Argument structure & affectedness: Reversative *un-* & cyclic *re-* at the morphosyntax-semantics interface

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1 Introduction

The complexities of morphological decomposition often reveal very significant information about larger questions relating to event structure, aspectual distinctions, and argument structure in affixation.[1]

My focus in studying these complexities: the English prefixes *un-* and *re-*.[2]

Un- has two main lives – adjectival and verbal, with very different interpretations (Horn 1988).

(1) *un-* + *lock* (V.) = *unlock* (V.) = the action of reversing a previous action of locking

reversative *un-*

(2) *un-* + *happy* (Adj.) = *unhappy* (Adj.) = the property of lacking the property of happiness

privative *un-*

Privative *un-* is equivalent to logical negation (Parsons 1990, Kratzer 2000, Horn 2005, Joshi 2012, De Clercq and Vanden Wyngaerd 2017).

[1] Thanks to the Syntax-Semantics Reading Group at the University of Minnesota (especially to Jean-Philippe Marcotte), to Arka Banerjee, and to two anonymous abstract reviewers in the past, for helpful comments.

[2] All judgements in this paper have been confirmed with 4 English native speakers, and have been corroborated with online searches on www.onelook.com; Mirriam Webster's results have been prioritized, while a Wiktionary with no examples have not been.

Reversative *un-* and privative *un-* have distinct etymologies and thus, distinct lexical representations (Jespersen 1917, Marchand 1960, Dowty 1979, Covington 1981, Thomas 1983, Horn 2002).

Reversative *un-* is very selective in the verbs it affixes to:

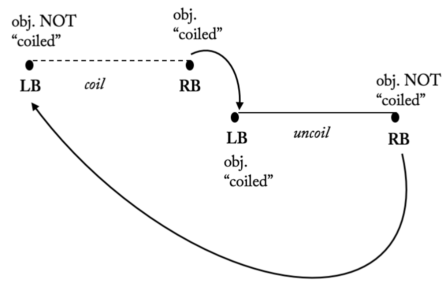
(3) a. John *unfolded* the shirt.

b. The DOJ agreed to *unfreeze* the company's assets.

c. *Usain Bolt *unran* 10 miles.

d. *Pollock *unpainted* a picture.

What does reversative *un-* denote?



(4) Two conditions need to hold for the successful derivation of an *un*-verb:
– the **result state**/Right Boundary of the BASE action is equivalent to the **initial state**/Left Boundary of the object when the *un*-verb commences.
– The **result state** of the object due to the action of the *un*-verb is equivalent in some salient way to the **initial state** of the object before the action of the BASE verb.

The prefix *re-* has also been argued to be sensitive to the outcome of the BASE verb.

(5) a. John rebuilt the house.

b. John restarted a car.

c. *John remasked his feelings.

d. *John reasked his question.

What does *re-* denote?

The answer to this question has been divided, especially in direct comparison with the adverb *again*:

(6) a. The court opened a case **again**.

b. The court **reopened** a case.

On the surface, they seem interchangeable, where there is a repeated occurrence of some event.

However, *again* (and its cross-linguistic counterparts) have a range of interpretations:

(7) a. repetitive: The *action* of opening happened again.

b. restitutive: The *state* of being open was restored.

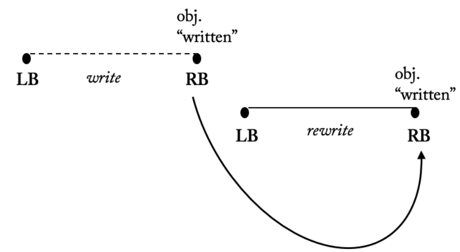
c. counterdirectional[3]: The state of being open occurred, followed by closing, followed by an opening.

Marchand (1960), Dowty (1979), Keyser and Roeper (1992), Williams (2006), Marantz (2007), Beck et al. (2009), Alexiadou et al. (2014), Csirmaz and Slade (2016), Blackham (2017), Stockall et al. (2019) – have widely argued that *re-* only has a restitutive interpretation.

Contrasting view: Lieber (2004), who argues *re-* is purely repetitive, and not restitutive.

I concur with the restitutive view but use the neutral term 'cyclic' to describe *re-* in order to discuss *re-* without a stance.

A purely restitutive meaning then restores the result state of the BASE verb:



(8) One condition needs to hold for the successful derivation of a *re*-verb:
– the **result state** of the *re*-verb's action is equivalent in some

[3]Old English had this interpretation of *again* which has since been lost (Beck 2005, Gergel and Beck 2015, Blackham 2017).

salient way to the **result state** of the BASE verb's action

What properties of verb roots are these affixes sensitive to?

un-:

- ∗ with 'non-resultative, durative verbs'; e.g. *play, sing, smoke, swim, wait, walk* (Marchand 1960)
- ✓ only with telic accomplishments (Dowty 1979, Horn 1988)
- ✓ only with change-of-state verbs (Dowty 1979, Horn 1988)

re-:

- ✓only with verbs with NP complements, and no ditransitives (Carlson and Roeper 1980)
- obeys the 'Sole Complement Generalization' in not occurring with two obligatory arguments (Wechsler 1989)
- ∗ with ditransitives because of 'clitic' status (Keyser and Roeper 1992)
- ✓ with some unaccusatives/inchoatives (*reascend, redescend, regrow*) while ∗ with others (**reexplode, *rearrive*) (Lieber 2004)
- requires a result state (Csirmaz and Slade 2016)
- targets a constituent below the verb – a lower event (and its end state) (Marantz 2007)

Two main camps of explanations can be distinguished:

syntactic: decomposition, first phase syntax

semantic: telicity, change-of-state

I will claim today that there are issues with the extant diagnostics and a single-minded pursuit of any of these options.
– looking at the full distribution of *un*-verbs and *re*-verbs
– highlighting the sensitivity to the affectedness of the object from the BASE action and the affix-derived action

Some research questions:

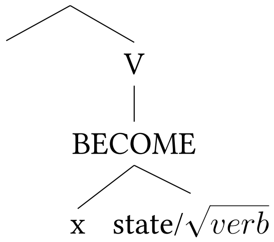
- **Argument structure**: What kernel of information do prefixes use in attachment to a stem? Where lies the overlap and non-overlap in the comparative argument structure of verbal *un-* and *re-*? How does this inform their comparative distribution?
- **Division of labor**: How does the morphosyntax interact with semantics?
- **Unification**: What analytical tools accurately capture the argument structure and distributional profiles of *un-* and *re-*?

2 Some approaches and issues

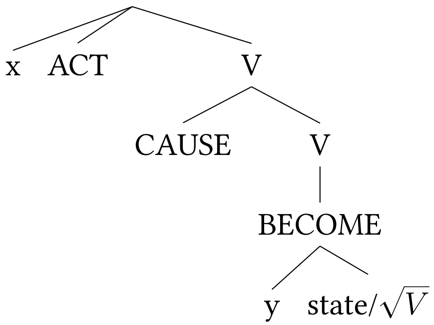
2.1 Pure decomposition

The tradition of McCawley (1968), McCawley (1972), Dowty (1979), Levin et al. (1999), a.o. ties Vendlerian aspectual distinctions (Vendler 1967) to differential decompositional spines in the syntax:

(9) achievement verbs: *break, explode, arrive, notice*



(10) accomplishment verbs: *clean, draw, fill*



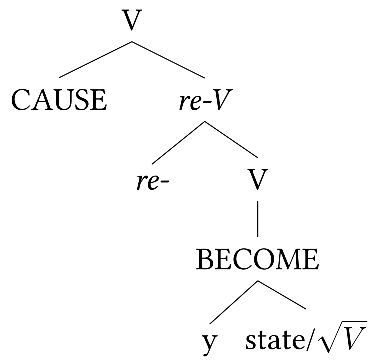
Activity predicates have only the ACT layer, while states have only have the content of the state.

Differentially articulated Fseqs like these have provided the foundation of distinguishing **argument structure in affixation** as well.

The big question: what morphosyntactic properties does *re-* have that allows it only a restitutive meaning?

Traditional, well agreed-upon answer: *re-* scopes over only the lower part of the decompositional spine, concretely only over the BECOME predicate (Dowty 1979, Marchand 1960, Marantz 2007, a.o.):

(11)



This analysis aims to capture the **condition** on *re*-affixation – (8):

The *re*-verb signifies an action that causes the BASE verb's result state to hold again.
– and does not signify a repeat of the BASE verb's action

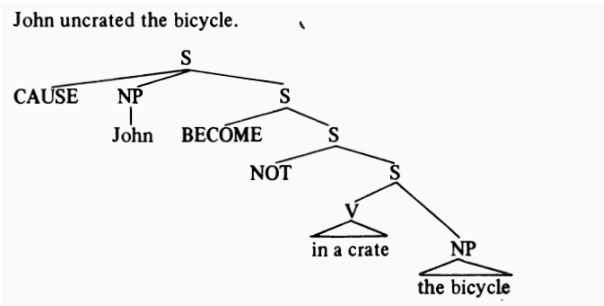
This analysis, in this form, gives rise to a concrete prediction:

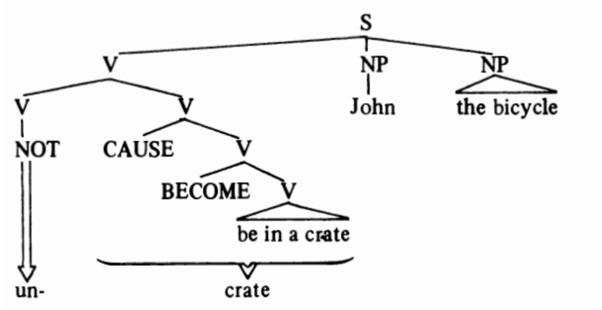
(12) Prediction of pure decomposition with *re-* scoping over BECOME:
Every verb with a result state should be able to take *re*-affixation

My argument: such a prediction is problematic, and vastly overgenerates.

The presence of a BECOME layer in the decomposition of a verb has often been assumed for change-of-state (COS) verbs as a class.
– Section 2.4 shows *re-* does not play nice with COS as a class (and that COS is not a homogeneous categorization).

Coming to *un-*, Dowty (1979) undertakes a pure decomposition analysis and flags the problems himself:





A negation operator is assumed inside the *un*-verb, which undergoes ‘raising’, leading to scopal interaction with predicates CAUSE and BECOME, which overgenerates.

Dowty: the following readings are predicted to exist when they do not:

(13) a. John didn’t cause the bicycle to come to be in the crate.

b. John caused the bicycle not to come to be in the crate.

Trying to map *un-* syntactically onto a lexicalist decompositional system leads to some problems given the conditions in (4):

- *un-* needs access to four total states: LB and RB of BASE, LB and RB of *un*-verb

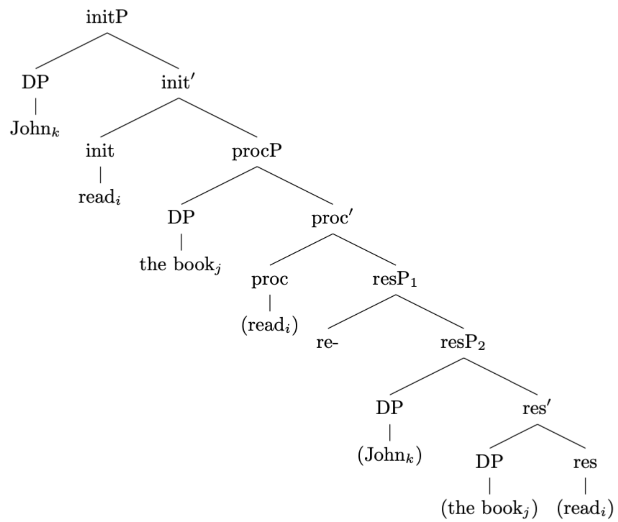
- The decomposition contains access to causing event and becoming states of the base verb and even if *un-* attached at the top of the tree, it is difficult to gain access to all 4 states and claim equivalence to sub-parts.

A decompositional approach is not sufficient to accurately capture the domains of affixation.

2.2 First phase syntax

Ramchand (2008) decomposes a VP layer into the possible projections of initiationP, processP, resultP based on the internal structure of the action

Csirmaz and Slade (2016): (16) provide a syntactic analysis of *re-* in a first phase syntax:



The problem is the same: the presence of a *res* layer does not guarantee that the result can be restored.

– a whole host of diverse predicates meet this description

Lots more about a direct implementation in a Ramchandian system in the Appendix.

2.3 Telicity

Both *un-* and *re-* attach to verbs belonging to a range of lexical aspect categories.
Variably telic predicates allow *un-* and *re-* prefixation:

(14) *unbraid, rebraid*
  a. Kim braided her hair in 5 minutes. (TELIC)
  b. Kim braided her hair for 5 minutes. (ATELIC)

(15) *uncoil, recoil*
  a. John coiled the ropes in 5 minutes. (TELIC)
  b. John coiled the ropes for 5 minutes. (ATELIC)

Many accomplishments and achievements (Dowty 1979) can take *un-* and *re-*:

(16) *unwrap, rewrap*
  Bill wrapped the presents. (DURATIVE;ACCOMPLISHMENT)
  (where the action holds at any instant within the entire duration of the event, which is usually for a longer period of time than a single instant.)

(17) *unselect, reselect*
  Ali selected 3 items in his online shopping cart.
  (PUNCTUAL;ACHIEVEMENT)
  (where the action holds for an instant of time).

Smith (1997) terms *re-* as a telic prefix. Lieber (2004) contests this position:

(18) a. The employees *restocked* the shelf for hours. ATELIC
  b. The scientists **reexploded* the bomb. TELIC

Telicity cannot be the property that accurately delimits the domain of affixation.

2.4 Change-of-state

Depending on **the kind of change** the action brings about, dynamic change-of-state predicates have been categorized into a multitude of classes (based on Tenny 1992, Jackendoff 1996, Krifka 1998, Hovav and Levin 2002, Hovav 2008, Beavers 2011).[4]

(19) a. **Causes a change in physical property** *un*: *, *re*: ▻
  *unpaint/repaint, *unclean/reclean, *unfix/refix, *unbreak/*rebreak
  b. **Transforms by altering integrity** *un*: *, *re*: *
  *unchange/*rechange, *unturn/*return[5], *uncarve/*recarve, *untransform/*retransform
  c. **Causes a change in location** *un*: *, *re*: *
  *unpush/*repush, *unmove/*remove[6], *unangle/*reangle
  d. **Just affects the surface via surface contact** *un*: ✓, *re*: ✓
  unpin/repin, unwrap/rewrap, uncheck/recheck, untwist/retwist, unpack/repack, unplug/replug
  e. **Brings about the creation of the object** *un*: *, *re*: ✓

[4] Symbols: ✓: good, * = bad, ▻ = good with most members of the class
[5] Where the intended meaning is to make a turn again.
[6] Where the intended meaning is to move again.

*undesign/redesign, *unbuild/rebuild,
*unconstruct/reconstruct, *uncreate/recreate,
*unfashion/refashion

f. **Brings about the consumption of the object** *un*: *, *re*: *
*undestroy/*redestroy, *uneat/*reeat,
*unconsume/*reconsume, *unreduce/*rereduce,
*undevour/*redevour

g. **Degree achievements** *un*: *, *re*: ▻
*unfill/refill, *undeepen/ *redeepen, *unwarm/rewarm,
*unheat/reheat, *uncool/recool, *unwiden/rewiden,
*undry/redry, *unempty/reempty

h. **No change specified by the action** *un*: *, *re*: *
*unswim/*reswim, *unwalk/*rewalk, *unponder/*reponder,
*unplay/*replay[7], *unlaugh/*relaugh

Several observations:

- *un*- only occurs with "surface contact/impact" verbs
- *un*- cannot occur with all of these sub-classes, even though they have all been tagged as 'change-of-state'
- *un*- is also ⁎ with predicates where a result state is not identifiable/specified at all (covering activity predicates flagged in previous work).
- *re*- casts a wider net than *un*-:
  ✓ with surface contact verbs (like *un*-), but also physical change verbs, creation verbs, most degree achievements (unlike *un*-)
  ⁎ with integrity altering verbs, location verbs, consumption verbs, no change specified verbs (like *un*-)
- The **only class of overlap** between *un*- and *re*- is the "surface contact/impact" class.

[7]Where *replay* is used intransitively because of attachment to the intransitive *play*, and not to the transitive counterpart.

Note that a pure decomposition approach would analyze all verbs in (19) as containing a BECOME that *re*- should be able to attach above
– incorrectly predicting *re*-'s compatibility with all these classes

Same problem for the view that analyzes *re*- as just requiring a result state.

If only a change/*any change* in a state of an object was required to be a BASE verb for *un*-
– all the classes would be incorrectly predicted to be compatible with *un*-

All changes on the object are not made equal.

Overall, the distributional facts of *un*- and *re*- tell us that some of the diagnostics in the literature are too broad, and result in overgeneration.

How can we accurately capture the distribution of *un*- and *re*-?

Proposal: the crucial factor is the ***effect of the action on the object*** at the boundaries of events, such that the conditions in (4) and (8) can be met.

3 Affectedness of the object

Let's look at the problem through the lens of the direct object of verbs.

Beavers (2011) presents a classification of predicates along an 'Affectedness Hierarchy'

The Affectedness Hierarchy: for all x, ϕ, e,

$$\exists s[result'(x,s,\mathbf{g}_\phi,e)] \rightarrow \exists s \exists g[result'(x,s,g,e)] \rightarrow \exists s \exists \theta[\theta(x,s,e)] \rightarrow \exists \theta'[\theta'(x,e)]$$

(*quantized*) (*non-quantized*) (*potential*) (*unspecified*)

The verb classes in (19) can be subsumed under these categories (Beavers 2011).

Quantized change: the highest degree of affectedness where a definite target state entailed by the predicate is reached; examples – accomplishments and achievements such as *break, destroy, shatter, devour.*

Non-quantized change is a lesser degree of affectedness of the object, and entails reaching a target state on the scale that is contextually salient; examples – degree achievements such as *widen, cool, lengthen, cut, slice.*

Unspecified for change means that the object is not entailed to undergo any change at all; examples – *see, laugh at, run, walk, smile, play, swim,* etc.

The remaining category is **potential for change**, which is where the *re-* and *un-* overlap lies!

Beavers: the class of potential-for-change (henceforth, **PFC**) predicates overwhelmingly contain "surface contact/impact predicates" (Fillmore 1970, Hovav and Levin 2002, Beavers 2011).

The objects of such predicates do not have to reach any defined target state as a result of the action.
– some examples: *tangle, tie, coil, bend, attach, twist, roll, furl, harness, leash, cross, braid, anchor, wrap*, etc.

Surface contact/impact predicates predicates the transmission of force on an object (cf. force dynamics in Croft 1990, 1991, a.o.), and the objects are consequently *force recipients* (Hovav and Levin 2001).

These verbs pass the *What happened to x* test that picks out force recipients – (20).
(Lakoff 1976, Jackendoff 1990, Hovav and Levin 2001)

But they do not entail **a lexically specified** outcome, as seen with causative alternations (cf. Kac 1976) – (21).

(20) a. What happened to the wire is that John twisted it.

b. What happened to the envelope is that John sealed it.

(21) a. John coiled the rope, and caused it to be knotted up.

b. John coiled the rope, and caused it to tear.

c. John coiled the rope, and caused it to break.

d. John coiled the rope, and caused it to disintegrate.

e. John coiled the rope, and caused it to come loose.

f. John coiled the rope, and caused it to tighten.

g. John coiled the rope, and caused it to remain intact.

No change in the object is entailed nor is any specific target result state entailed by the PFC predicate *coil.*

PFC predicates are thus a separate ontological class from the class that has been traditionally called dynamic 'change-of-state' predicates
(in for e.g., Tenny 1992, Jackendoff 1996, Krifka 1998, Hovav and Levin

2002, a.o.)
– these verbs lexically entail *integral change* in the object.

See the Appendix for another class of verbs, which I call *impingement-entailing*, which have been traditionally clubbed under COS/ surface contact'. I argue for keeping integral change distinct from surface impingement.

The 'potential' in the 'potential for change' classification has another consequence.

Since integral change is not entailed, PFC predicates are the only class that leave their object in a state that allows reversal to the original state before any change that might have happened.

Un- is sensitive to exactly this information about verbs and their results.

Keeping in mind lexically entailed affectedness of the object, the distributions of the two affixes are as follows:

un-	***re-***
✗ unspecified for change	✗ unspecified for change
✓ potential for change	✓ potential for change
✗ non-quantized change	✓$_{some}$ non-quantized change (deg. ach.s)
✗ quantized change	✓$_{some}$ quantized change (creation verbs)

Figure 1: The distribution of *un-* and *re-*

The distribution of *un-* looks cleaner that the distribution of *re-*:
– intuitively, *re*-affixation is 'easier' than *un*-prefixation
– since allowing a similar result state to obtain again is allowed by a larger class of verbs than allowing a reversal to a prior state of the object before the action.

4 Proposal

4.1 Verb roots

Proposal piece 1: **Verb roots encode sets of outcomes**

The prefixes *re-* and *un-* are sensitive to the states of the object before and after the force transmission action of the BASE verb.

Where do prefixes find this information?

This information is partially stored inside the lexical meaning of a verb, and consequently determines verb-affix compatibility.

First, I propose viewing the the lifespan of an entity as composed of discrete units, or lifespan points, that are points in the existence of the entity.

(22) lifespan of an object x= [$l_0(x)$, $l_n(x)$]
where l is a variable over the smallest discrete unit in the existence of an entity, and the entire lifespan is a closed interval.

At each such lifespan point $l(x)$, an entity has multiple properties across multiple different dimensions.

For e.g., at a point in the existence in the lifespan of a shirt – l_{22} – a shirt can have the following properties:

(23) l_{22} (shirt)$_{\{\textit{white, size-large, linen, has-2-pockets, has-2-buttons, has-collars, made-in-USA,...}\}}$

A description of the shirt can be provided based on any subset of these properties at l_{22}; not every dimension is salient for reference in every context.

Similarly, different subsets of properties of a particular object can be affected by the action encoded in a verb applied to the object:

– *Tom dyed the shirt* vs. *Tom cut up the shirt*:

: at a lifespan point corresponding to the end of the event *dying*, the property of being the color white has been altered, with no change entailed to the dimensions of size or collars or material, etc.
: at a lifespan point corresponding to the end of the event *cut-up*, there is alteration in the size or dimensions of the shirt and no change to colors or manufacturing, etc.

Verbs that lexically entail integral change in objects (COS verbs) or the possibility of change (PFC) affect some or all properties of the objects associated with some or all lifespan points of the object.

– e.g. *evaporate* entails that the integrity of the object be fundamentally altered
– *attach* does not entail any change, but leaves open the possibility of integral change.

All verbs in all languages come lexically equipped with a **set of outcomes** along the dimension supplied by the property in the verb.

This set consists of possible *states* that the object can be in when it undergoes the action of the verb. Every outcome is a state.

A *state* k is a function from a time point to a lifespan point of an object x:

(24) A state k: $t \rightarrow l(\mathrm{x})$,
where $t \in \mathrm{I}$ and $l(x) \in [l_0(x), l_n(x)]$

A set of outcomes is thus a set whose members are individual functions that constitute discrete, non-contiguous points of existence of an object after the action of the verb has applied to it.

Such a set concretely embodies the 'potentiality' of change of a verb root.[8] For an object x, say a piece of wire:

(25) Set of Outcomes (*fold*) =

$$\left\{ \begin{array}{l} k_1 : \ t'' \rightarrow l(x)_{\text{no impingement (after folding)}} \\ k_2 : \ t'' \rightarrow l(x)_{\text{slightly bent (after folding)}} \\ k_3 : \ t'' \rightarrow l(x)_{\text{halfway bent (after folding)}} \\ k_4 : \ t'' \rightarrow l(x)_{\text{greatly bent (after folding)}} \\ k_5 : \ t'' \rightarrow l(x)_{\text{damaged beyond repair (after folding)}} \end{array} \right\}$$

There are manifestly many other properties of an object at every lifespan point, as exemplified in (23); the set of outcomes contains only the one(s) relevant to the verb.

Proposal piece 2: **a set of thresholds is contextually available**

Another component, which though not part of the verb meaning, is still crucial for argument structure considerations.

This is the state of the object at a moment in time diametrically opposed to the time of outcome – right before the action of the verb is applied to the object.

This is a **a set of thresholds**, which reflects possible states an object (say, a shirt) can be in at the start of the action. Every threshold, just like every outcome, is a state; i.e. a function from a time point to a lifespan point.

[8] This concept of 'potentiality' has been difficult to pin down in the literature. 3 main views exist, each with certain issues, compositional or otherwise: Copley and Harley (2011) present a branching futures analysis; Hovav and Levin (2001) present a force-dynamic view based on Croft (1990), Croft (1991); Beavers (2011) uses Tenny (1992)'s Latent Aspectual Structure. Here, my goal is to pin down this notion formally as well as compositionally, especially given its role in argument structure.

(26) Set of Thresholds (*fold*) =

$$\left\{ \begin{array}{ll} k_1 : & t' \rightarrow l(x)_{\text{no impingement}} \\ k_2 : & t' \rightarrow l(x)_{\text{slightly torn}} \\ k_3 : & t' \rightarrow l(x)_{\text{majorly torn}} \\ k_4 : & t' \rightarrow l(x)_{\text{unbottoned}} \\ k_5 : & t' \rightarrow l(x)_{\text{color damaged}} \end{array} \right\}$$

Just like with outcomes, the properties each state in a set of thresholds maps to can vary along various different dimensions, many of which may be unrelated to the verb.

In a sense, the set of thresholds can encompass a higher degree of variability among states than the set of outcomes, because outcomes are predictable while thresholds are not.

The set of outcomes is thus part of lexical meaning, and the set of thresholds is computed contextually.

Assuming a temporal trace function τ that maps events to their duration or run time (Krifka (1998):

(27) a. the Set of Outcomes of *e* (O_e) = contains state(s) of the object that are RB(τ(*e*)) → a lifespan point of the object

b. the Set of Thresholds of *e* (T_e) = contains state(s) of the object that are LB(τ(*e*)) → a lifespan point of the object

For example,
for a PFC predicate like *wrap*, for an object like *the rope*:

(28) John *wrapped* the rope around the bundle of logs.

(29) Set of Thresholds (*wrap*) =

$$\left\{ \begin{array}{ll} k_1 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{no surface alternation}} \\ k_2 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{slightly-frayed}} \\ k_3 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{majorly-frayed}} \\ k_4 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{plaited}} \\ k_5 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{made-of-manila}} \\ k_6 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{white}} \\ k_7 : & LB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{inexpensive}} \end{array} \right\}$$

Set of Outcomes (*wrap*) =

$$\left\{ \begin{array}{ll} k_1 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{no surface alternation}} \\ k_2 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{some surface alternation}} \\ k_3 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{slightly-frayed}} \\ k_4 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{majorly-frayed}} \\ k_5 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{plaited}} \\ k_6 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{made-of-manila}} \\ k_7 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{white}} \\ k_8 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{inexpensive}} \\ k_9 : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{discolored}} \\ k_{10} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{snapped}} \\ k_{11} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{broken}} \\ k_{12} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{hardened}} \\ k_{13} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{stretched}} \\ k_{14} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{knotted up}} \\ k_{15} : & RB(\tau(\textit{wrap})) \rightarrow l(rope)_{\text{torn}} \end{array} \right\}$$

The properties at each lifespan point can be non-overlapping or even opposites in the set of outcomes, especially **since a PFC predicate does not entail any specific result** while leaving the possibilities of integral change or impingement (surface alteration) open.

Encompassing many such possibilities within the space of possible outcomes results in a set of outcomes larger than that of a set of thresholds.

Assuming that the action/force transmission of dynamic verbs applies to the object:

(30) $[\![$APPLIES$]\!](e)(x)$ = the entire action/force transmission of *e* takes place on *x*

This would ensure that the dynamic process happened on *x*; would not apply for stative verbs.

The formal definition of a dynamic transitive verb root thus is as follows (prior to existential closure over the event):

(31) a. $[\![\textit{wrap}]\!]^g = \lambda e_v.\lambda x_e[\text{wrap}(e)(x) \wedge O_e=\{k \mid k= \text{APPLIES}(e)(x)\}]$

b. $[\![\textit{fold}]\!]^g = \lambda e_v.\lambda x_e[\text{fold}(e)(x) \wedge O_e=\{k \mid k=\text{APPLIES}(e)(x)\}]$

c. $[\![\textit{twist}]\!]^g = \lambda e_v.\lambda x_e[\text{twist}(e)(x) \wedge O_e=\{k \mid k=\text{APPLIES}(e)(x)\}]$

d. $[\![\textit{zip}]\!]^g = \lambda e_v.\lambda x_e[\text{zip}(e)(x) \wedge O_e=\{k \mid k=\text{APPLIES}(e)(x)\}]$

e. $[\![\textit{seal}]\!]^g = \lambda e_v.\lambda x_e[\text{seal}(e)(x) \wedge O_e=\{k \mid k=\text{APPLIES}(e)(x)\}]$

The set of outcomes O for verbs like *wrap, fold, twist, zip, seal*, etc. is a multi-membered set, such as in (29).

A multi-membered set of outcomes is the hallmark of a PFC verb; i.e. the locus of the property of 'potential for change'.

The potentiality comes from the fact that the action of the verb applied to the direct object is able to yield various **discrete** outcome states, each distinct from the other, where some of the outcomes show integral change or visible impingement on the object, while other outcomes do not have any alteration.

In contrast, for non-PFC verbs with lexically specified target result states, the set of outcomes will be **singleton sets** contain only the lexically specified result.
– including quantized change and non-quantized change verbs

Verbs that are unspecified for change have **empty** outcome sets

True intransitive verbs have no outcome sets at all since they lack an object.

The various classes of non-PFC verbs can now be given the following semantics:

(32) a. Change in observable physical property verbs (*break, fix, clean*, etc.)
$[\![\textit{break}]\!]^g = \lambda e_v.\lambda x_e[\text{break}(e)(x) \wedge O_e = \{k \mid k=\text{APPLIES}(e)(x)\}]$,
where $O_{break} = \{k : RB(\tau(\textit{break})) \rightarrow l(x)_{\text{broken in some salient way}}\}$

b. Transformation verbs (*turn, carve, transform*, etc.)
$[\![\textit{transform}]\!]^g = \lambda e_v.\lambda x_e[\text{transform}(e)(x) \wedge O_e = \{k \mid k=\text{APPLIES}(e)(x)\}]$,
where $O_{transform} =$
$\{k : RB(\tau(\textit{transform})) \rightarrow l(x)_{\text{altered in some salient way}}\}$

c. Movement verbs (*push, move, angle*, etc.)
$[\![\textit{push}]\!]^g = \lambda e_v.\lambda x_e[\text{push}(e)(x) \wedge O_e = \{k \mid k=\text{APPLIES}(e)(x)\}]$,
where $O_{push} =$
$\{k : RB(\tau(\textit{push})) \rightarrow l(x)_{\text{displaced in some salient way}}\}$

d. Consumption verbs (*destroy, reduce, eat*, etc.)
$[\![\textit{destroy}]\!]^g = \lambda e_v.\lambda x_e[\text{destroy}(e)(x) \wedge O_e = \{k \mid k=\text{APPLIES}(e)(x)\}]$,

where $O_{destroy}$ = $\{k : RB(\tau(destroy)) \rightarrow l(x)_{\text{cease to exist}}\}$

e. Creation verbs (*construct, create, build*, etc.)
$[\![create]\!]^g = \lambda e_v.\lambda x_e[\text{create}(e)(x) \wedge O_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$,
where O_{create} = $\{k : RB(\tau(create)) \rightarrow l(x)_{\text{come into existence}}\}$

f. Degree achievement verbs (*fill, heat, cool*, etc.)[9]
$[\![cool]\!]^g = \lambda e_v.\lambda x_e[\text{cool}(e)(x) \wedge O_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$,
where O_{cool} =
$\{k : RB(\tau(cool)) \rightarrow l(x)_{\text{attain a contextually salient degree in temperature}}\}$

g. Impingement entailing verbs (*scrub, shovel, scratch*, etc.)
$[\![scratch]\!]^g = \lambda e_v.\lambda x_e[\text{scratch}(e)(x) \wedge O_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$,
where $O_{scratch}$ = $\{k : RB(\tau(scratch)) \rightarrow l(x)_{\text{surface altered}}\}$

h. No change specified verbs (*swim, play, ponder*, etc.)
$[\![play]\!]^g = \lambda e_v.\lambda x_e[\text{play}(e)(x) \wedge O_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$,
where $O_{play} = \{\}$

Thus, we have the following hierarchy of outcome sets depending on verb class:

(33) multi-membered sets (PFC) > singleton sets (I-E[10], COS) > empty sets (no change specified)

(where COS includes quantized and non-quantized change verbs)

4.2 *Un-* and *Re-*

The set of outcomes of the verb's action being built into the meaning of every verb has a direct consequence in compositionality:

[9]Keeping in view standard analysis of degree achievement verbs in Kennedy and Levin (2008).

[10]See Appendix for details on why Impingement-Entailing verbs have singleton set outcomes.

– productive and impossible combinatorics as mandated by the argument structure of verbal affixes.

Re- and *un-* share a kernel of meaning.

Going as far back as Dowty (1979), we find insight tying them together:

"Despite the syntactic problems with generating the internal readings for *re-*, *un-*, *again*... **they provide evidence for exactly the same "split" in the meaning of the verb**, I believe the arguments from derivational prefixes and adverbs reinforce each other." (Dowty 1979, p. 259)

Descriptively, both *un-* and *re-* are **result state modifiers**:

They both target the result state of a prior event and via the action of the newly formed *un*-V and *re*-V yield a new result state still connected in important ways to the prior event's result state.

For each event and its object, a result state `res` and a pre-state `pre` can be defined:

(34) $[\![\texttt{res}(e)(x)]\!] := k_e(t')(l(x)) = 1$,
where $t' = RB(\tau(e))$ and $l(x) \in [l_0(x), l_n(x)]$

(35) $[\![\texttt{pre}(e)(x)]\!] := k_e(t')(l(x)) = 1$,
where $t' = LB(\tau(e))$ and $l(x) \in [l_0(x), l_n(x)]$

`Res` and `pre` are thus operators that yield the state ($t \rightarrow l(x)$) of an object x at the boundaries of events:
– `res` yields the state of the object at the right boundary of the event,
– while `pre` yields the state of the object at the left boundary of the event.

(Recall that each lifespan point contains (various) properties that an object has.)

Two crucial things:

- $\texttt{res}$ and $\texttt{pre}$ are not temporal operators, i.e. they do not yield the temporal boundaries of events, but yield states of the objects
- These operators allow us to compute **equivalence** (=) between states and even events
(a sticky topic in event semantics; cf. Lemmon 1967, Parsons 1990, Maienborn 2011, a.o.)

Putting all this together, and assuming a two-place temporal precedence relation $\ll$, the meaning of reversative *un-* is as follows:

(36) $[\![un\text{-}]\!]^g := \lambda P_{<v<et>>}.\lambda x.\lambda e.\exists Q \exists e' : [\mathrm{P}(e')(x) \wedge \tau(e') \ll \tau(e) \wedge \texttt{res}(e')(x) = \texttt{pre}(e)(x) \wedge |\mathrm{O}_{\mathbf{e'}}| > 1].\ \mathrm{Q}(e)(x) \wedge \texttt{res}(e)(x) = \texttt{pre}(e')(x)$

Applied to a sentence such as *Veena unfolded the parchment*:

The meaning of *un-* is defined iff:
– there is a prior event of folding a parchment whose result state is the state of the object that the event of unfolding operates on, i.e. the unfolding can begin iff the object is still folded. *Un-* asserts that the result of the *unfolding* action renders the parchment in a state with the same properties as it was at the pre-state or at the commencement of the *folding* action. Thus, the result of the *folding* action has been undone at the end of the *unfolding* action.
– *un-* is able to attach to a verb like *fold* only because *fold* satisfies the last well-definedness clause, i.e. the set of outcomes of a verb like *fold* is a multi-membered set, since it entails no specific result state.

This captures the "inverseness/contrast at the heart of *un-*'s meaning" (Horn 1988).

(37) **The distribution of reversative *un-*:**
un- demands a multi-membered outcome set in a BASE verb whereby there can be inverse equivalence between *res* and *pre* states, and only PFC verbs are able to meet that demand, to the exclusion of all other verbs types which have either singleton outcome sets or empty outcome sets.

The prefix *re-* also presupposes a core fact about the result state of a prior event.

(38) $[\![re\text{-}]\!]^g := \lambda P_{<v<et>>}.\lambda x.\lambda e.\exists e' : [\mathrm{P}(e')(x) \wedge \tau(e') \ll \tau(e) \wedge \texttt{res}(e)(x) = \texttt{res}(e')(x) \wedge \neg\exists k' \in \mathrm{T}_e \text{ s.t. } k' \in \mathrm{O}_{e'} \rightarrow \mathrm{P(e)(x)} = \#].\ \mathrm{P(e)(x)}$

The meaning of *re-* is defined iff:
– a presupposition stating that the result state of the object is in at the right boundary of the BASE event be equivalent to the result state the object is in at the left boundary of the *re*-verb event is satisfied
– *re-* is able to attach to verbs iff there does not exist a state of the object in the threshold set of the *re*-verb event such that if that state existed in the outcome set of the BASE verb, then the *re*-verb's action on the object would be undefined.

To see this analysis in action, consider the minimal pair below.

(39) a. Raj reloaded the truck.

b. *The children reshattered the mirror.

The semantics of *load* (degree achievement, cf. Dowty 1991, Kennedy and McNally 1999) is as follows:

(40) $[\![load]\!]^g = \lambda e_v.\lambda x_e[\mathrm{load}(e)(x) \wedge \mathrm{O}_e = \{k\,|k{=}\textsc{applies}(e)(x)\}]$,
where $\mathrm{O}_{load} = \{k : RB(\tau(load)) \rightarrow l(x)_{\text{attain a contextually salient volume of material}}\}$

This singleton outcome set of *load* does not contain a state of the object that would prevent a repeat of the action to achieve another contextually salient degree of 'loadedness'.

Now compare with *shatter*:

(41) $[\![\textit{shatter}]\!]^g = \lambda e_v.\lambda x_e[\text{shatter}(e)(x) \wedge O_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$, where $O_{shatter} = \{k : RB(\tau(\textit{shatter})) \rightarrow l(x)_{\text{integrally break apart into pieces}}\}$

Since at the threshold of an attempted verb like **reshatter* the object has to at least exist in an intact state, the outcome of *shatter* on the object prevents a repeat of the action, thus rendering *reshatter* impossible.

Thus, the semantics in (38) correctly predicts compatibility and incompatibility of *re-* with different classes of predicates, depending on the sets of outcomes in verb meanings.

Note the one condition stated above in (8) was a necessary but not sufficient condition; the semantics in (38) now gives us all the necessary and sufficient conditions.

re- is not sensitive to the *cardinality* of the outcome set of the BASE verb, unlike *un-*.

The consequence of this is that ***re-* is in theory able to productively attach to a wider range of predicates**, whether they be multi-membered outcome sets (like PFC predicates) or singleton outcome sets (like sub-types of quantized or non-quantized change).

(42) **The distribution of cyclic *re-*:**
re- demands that there the object not be in a state at the end of

the BASE action whereby the result of the BASE action cannot be restored via the putative *re-* + BASE action.

The comparative distribution of both affixes as laid out in Table 3 has now been captured.

Pursuing a full/strict compositionality approach:

(43)

VP $[\![\textit{unfold the parchment}]\!]$
- V $[\![\textit{unfold}]\!]$
  - Aff $[\![\textit{un-}]\!]$
  - V $[\![\textit{fold}]\!]$
- DP $[\![\textit{the parchment}]\!]$

(44)

a. $[\![\textit{un-}]\!]^g = \lambda P_{<v<et>>}.\lambda x.\lambda e.\exists Q \exists e' : [P(e')(x) \wedge \tau(e') \ll \tau(e) \wedge \texttt{res}(e')(x) = \texttt{pre}(e)(x) \wedge |O_{\mathbf{e'}}| > 1].\ Q(e)(x) \wedge \texttt{res}(e)(x) = \texttt{pre}(e')(x)$

b. $[\![\textit{fold}]\!]^g = \lambda e_v.\lambda x_e[\text{fold}(e)(x) \wedge O_e{=}\{k \mid k{=}\textsc{applies}(e)(x)\}]$

c. $[\![\textit{unfold}]\!]^g = \lambda x \lambda e \exists Q \exists e' : \lambda x \lambda e \exists Q \exists e' : [\text{fold}(e')(x) \wedge O_{e'} = \{k \mid k = \textsc{applies}\,e'(x)\} \wedge \tau(e') \ll \tau(e) \wedge \texttt{res}(e')(x){=}\texttt{pre}(e)(x) \wedge |O_{e'}| > 1].\ Q(e)(x) \wedge \texttt{res}(e)(x) = \texttt{pre}(e')(x)$

d. $[\![\textit{the parchment}]\!]^g = \iota x.\text{parchment}(x)$

e. $[\![\textit{unfold the parchment}]\!]^g = \lambda e \exists Q\, \exists e' : [\textit{fold}(e')(\iota x.\text{parchment}(x)) \wedge O_{e'} = \{k \mid k = \textsc{applies}\,e'(\iota x.\text{parchment}(x))\} \wedge \tau(e') \ll \tau(e) \wedge \texttt{res}(e')(\iota x.\text{parchment}(x)) = \texttt{pre}(e)(\iota x.\text{parchment}(x)) \wedge |O_{e'}| > 1].\ Q(e)(x) \wedge \texttt{res}(e)(\iota x.\text{parchment}(x)) =$

$\texttt{pre}(e')(\iota x.\text{parchment}(x))$

5 Conclusion

Verbal affixes have argument structure that goes far beyond category information or even simple event decomposition information.

I argued that affixes like *un-* and *re-* are sensitiveness to the affectedness of the direct object and this information is built into their semantics.

Argument structure is a morpho-syntactic-semantic phenomenon, because a verb root encodes a set of outcomes that plays a large role in successful morphological derivation.

The framework of analysis here provided opportunities for compositionally formalizing the notions of equivalence between states/events and also 'potentiality of change' of an action.

Previously used diagnostics of neat lexical aspect classes, telicity, pure decomposition or first phase syntax, 'change-of-state' diagnosis – were all argued to be singly insufficient in correctly capturing full domains of affixation.

Un- and *re-* are modelled as result state modifiers that place restrictions of the state of the object at the boundaries of events, and can interact with above factors but very specifically and conditionally.

These specifications and conditions feeding their distribution can be mapped exhaustively only at the interfaces, modelling several factors at once.

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6 Appendix

6.1 Impingement vs. integral change

A special set of verbs that have been included under the PFC category by Beavers (2011) and under 'potential or latent incremental theme verbs' by Hovav and Levin (2002) fall under contact verbs:
hit, wipe, kick, punch, slap, scrub, scratch, shovel, rub, sweep, comb

However, these verbs all disallow *un*-and *re*-prefixation:

(45) Rahul *un/*re(hit/ wiped/ kicked/ punched/ slapped/ scrubbed/ scratched/ shovelled/ rubbed/ swept/ combed/ the object.)

These verbs actually form a class of their own that is distinct from both PFC and pure COS verbs.

These verbs do not entail integral change, but instead entail a form of *impingement* that is irreversible.
– I call these verbs *impingement-entailing predicates.*
They entail affectedness of the object:

(46) a. John just shovelled the driveway, #but it is not shovelled.

b. John just scratched the car, #but it is not scratched.

However, the exact nature of the imposition by these verbs are dependent on properties of the object, specific ways in which the action of a predicate interacts with an object, how much force or pressure is applied while the action takes place, etc.

To get at the heart of the concept of impingement as a surface-level, possibly invisible imposition, distinguishing it from integral change, I devised the 'but [the action] didn't affect the surface at all' test.

(47) a. Rahul hit the car, but that didn't affect the surface of the car.

b. Rahul wiped the table, but that didn't affect the surface of the table.

c. Rahul kicked the screen, # but that didn't affect the surface of the screen.

d. Rahul punched the wall, # but that didn't affect the surface of the wall.

e. Rahul slapped the horse, # but that didn't affect the surface of the horse.

f. Rahul scrubbed the carpet, # but that didn't affect the surface of the carpet.

g. Rahul scratched the car, # but that didn't affect the surface of the car.

h. Rahul shovelled the driveway, # but that didn't affect the surface of the driveway.

i. Rahul rubbed the meat, # but that didn't affect the surface of the meat.

j. Rahul swept the floor, # but that didn't affect the surface of the floor.

k. Rahul combed his hair, # but that didn't affect the surface of his hair.

Verbs like *hit/wipe* can also easily entail impingement if a different object is supplied; for e.g. one with softer exteriors than those in (47)(a-b).

The main observation then is that the large class of verbs that has been deemed as 'surface contact/impact predicates' actually contains further sub-divisions:

(48) surface contact/impact predicates

potential-for-change predicates   impingement-entailing predicates

I thus advocate for keeping the notions of impingement and integral change distinct.

(49) integral change not entailed $>$ impingement entailed $>$ integral change entailed

As before, telicity does not help isolate this class (cf. Horn (2002), who attributes **unhit* to the base verb *hit* being an atelic activity).

For example, Hovav and Levin (2002)(274) note that 'surface contact verbs may pattern as telic or atelic with respect to standard telicity tests.' Their examples (Hovav and Levin (2002): 17, 18):

(50) a. Lee scrubbed the tub for hours. (atelic)

b. Lee scrubbed the tub in three minutes flat. (telic)

(51) a. Lee is scrubbing the tub and has scrubbed it for the last hour. (atelic)

b. Lee is scrubbing the tub and still hasn't finished. (telic)

Based on all these distinctions, following properties can be attributed to the distinct types of verbs:

Full distribution table with I-E included:

PFC	I-E	COS
✓ force transmission occurs	✓ force transmission occurs	✓ force transmission occurs
✗ integral change entailed	✗ integral change entailed	✓ integral change entailed
✗ impingement entailed	✓ impingement entailed	✓ impingement entailed

Figure 2: Classes of force transmitting verbs

un-	***re-***
✗ unspecified for change	✗ unspecified for change
✓ potential for change	✓ potential for change
✗ impingement-entailing	✗ impingement-entailing
✗ non-quantized change	✓$_{some}$ non-quantized change (deg. ach.s)
✗ quantized change	✓$_{some}$ quantized change (creation verbs)

Figure 3: The distribution of *un-* and *re-*

6.2 Integration with a first phase syntax?

Two plausible options lie before us for a synergy between syntax and semantics with respect to affixal argument structure:

strict compositionality,
or
an integration with a system of articulated event structure (Ramchand 2008)

(43) and (44) above laid out the strict compositionality approach.

First phase syntax approach:

Ramchand (2008) posits a decomposition of the VP layer into initiationP, processP, resultP with argument relations like INITIATOR, UNDERGOER, RESULTEE:

Ramchand (2008), p.38: 'I will tie these argument relations to a **syntactically represented event decomposition**.'

Ramchand (also Pustejovsky 1991) explores the vital question of how much is represented in the lexicon vs. how much is general conceptual information vs. what is the syntax equipped to do.

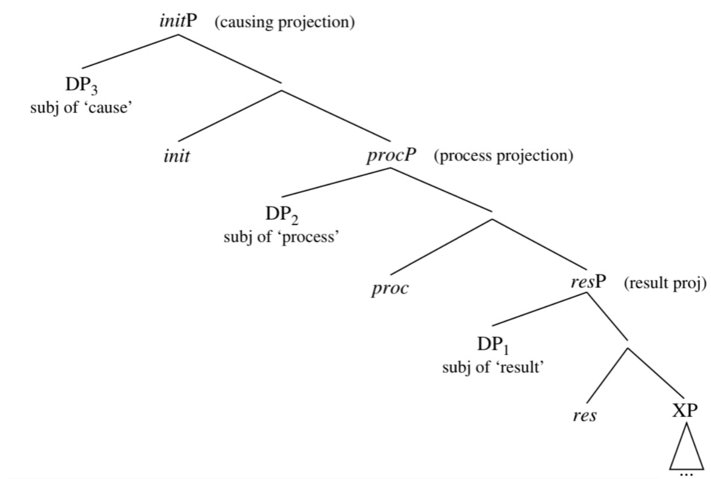

Figure 4: Ramchand (2008): 3(1)

In this work, I have proposed that affixes are sensitive to the internal structure of verbs – i.e. affixes can 'see' the outcome sets of verb roots.

Then, operators such as `res` and `pre` can yield lifespan points of an object given the boundaries of events.

This mechanism allows equivalence between states of the object across actions – as demanded by prefixes like *un-* and *re-*.

Question: Since the shared goal is a transparent representation of event structure decomposition, can the `res` and `pre` operators I have formulated be directly assimilated into Ramchand's framework – into the *init* and *res* heads?

Some complications, conceptual and technical, arise:

- The conception of *res*: Ramchand's *res* (Ramchand 2008, 3(10)) is a predicate that holds of an individual (the RESULTEE):

  (52) $[\![res]\!] = \lambda P \lambda x \lambda e[P(e)\ \&\ res'(e)\ \&\ State(e)\ \&\ Subject(x,e)]$

  From a the viewpoint of argument structure in affixation, this information will not be sufficient, since the actual state of the object is not known.

- Vendler's accomplishment class does not have a *res* layer in Ramchand (2008):

  'All of the accomplishments – the ones which embody duration as well as boundedness – are [init, proc] verbs.' (Ramchand 2008, p. 77)

  This makes the accomplishment-heavy distributions like *un*-'s and *re*-'s not straightforward to explain.

- Crucially, some important nuances become tricky:

  – a Ramchandian 'process' is 'an eventuality that contains internal change' (p. 44): this leaves open how processes without integral change can be represented
  – Same conception issue with PFC verbs with no entailed result
  – *init, proc*'s interpretation comes from their position in the hierarchical structure: this appears opposed to the analysis where `res`

and `pre` are semantically defined operators, but it might be able to position them hierarchically above and below the event

- Lexical items contain category features that would allow sets of outcomes to be semantically present in verb roots.

- Ramchand also uses her thematic participant relations to categorize verbs – this gives arise to the same issue as with a pure decomposition approach where a diverse range of verbs have the same characterization but does not accurately predict affix distribution.