{\text{OPEN}}$ ] ] ] ] ]$]\!]$
$= \exists v \exists e[effector'(\mathbf{kim}', v) \wedge cause'(v, e) \wedge \exists s[become'(s, e) \wedge \mathbf{open}'(\mathbf{door}', s)]]$

- Further support comes from sublexical modifiers like *again* (also *for an hour* and *too*). Such modifiers generally can apply to any stative or eventive predicate:

(7) Kim loved peanuts again/smelled bad again/sneezed again/cried again.

- This suggests a very general analysis of *again* as taking any eventuality-denoting predicate and asserting it now while presupposing it held at a previous time as well:

(8) $[\![ \text{again} ]\!] = \lambda P \lambda z \lambda e'''[P(z, e''') \wedge \partial \exists e''[e'' \ll e''' \wedge P(z, e'')]]$

- If the roots of change-of-state verbs are stative predicates and the combinations with *v* are eventive predicates then we derive the possibility of a scopal ambiguity with *again*.

(9) John flattened the rug again.

a. $[_{vP}$ John $[_{v'}\ v_{\text{cause}}$ $[_{vP}$ the rug [ $v_{\text{become}}$ [ $\sqrt{\text{FLAT}}$ again ] ] ] ] ] (restitutive)

b. [ $[_{vP}$ John $[_{v'}\ v_{\text{cause}}$ $[_{vP}$ the rug [ $v_{\text{become}}$ $\sqrt{\text{FLAT}}$ ] ] ] ] again ] (repetitive)

- Thus classic decompositions make predictions about entailment and sublexical modification.

## 3 Measure Functions in Adjectives and Verbs

- Scalar approaches to change, though, have largely rejected the notion of that the roots of change-of-state verbs are stative.

- Instead, roots are treated as measure functions returning degree $d$ theme $x$ holds of property $\delta$ at some time/state (10a). Higher heads introduce comparison (Kennedy 2007, Kennedy and Levin 2008), e.g. *pos* compares $d$ to $\delta$'s "positive standard" ( $\boldsymbol{\delta}_P$ = $P$'s dimension):

(10) a. $[\![ \sqrt{\text{FLAT}} ]\!] = \lambda x \lambda s[\mathbf{flat}'(x, s)]$ (returns degree, *not* truth value)

b. $[\![ pos ]\!] = \lambda P \lambda x \lambda s[P(x, s) \geq \mathbf{stnd}'_{\mathbf{pos}}(\boldsymbol{\delta}_P)]$

c. $[\![ \text{flat}_{\text{adj}} ]\!] = [\![$ [ *pos* [ *adj* $\sqrt{\text{FLAT}}$ ] ] $]\!] = \lambda x \lambda s[\mathbf{flat}'(x, s) \geq \mathbf{stnd}'_{\mathbf{pos}}(\text{FLATNESS})]$

- Different scales yield different positive standards owing to Interpretive Economy ("Maximize the contribution of the conventional meanings of the elements of a sentence to the computation of its truth conditions") (Kennedy 2007: 36):

(11) a. The rod is straight. (max endpoint adjective: standard is max)
b. The towel is wet. (min endpoint adjective: standard is min)
c. The road is wide. (open adjective: standard is from pragmatic context)

- Kennedy and Levin (2008) extend this to verb meanings. There are two conditions to be accounted for. First, the final degree must be higher than the initial degree, i.e. change occurs:

(12) a. #She straightened the rod, but it's just as straight as/curvier than before.
b. #She wet the towel, but it's just as wet/drier than before
c. #They widened the road, but it's just as wide/narrower than before.

- Second, unless context intervenes the final degree depends partly on scale type (Kennedy and Levin 2008: 168-170), though in a way distinct from how it is determined by adjectives:

(13) a. She straightened the rod. (max endpoint: final degree is max or above initial)
b. She wet the towel. (min endpoint: final degree is min or above initial)
c. They widened the road. (final degree is above initial degree)

- We call this the "verbal standard". Kennedy and Levin define the root as a measure of change function returning the degree of increase, effectively creating a minimal endpoint scale.

- For maximal endpoint scales the lexical maximum can serve as the default; for all other scales the theme's initial degree is the minimum, defaulting to that. Telic readings draw out a (lexical or contextual) maximum reading, atelic readings a minimum reading:

(14) a. Kim straightened the rod in/(?)for ten minutes. (telic = max, atelic = min)
b. Kim cooled the rod for/?in ten minutes. (atelic = min, telic = conextual max)

- In sum, the (final) state is of holding a degree at or above some standard determined by scale type, word category, and context, with a measure function as the core, not a stative predicate.

- The advantage here is a more fine-grained analysis of how verb and adjective meanings relate, and of how aspectual factors like telicity are calculated.

- Are stative and measure function analyses of verb meaning compatible?

## 4 Problems with a Decompositional Measure Function Analysis

#1 But a dangling issue is how to handle sublexical modifiers scoping over roots:

(15) Kim opened the door again (and it had been open before).
[$_{vP}$ Kim [$_{v'}$ $v_{\text{cause}}$ [$_{vP}$ the door [$_{v'}$ $v_{\text{become}}$ [ $\sqrt{\text{OPEN}}$ again ] ] ] ] ]

- If roots were measure functions, the lowest attachment site for *again* would be $v_{\text{become}}{}'$, requiring a repetitive reading, contra §2.

#2 We could posit a special *again* returning the degree $x$ holds now, presupposing it held before.

(16) $[\![\text{again}]\!] = \lambda P[P]$, Presupposition: $\forall s \forall x \exists s' \ll s[P(x, s) = P(x, s')]$

- However, the current and prior degrees can differ, arguing against this alternative:

(17) She widened the road again — it was built 20′, got narrowed to 15′, and now it's 30′.

#3 We could say the root is a stative predicate that says theme $x$ holds some degree $d$ on the scale in state $s$, and assume higher heads introduce comparison to the standard:

(18) $[\![\sqrt{\text{OPEN}}]\!] = \lambda x \lambda s \exists d[\mathbf{open}'(x, s) = d]$

- However, comparison must be under *again*. If roads must be 50′ wide to be deemed wide and Kim's job is to ensure wideness, on a telic reading (19) means the road ends up 50′.

(19) [ The road was built 30′ wide. Kim made it 50′ wide in one day. ]
Kim widened the road in a single day.

- Here restitutive modification requires the contextual standard to be met twice:

(20) [ The road was built 50′ wide, but got narrowed. Kim made it 50′ in one day. ]
#[ The road was built 30′ wide, but got narrowed. Kim made it 50′ in one day. ]
Kim widened the road again in a single day.

- Even on restitutive readings comparison to a standard is under *again*, and thus in the root.

#4 With a maximal scale and telic reading the default restitutive comparison is to the maximum:

(21) She straightened the rod again in five minutes, #but it never was straight.

- But with open scale roots the comparison could be to a prior degree that isn't the positive standard (cp. deadjectival verbs do not in entail "become Adj"; Kennedy and Levin 2008):

(22) [ A road is built too narrow, and somehow gets narrowed even more. Sandy's job is to restore it to its previous width, albeit it's still too narrow. ]
Sandy widened the road again in a single day, but it never has been wide.

- Thus the comparison under *again* is to the verbal standard, not the positive standard.

#5 But with adjectives it's the positive standard under *again*:

(23) The road is wide again. ≈ The road is and was above standard width.

- So the standard in the root isn't the verbal or positive standard.

| Roots introduce comparison to something, *but not any specific standard*. The actual standard instead comes from the word category, the scale, and context. |
|---|

## 5 Fitting a Scalar Analysis on a Decompositional Approach

- We propose that roots are stative predicates that introduce comparison but *not* a specific standard, building on and expanding the analysis of scalar change in event structures in Beavers and Koontz-Garboden (2020: 35-48).

- In particular, roots introduce comparison to a patient/scale-specific standard $\mathbf{d}_x^{\delta}$:

  (24) $[\![ \sqrt{\text{WIDE}} ]\!] = \lambda x \lambda s \exists d[\mathbf{wide}'(x, s) = d \wedge d \geq \mathbf{d}_x^{\text{WIDTH}}]$

- *pos* introduces the positive standard by setting the root-supplied standard equal to the positive standard (where $\mathbf{d}_x^{\boldsymbol{\delta}_P}$ for scalar stative predicate $P$ is its standard $\mathbf{d}_x^{\delta}$):

  (25) $[\![ \textit{pos} ]\!] = \lambda P \lambda x \lambda s[P(x, s) \wedge \mathbf{d}_x^{\boldsymbol{\delta}_P} = \mathbf{stnd}'_{\mathbf{pos}}(\boldsymbol{\delta}_P)]$

- Applying (25) to *wide* and taking a patient and $\exists$-binding $s$ produces the following, where the ultimate interpretation depends on how we interpret the positive standard (see e.g. (11)).

  (26) $[\![$ [ The road is [ *pos* [ *adj* $\sqrt{\text{WIDE}}$ ] ] ] $]\!]$ ("The road is wide")
  $= \exists s[\exists d[\mathbf{wide}'(\mathbf{road}', s) = d \wedge d \geq \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}}] \wedge \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}} = \mathbf{stnd}'_{\mathbf{pos}}(\text{WIDTH})]$
  "There is a state $s$ in which the road holds a degree $d$ of WIDTH at or above the positive standard for WIDTH."

- Alternatively, a comparative head (e.g. $\mu$ of Kennedy and Levin 2008: 180) can apply instead of *pos*, setting the standard as the degree $d'$ of the thing(s) the patient is being compared to:

  (27) $[\![ \mu ]\!] = \lambda P \lambda d' \lambda x \lambda s[P(x, s) \wedge \mathbf{d}_x^{\boldsymbol{\delta}_P} = d']$

- We assume *-er/more* must apply to interpret $d'$, either through a selected *than* PP argument (which we assume only *-er/more* takes syntactically) or a contextually defined open variable $\mathbf{d_c}$ (assuming PPs return degrees based on elliptical structures; see e.g. Wellwood 2015).

  (28) a. $[\![ \textit{-er/more}_1 ]\!] = \lambda P \lambda x \lambda s[P(x, \mathbf{d_c}, s)]$ (contextually defines $d'$)
  b. $[\![ \textit{-er/more}_2 ]\!] = \lambda P \lambda d' \lambda x \lambda s[P(x, d', s)]$ (saturates $d'$)

  (29) a. $[\![$ [ the road is [ *-er*$_1$ [ $\mu$ [ *adj* $\sqrt{\text{WIDE}}$ ] ] ] ] $]\!]$ ("The road is wider")
  $= \exists s[\exists d[\mathbf{wide}'(\mathbf{road}', s) = d \wedge d \geq \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}}] \wedge \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}} = \mathbf{d_c}]$
  b. $[\![$ [ the road is [ [ *-er*$_2$ [ $\mu$ [ *adj* $\sqrt{\text{WIDE}}$ ] ] ] than the field ] ] $]\!]$
  $= \lambda x \lambda s[\exists d[\mathbf{wide}'(\mathbf{road}', s) = d \wedge d \geq \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}}] \wedge \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}} = \mathbf{width\text{-}of\text{-}field}']$

- Roots do not take such PPs, ruling out comparative readings (though see §10).

- For verbs, $v_{\text{become}}$ ensures there is an event of change at the end of which the theme holds a degree above the root-supplied standard and at the beginning it held a degree below it, where the root-supplied standard is in turn defined as the verbal standard. Thus $v_{\text{become}}$:

  (30) a. introduces an event $e$ of the coming about of $s$,
  b. takes root $P$ and sets $P$'s standard at or above the verbal standard,
  c. sets $x$'s $\exists$-bound initial degree $d_i$ below the standard,
  d. and introduces an open difference degree threshhold argument $d_d$ for $d_f$ - $d_i$

  (31) $[\![ v_{\text{become}} ]\!] = \lambda P \lambda d_d \lambda x \lambda e \exists s \exists d_f \exists d_i[[become'(e, s)] \wedge [P(x, s) \wedge \mathbf{d}_x^{\boldsymbol{\delta}_P} \geq \mathbf{stnd}'_{\mathbf{V}}(\boldsymbol{\delta}_P)] \wedge [\mathbf{R}'_P(x, init(e)) = d_i \wedge \mathbf{d}_x^{\boldsymbol{\delta}_P} > d_i] \wedge [\mathbf{R}'_P(x, s) = d_f \wedge d_f \text{ - } d_i \geq d_d]]$
  (where $init$ is the intial state of $e$ and $\mathbf{R}'_P$ is $P$'s measure function)

- Since $v_{\text{become}}$ entails $d_f$ is at or above the root-supplied standard and $d_i$ is below it it follows that $\mathbf{d}_f > d_i$, i.e. a change occurred. The root-supplied standard is in turn equated with the verbal standard, giving rise to the various readings discussed above (e.g. (13)).

(32) $[\![$ [ $v_{\text{become}}$ $\sqrt{\text{WIDE}}$ ] $]\!]$ = $\lambda d_d \lambda x \lambda e \exists s \exists d_f \exists d_i [[become'(e,s)] \wedge [\exists d[\mathbf{wide}'(x,s) = d \wedge d \geq \mathbf{d}_x^{\text{WIDTH}}] \wedge \mathbf{d}_x^{\text{WIDTH}} \geq \mathbf{stnd}'_{\mathbf{V}}(\text{WIDTH})] \wedge [\mathbf{wide}'(x, init(e)) = d_i \wedge \mathbf{d}_x^{\text{WIDTH}} > d_i] \wedge [\mathbf{wide}'(x,s) = d_f \wedge d_f \text{ - } d_i \geq d_d]]$

- *-er/more (PP)* must apply just as above to deal with the difference value, though *-er* we assume is $\emptyset$ with no PP and *more* with a PP in the verbal domain (agreeing with Wellwood 2015 that the structure of comparison is the same across categories):

(33) a. $[\![$ [ $\emptyset$/*more*$_1$ [ $v_{\text{become}}$ $\sqrt{\text{WIDE}}$ ] ] $]\!]$ = $\lambda x \lambda e \exists s \exists d_f \exists d_i [[become'(e,s)] \wedge [\exists d[\mathbf{wide}'(x,s) = d \wedge d \geq \mathbf{d}_x^{\text{WIDTH}}] \wedge \mathbf{d}_x^{\text{WIDTH}} \geq \mathbf{stnd}'_{\mathbf{V}}(\text{WIDTH})] \wedge [\mathbf{wide}'(x, init(e)) = d_i \wedge \mathbf{d}_x^{\text{WIDTH}} > d_i] \wedge [\mathbf{wide}'(x,s) = d_f \wedge d_f \text{ - } d_i \geq \mathbf{d_c}]]$

b. $[\![$ [ [ *more*$_2$ [ $v_{\text{become}}$ $\sqrt{\text{WIDE}}$ ] ] than the field ] $]\!]$
= $\lambda x \lambda e \exists s \exists d_f \exists d_i [[become'(e,s)] \wedge [\exists d[\mathbf{wide}'(x,s) = d \wedge d \geq \mathbf{d}_x^{\text{WIDTH}}] \wedge \mathbf{d}_x^{\text{WIDTH}} \geq \mathbf{stnd}'_{\mathbf{V}}(\text{WIDTH})] \wedge [\mathbf{wide}'(x, init(e)) = d_i \wedge \mathbf{d}_x^{\text{WIDTH}} > d_i] \wedge [\mathbf{wide}'(x,s) = d_f \wedge d_f \text{ - } d_i \geq \mathbf{change\text{-}in\text{-}field}']]$

- Applied to a patient, with the event bound, produces (34) (for the case without a *than* PP).

(34) $[\![$ [ the road [ $\emptyset$/more$_1$ [ $v_{\text{become}}$ $\sqrt{\text{WIDE}}$ ] ] ] $]\!]$ ("The road widened (more)")
= $\exists e \exists s \exists d_f \exists d_i [[become'(e,s)] \wedge [\exists d[\mathbf{wide}'(\mathbf{road}', s) = d \wedge d \geq \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}}] \wedge \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}} \geq \mathbf{stnd}'_{\mathbf{V}}(\text{WIDTH})] \wedge [\mathbf{wide}'(\mathbf{road}', init(e)) = d_i \wedge \mathbf{d}_{\mathbf{road}'}^{\text{WIDTH}} > d_i] \wedge [\mathbf{wide}'(\mathbf{road}', s) = d_f \wedge d_f \text{ - } d_i \geq \mathbf{d_c}]]$
$\approx$ "There is an event $e$ in which the road goes from holding some degree $d_i$ of WIDTH below the verbal standard for WIDTH to some degree $d_f$ of WIDTH above the verbal standard, forming a difference of at least $\mathbf{d_c}$ degrees between the two degrees."

- Finally, this analysis captures the *again* facts when *again* scopes over the root:

(35) $[\![$ [ $\sqrt{\text{WIDE}}$ again ] $]\!]$ = $\lambda z \lambda e''' [\exists d[\mathbf{wide}'(z, e''') = d \wedge d \geq d_z^{\text{WIDTH}}] \wedge \partial \exists s' [s' \ll s \wedge \exists d[\mathbf{wide}'(z, e'') = d \wedge d \geq d_z^{\text{WIDTH}}]]]$

- This ensures the theme now and before held a degree above the root-supplied standard, which *adj* will fill in as the positive standard and $v_{\text{become}}$ as the verbal standard.

## 6 Incrementality in Change of State

- Above we assumed a $become'$ predicate as part of the logical denotation of $v_{\text{become}}$. But since, as usual on scalar analysis, $v_{\text{become}}$ introduces a change from not being above the standard to being above it, do we need $become'$?

- Comparison to standards alone is sufficient to predict some facts about change-of-state verbs. For example, as Kennedy and Levin (2008) note maximal endpoint scalar predicates default to telic readings and open scale predicates to atelic readings:

(36) a. Sally straightened the rod in/(?)for an hour.

b. Sally widened the opening for/?in an hour.

- But it is also known that sometimes patient expression can figure into telicity, most famously noted for predicates of consumption and creation (Krifka 1989, Dowty 1991, Tenny 1992):

  (37) a. Sally drank a glass of wine in/?for an hour.
  b. Sally drank wine for/??in an hour.

- A standard analysis (e.g. Krifka 1989) is that the theme's quantity measures the progress of the event: knowing the quantity of the one tells you the quantity of the other. Crucially, this holds for *all* change predicates (see Beavers 2012a):

  (38) a. Sally straightened rods for/??in an hour.
  b. Sally widened openings for/??in an hour.

- Scales and themes also figure into durativity: gradability of scales and/or mereological complexity of themes (at least as conceived in context) are required for durative readings (Beavers 2012a), using ambiguity of *in an hour* modifiers as a test for durativity (Kearns 2000):

  (39) a. The drop of soup will cool from 0.1°C to 0.0°C in an hour. (*after*)
  b. The drop of soup will cool from 100.0°C to 0.0°C in an hour. (*during/after*)
  c. Six bowls of soup will cool from 0.1°C to 0.0°C in an hour. (*during/after*)
  d. Six bowls of soup will cool from 100.0°C to 0.0°C in an hour. (*during/after*)

- Beavers (2012a) subsumes all of these facts under a single analysis wherein change is reaching the scalar standard through incremental progress wherein various parts of the theme traverse the scale from their initial to final degrees as a type of metaphorical movement:

  (40) **Figure/Path Relation:** An event $e$, patient $x$, and continuous, ordered set of degrees $S$ on some dimension $\delta$ stand in a Figure/Path Relation (FPR) iff every unique part $x' \leq x$ corresponds to a unique subevent $e' \leq e$, the sum of all such subevents constitutes $e$, and each $e'$ stands in a Movement Relation (Krifka 1998) with a continuous subset $S' \subseteq S$, where $S'$ includes $x'$'s initial degree of $\delta$ in $e'$ and where the maximal degree in $S'$ is $x'$'s final degree of $\delta$ in $e'$.

- Thus when a quantity of soup cools, different bits of it head from their initial temperatures to their final temperatures along the ordered scale, perhaps going up and down a bit in temperature, until all of it settles on its final degree, and the event is measured by this progress.

- Telicity requires specificity of theme quantity *and* the upper boundary on the scale.

- We can define $become'$ as introducing incrementality, with the rest of the meaning of $v_{\text{become}}$ delimiting the scalar endpoints (where $\boldsymbol{\delta}_s$ is the dimension of state $s$, $\mathbf{S}_s$ the set of degrees of $s$, and $\mathbf{d}_{\mathbf{x}}^{\boldsymbol{\delta}_s}$ is the degree asserted of some patient $x$ on $\boldsymbol{\delta}$ in state $s$):

  (41) for all $e, s, x$ where $x$ is the patient of $e$, $become'(s, e)$ is true iff $s$ holds at the end of $e$ and $e$ is FPR-related to $\mathbf{x}$ and the continuous, ordered set of degrees $S' \subseteq \mathbf{S}_s$ of $\boldsymbol{\delta}_s$ containing $\mathbf{d}_{\mathbf{x}}^{\boldsymbol{\delta}_{init'(e)}}$ and whose maximal degree is $\mathbf{d}_{\mathbf{x}}^{\boldsymbol{\delta}_s}$.

$\therefore$ Thus we need measured progress as part of the analysis of $v_{\text{become}}$, further showing that (a) degrees are not sufficient to capture everything about the aspectual properties of change and (b) we need something like $v_{\text{become}}$ to introduce measured change, since roots alone do not.

## 7 Scales and Comparison in Causative Heads

- So far, $v_{\text{become}}$ introduces comparison between difference values via an open difference variable, but also disallows targeting the absolute degree of the root, which is inaccessible.
- It turns out $v_{\text{cause}}$ also seems to introduce comparison of degrees of prototypicality or quality, modelable on a scale following Kennedy and McNally (2010) and Bochnak (2010, 2013).
- Consider the following context and associated sentence:

(42) [ You and I both have glasses of water; mine is an insulated cup and yours is a regular glass cup. I stick mine in the microwave, and then I stick yours in the microwave one minute later, and they finish microwaving at the same time. When I take both out, mine is cooler than yours because of the insulated cup. ]

a. I heated up my drink more than yours, but your drink didn't heat up more than mine.

b. I heated up my drink more than yours, but my cup went up by 3°C and yours went up by 4°C.

- This seeming contradiction would only be possible if the causative *heat* introduces a property distinct from the difference value introduced by the inchoative.
- This is the 'goodness' of the heating, e.g. how long or how effective the event is, and *more* is asserting a greater-than ordering between the prototypicality of two events.
- This could be accommodated with an analysis of $v_{\text{cause}}$ as follows that applies a state of the larger event having a certain quality compared to a comparison $d'$:

(43) $[\![ v_{\text{cause}} ]\!] = \lambda P \lambda d' \lambda y \lambda v \exists e[\mathit{effector}'(y, v) \wedge \mathit{cause}'(v, e) \wedge P(e) \wedge \exists d \exists s[\mathbf{quality}'(v \oplus e, s) = d \wedge d \geq d']]$

- Comparative heads as above can introduce a *than* PP targeting quality degrees to which individuals underwent changes or eliminate the argument for contextual interpretation.
- Importantly, introducing a comparison between degrees of prototypicality does not render the difference degree opaque to modification, and as such can still be targeted by *than* PPs:

(44) [ You and I both have pots of water, but the water in my pot is 10°C and the water in yours is 20°C. We put both in ovens heated to 90°C, and after an hour we check and the water in both is 90°C. ]
I heated up my water more than yours, because mine warmed up by 80°C and yours warmed up by 70°C.

- Here there's not obviously a prototypicality difference, but there's still a difference in difference degrees. So causatives allow both difference degree and quality comparison — exactly as expected since the causative embeds the inchoative on a decompositional analysis.

## 8 Comparison in Adjectives and Verbs

- Our analysis derives the inchoative verb directly from the root. However, an alternative analysis could be that the inchoative verb is deadjectival, and thus is derived from an adjectival base (cf. Bobaljik 2012).

- The adjective expresses the absolute property degree which holds of its argument. This degree is compared to a property standard in the case of a positive adjective, or the degree of the argument of a *than* phrase in the case of a comparative adjective.

- Under such an analysis, the inchoative verb would embed an adjective. This analysis would specifically predict that the semantics of an adjective would be embedded in the semantics of an inchoative verb. Specifically, the property degree should be accessible.

#1 Combining *more/-er* with an adjective expresses that the absolute property degree of the subject is greater than that of the DP argument of the *than* phrase.

(45) The river is wider than the road. ≈ The degree of width of the river is greater than the degree of width of the road.

- If change of state were introduced directly over a comparative adjective, then change semantics would be predicated over the absolute property comparison. Thus, the reading for (46) should be one where the river became wider than the road, entailing (45), contrary to fact:

(46) The river widened more than the road (but the river was not wider than the road).

#2 Instead, *more* in inchoatives targets a difference value of how much change occurred (Hay et al. 1999), asserting it is greater than that of the *than* DP, a contradiction if this is not so:

(47) #The river widened more than the road. The river increased by $3'$ and the road by $4'$.

- Specifically, *more* with an inchoative cannot target the property degree, instead requiring a separate resultative construction with *to*.

(48) a. The river widened more than 12 feet. $\not\approx$ The river increased in wideness and ended up 12 feet wide.

b. The river widened (more than the road) to 12 feet. ≈ The amount the river increased in width (more than the amount the road increased in width) and ended up 12 feet wide.

∴ This felicity pattern indicates that (a) change-of-state verbs are not built on comparatives semantically and (b) the presence of a higher comparison means there is no access to the property standard associated with adjectives.

- Thus, among the three possible types of comparison – absolute property, difference degree, and quality – only the latter two, the verbal comparisons, can exist within the same structure. They are mutually exclusive with the adjectival comparison, easily captured if nothing like a comparative adjective underlies change-of-state verbs.

## 9 Subject-oriented Comparison

- Borer (1991) and Kastner (2018) have argued for the adjectival nature of comparison by suggesting that at least some PC root verbs are deadjectival.
- In particular, they show an asymmetry in the interpretation of *like* modifiers. *Like* PPs can compare properties with adjectives or manners with activities:

  (49) a. John runs like a dog.
  b. His muscles are hard like cement.

- Inchoatives allow both manner and property comparison, but causatives just manner:

  (50) a. John reddened like a tomato.
  (means: John became red to the degree a tomato is red.)
  (also means: John became red the same way a tomato becomes red.)
  b. John reddened his face like a tomato.
  (means: John made his face red the same way a tomato becomes red.)
  (cannot mean: John made his face red to the degree a tomato is red.)

- Because (49b) has the property reading, Borer and Kastner claim it underlies all cases where the property reading is available. Thus the inchoative is deadjectival but not the causative.
- However, the facts in (50) can be successfully captured with an analysis of *like* as just a quality-modifying term. Quality scales in Kennedy and McNally (2010) were introduced to distinguish between chromatic and intensity readings of color terms like *red*.
  - Chromatic readings (e.g. *red* vs. *green*) are instances of predicating over a quality scale, as the redness of the entity is being measured relative to a prototypical concept of red.
  - Intensity readings (e.g. *more red* vs. *less red*) are instances of predicating over a property scale, e.g. measuring how much of the color the entity has.
- The reading for *redden* in (50a) is actually a chromatic reading, not an intensity reading, as *tomato* provides a chromatic standard for redness against which John is being compared. That is, the paraphrase is 'John reddened to the particular hue of red a tomato has.'
- Thus it is felicitous to assert chromatic equivalency with *like* and deny intensity equivalency:

  (51) John reddened like a tomato, but his face was still less red than (a nice, ripe) one.

- This effect can be seen with non-color terms, e.g. *harden* equivalent to *hard* in (49b).

  (52) His muscles hardened like cement, but were still less hard than some (cement).

- Thus, *like* can be given a denotation as in (53), where it independently compares the quality of participant of the event which it is modifying in the relevant state to that of its argument.

  (53) $[\![\textit{like}]\!] = \lambda x \lambda P \lambda y \lambda e[P(y,e) \wedge \exists s \exists s' \exists e'[participant'(e',x) \wedge \mathbf{quality}'(e,s) \geq \mathbf{quality}'(e',s')]]$

- Furthermore, *like* mandatorily attaches high, after comparative morphology but before the surface subject, and thus will always predicate over the highest event of which the surface subject will always be the participant.
  - In an inchoative with just $v_{\text{become}}$ this is the patient, and thus the prototypicality is of the change-of-state event. Because this is tied intrinsically to the state, both manner quality and property quality readings are possible.
  - In an causative with $v_{\text{cause}}$ this is an agent, and because $v_{\text{cause}}$ is already asserts something about the quality of the causing event, **quality** in like is similarly constrained in its dimension of measurement. As such, property quality readings are excluded.
- The presence or absence of a property reading comes from the interaction of high attachment of *like* and the constraints placed on the interpretation of prototypicality by the verb.

$\therefore$ The data in (50) do not hinge on a structural asymmetry, i.e. presence/absence of an adjective. It emerges from independent properties of the components of the verb and its modifiers.

## 10 Root Licensed Degree Modification?

- So far, roots introduce comparison, while functional heads introduce standards and access to degrees for comparative expression. Could resultatives be root-licensed degree expressions?

  (54) Mary opened the door wide.

- Here *wide* indicates the final degree, which is supposedly in the root meaning (e.g. $d$ in (24)).
- It is beyond our scope to provide an account of resultatives, not least because they are known to come in a wide range of types that may not all be the same construction (see e.g. Wechsler 1997, Rappaport Hovav and Levin 2001, Goldberg and Jackendoff 2004, Kratzer 2004) and are subject to a variety of scalar semantic and aspectual constraints on possible combinations (see e.g. Wechsler 2005, Beavers 2008) (see Beavers 2012b for an overview).
- However, it is unlikely that roots are providing access to the final degree here *per se*:
  - Overt degree phrases are possible with some adjectives, but the reading is a current degree with positive adjectives but a difference with comparatives:

    (55) a. The rod is $10'$ long $\approx$ The rod has a length of $10'$
    b. The rod is $10'$ longer $\approx$ The rod is longer (than something) by $10'$
  - This suggests that access to degrees is governed by functional heads, not roots.
  - Resultative modifiers are quite unique and specific to verbal constructions, allowing AdjP, PP, and NP result states that rarely occur absent verbal structure context:

    (56)

| **resultative** | **deverbal adjective** | **simple adjective** |
|---|---|---|
| sharpen $x$ to a point | $x$ is sharpened to a point | *$x$ is sharp to a point |
| lengthen $x$ to $10'$ | $x$ is lengthened to $10'$ | *$x$ is long to $10'$ |
| smooth $x$ flat | $x$ is smoothed flat | *$x$ is smooth flat |
| break $x$ open | $x$ is broken open | N/A |
| open $x$ wide | $x$ is opened wide | $x$ is open wide |

- Whatever resultatives are, they are clearly only productively licensed in verbal contexts, and thus verbal templatic structure must play a role, licensing access to the root's final degree.

## 11 Conclusion

- A scalar analysis of change is possible in a decompositional approach, but classic aspects of decompositional such as sublexical scope give us insights into how best to integrate scales.
- Roots introduce absolute degree comparison, but standards and degree accessibility come from functional heads (see also Bochnak et al. 2020). Different templatic levels introduce different notions of scalarity, including difference degrees for $v_{\text{become}}$ and quality for $v_{\text{cause}}$.

(57)

| **head** | **introduces comparison** | **standard expressable by *than*** |
|---|---|---|
| $\sqrt{\text{ROOT}}$ | to generic standard | no |
| *adj* | no | no |
| *pos* | no (but sets positive standard) | no |
| $\mu$ | no (but sets comparative standard) | yes (comparative standard) |
| $v_{\text{become}}$ | to difference degree (and sets verbal standard) | yes (difference degree) |
| $v_{\text{cause}}$ | to quality degree | yes (quality degree) |

- An alternative might decompose the semantics of our ultimate root forms into smaller heads (perhaps like Wellwood 2015) below category heads, but the results would be equivalent.
- Analyses that build truly adjectival meaning into verbs though seem not to be correct — rather, a more stripped down core of unspecified comparison is shared between adjectives and verbs, which are thus derived equipollently despite their surface morphology.
- The resulting picture, then, is that we need standard decompositional analyses built around stative roots, but the root meanings have to be much more complex than standardly assumed.
- More specifically, from (57) we see that the types of meanings roots and templates introduce in building scalar comparisons overlap quite a bit.
- This is in line with the results of Beavers and Koontz-Garboden (2020) and Beavers et al. (2021), who show that canonically templatic notions such as change, causation, and possession can be introduced by either roots or templates (contra e.g. Embick 2009, Dunbar and Wellwood 2016). Comparison is another one of those shared notions.
- Yet the results here suggest that templates are still needed even if they are not semantically unique: what degrees are modifiable, where attachment points are available for sublexical modifiers, and certain cases of regular addition of meaning (setting standards, introducing incrementality and causation) seem to require them.

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