Noname manuscript No.
(will be inserted by the editor)

Accepted for publication in *Linguistics and Philosophy*

Verb roots encode outcomes: argument structure and lexical semantics of reversal and restitution

Diti Bhadra

Received: date / Accepted: date

Abstract This paper makes a new proposal about the lexical semantics of verbs through the exploration of the distribution and semantics of the reversative affix *un-* and the restitutive affix *re-*. We argue that these affixes tell a story of derivational morphology that is based not on categorization of verbs into neat aspectual and decompositional classes, but on the result of the verb's action on the object and whether or not such a result state permits reversal and restitution. The argument structure of these affixes shows us that morphology interacts with semantics in a true compositional sense, whereby the affectedness of the object is a crucial factor determining compatibility and composition. We propose an approach to verb meaning that encodes this important information as outcomes: the lifespan properties of the object after the action occurs on it. We propose, formulating the Verb-Root-Outcomes (VRO) framework, that all verb roots come equipped with sets of outcomes. A wide array of verbs that have been classified as 'change-of-state' are shown to have different sub-classes based on the shape of the outcome set, and this also allows a formal definition of what 'potential' change could mean. The affixes *un-* and *re-* are modelled as result-state modifiers, which are sensitive to the outcomes of the action of the verb stem they attach to, and only attach when their presuppositions about the state of the object are met. Apart from directly comparing reversal and restitution with the same formal notion of equivalence, this approach also allows a transparent representation of event decomposition, whereby change in the object is able to be tracked at a granular level and its importance in determining the success of morphological derivations highlighted. This theory argues for compositional semantic interpretation at a sub-lexical level while also showing how sentential and pragmatic factors affect verb meaning and derivational affixation.

Keywords verb roots, lexical semantics, morphosemantics, argument structure, *un-*, *re-*, change of state, lifespans, outcomes, thresholds, reversal, restitution, affectedness, states, affixes, event structure, events, derivational morphology, verb classes, morphology

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. All three of these domains have been argued to converge in the distribution of the English prefixes *un-* and *re-*, which are very selective in their choice of verbs to attach to (henceforth called BASE verbs). For example, *un-* accepts *fold* and *freeze* as BASE verbs, but not *run* or *paint*.

(1) a. John *unfolded* the shirt.
b. The Department of Justice agreed to *unfreeze* the company's assets.
c. *Usain Bolt *unran* 10 miles.
d. *Frida Kahlo *unpainted* a picture.

Au contraire, *re-* allows all of the above as BASEs (*refold, refreeze, rerun, repaint*), yet disallows the following (which *un-* also disallows):

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(2) a. *The solution reevaporated.
b. *The scientists reexploded the bomb. Lieber (2004)

Several genres of explanations have been put forward to characterize the distribution of the two prefixes independently of each other. Analyses using syntactic arguments have been offered along the lines of lexicalist/decompositional profiles of the BASE verbs (Dowty 1979 for *un-*, Marantz 2007 for *re-*), or in a first phase syntax (Ramchand 2008) with a resultP predication layer (Csirmaz and Slade 2016) for *re-*, or of *re-* as a (clitic-like) element in complementary distribution with ditransitives (Carlson and Roeper 1980, Wechsler 1989, Keyser and Roeper 1992). Semantic characterizations of *un-*'s distribution have included lexical aspectual distinctions like telicity and Vendlerian distinctions of achievements vs. accomplishments, and 'change of state' properties (Marchand 1960, Dowty 1979, Horn 1980, 1988). In this paper, we launch a comparative investigation of both affixes together, review these extant diagnostics, and argue that pursuing any of these avenues of explanations single-mindedly does not capture the full distribution accurately. This formal, comparative investigation reveals that that the distribution of *re-* is more diverse than that of *un-*. In other words, *re-* is compatible with more varied predicate classes than *un-* is (though not necessarily more predicates in number). Interestingly though, *re-* and *un-* converge on a specific class of predicates, which we will argue to be a semantically coherent class of verbs.

Concretely, this paper will explore how argument structure in the domain of affixation interacts with the principles of morphosemantics. Both of these affixes appear to be sensitive to certain aspects of the event structure related to the action depicted by the base verbs they attach to. Where do affixes find this information? We will propose a new verb root semantics[1], which includes a dimension of the effect of the verb's action on an object, formalized as *outcomes*. We will argue that morphemes such as *un-* and *re-* carry presuppositions that are sensitive to result states and prior states of BASE events and the effect of these events on the integrity of and the impact on the direct object. It is this kind of sensitivity to outcomes that feeds into argument structure and thus determines the compatibility or lack thereof of these affixes with different classes of predicates. In demonstrating an overlap in the distribution of *un-* and *re-* as well as their distinct differences, we argue that the comparative profiles can be fully captured only if both affixes are formally analyzed with the same semantic tools, i.e. if both are recognized as *result state modifiers*.

We review all of the different properties that have been argued to be important in capturing *un-* and *re-*'s distribution in previous work. We highlight the fact that these morphemes tell us a lot about verbal meaning and morphosemantics and point towards very specific tools of formal analysis as result state modifiers. Concretely then, throughout the paper, we will pursue the following research questions:

1. **Argument structure**: What kind of information are prefixes sensitive to when attaching to a stem? Where do the argument structures of verbal *un-* and *re-* overlap? How does this inform their comparative distribution?
2. **Division of labor**: How does the morpho-syntactic domain interact with semantics at the sub-lexical level and higher?
3. **Unification**: What analytical tools accurately capture the argument structure and distributional profiles of *un-* and *re-*?

This paper is organized as follows. We first start with the study of *un-*, in Section 2, covering its properties and distribution. We do the same for *re-* next in Section 3. Then we provide a comparative summary of what we have learnt in Section 4. We lay out all the components of our analysis and our Verb-Root-Outcomes framework in Section 5, with worked out examples and predictions for both affixes and verb meaning. Then in Section 6, we discuss some previous explanations, as well as previous definitions of some concepts we use, and bring up a few issues. Section 7 concludes.

A note on our methodology for the empirical basis of the paper is in order. Since this is primarily a paper on morphosemantics, we have two categories of data paradigms – word-level (i.e. the bare verb) and minimal VP level (i.e. the verb and its direct object). Each judgement presented about a bare verb in the paper is supported by: a) searching for it in a one-billion-word corpus – The Corpus of Contemporary American English (COCA; which contains many low frequency constructions as well) and organizing the search results; b) searching for it via the Google search engine for hits on the internet; c) consulting established lexicographic sources such as

[1] A disclaimer about our use of the term 'verb roots' in in order, given its wide use in morphosyntax, syntax, and semantics. What we focus on is the *meaning of verbs*. Whether this is inherent to a Root or a Root+v combination is not a point of contention here (unlike in the syntactic literature where it is a point of great debate as to whether roots are category-less syntactic terminals or a relevant unit of syntactic information; see Alexiadou et al. 2014b for an overview). Our semantic proposals about what the meanings of verbs look like could be implemented either way. We use 'verb roots' in the sense of units of meaning that affixes attach to (often called 'stems'), i.e. the lexical category of a base 'verb' in semantics, and thus this paper in many ways is about a new proposal about lexical semantics of verbs and affixes.

Merriam Webster or Oxford Dictionary; and d) consulting native speakers of American English about their intuitions. The results presented show unified results from across these sources. In organizing the COCA search results, we performed the standard process of data filtering, whereby ungrammatical results or typos (from informal sources such as blog posts or comments on posts) were weeded out after verification. Each judgement presented about a minimal VP unit is supported by: a) Google searches for hits on the internet; b) searches on COCA and organization of the results; c) consulting native speakers of American English. Throughout the paper, an asterisk (*) denotes the unavailability of the word-level occurrence of the verb, irrespective of direct object. A hashtag (#) is used to denote infelicity at higher levels of structure (minimal VP and sentence-level). Although the results we found in each case were mostly consistent across all these sources, we have flagged any differences and tagged the data coming from the corpus, internet, and dictionary sources wherever appropriate or relevant.

2 The distribution of *un-*

Un- has always presented an interesting challenge to students of morphosemantics, in that it has two main lives – adjectival and verbal, with very different interpretations.[2] For example, when attached to a root verb, a reverse action is entailed, while attached to an adjective the lack of the adjectival property is denoted.

(3) *un-* + *lock* (**V.**) = *unlock* (V.) = the reversal of a previous action of locking
reversative *un-*

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

Following Horn (1988), we use the terms *reversative* and *privative* for the avatars of *un-* in (3) and (4), respectively. In the existing literature on *un-*, three main strands of discussion can be identified: (i) whether or not there are two homophonous *un-*s in the lexicon, one attaching to adjectives and participles, and the other to verbs; (ii) what kinds of verbs reversative *un-* can or cannot prefix to; (iii) what the notion of 'reversal of an action' means and how it can be incorporated into the meaning the prefix. We discuss each of these in turn across the paper.

An explicit assumption of homophony between two lexically distinct *un-*s is present in many previous works (Jespersen 1917, Marchand 1960, Dowty 1979, Covington 1981, Thomas 1983, Horn 2002), while some others posit that there is a single morpheme *un-*, represented in the lexicon as one single entity (Maynor 1979, Andrews 1986). Some of the proponents of the homophony view point to the historically distinct origins of the adjectival and verbal *un-*, i.e. that their cognates in Old English, German, Latin, and Greek were distinct, and that the two prefixes have 'mutually exclusive distributions' (Dowty 1979: 257). The opponents of this view suggest that since both adjectival and verbal *un-* seem to share a core meaning of "oppositeness" they should also share one lexical entry. However, a semantics of oppositeness that can account for *un-*verbs, nouns, and adjectives is not provided, making the single lexical entry viewpoint "more a promise than an analysis" (Horn 2002: 13). In this paper, we concur with the proponents of the homophony view that *un-* has distinct lives, and that reversative and privative *un-* have different formal semantic representations, where the former has many constraints on its distribution that is not subsumable under one lexical entry with the latter.

Privative *un-* has received much scholarly attention, with the general consensus being that it is equivalent to logical negation (Parsons 1990, Kratzer 2000, Horn 2005, Pylkkänen et al. 2009, Joshi 2012, De Clercq and Vanden Wyngaerd 2017). Concurring with these works that it is straightforwardly the logical negation operator, we do not discuss privative *un-* further in this paper. Consequently, in the rest of the paper, whenever *un-* is mentioned in bare form, it refers to reversative *un-* only.

The interesting complexities of distribution reside with reversative *un-*. While many verbs allow reversative *un-*prefixation, many verbs completely disallow it. For example, it is common to *unwrap* presents, but seems impossible to *unbelieve* propositions; it is easy to *untwist* a wire, but very difficult to *unfuse* two metals. Reversative *un-* thus places strict restrictions on its compatibility with classes of predicates. The nature of these restrictions has been studied before. The earliest explorations of reversative *un-* highlighted that lexical aspect and transitivity were two crucial factors *un-* is sensitive to. For example, Marchand (1960) described *un-*'s distribution as being ungrammatical with 'non-resultative, durative verbs' such as *play, sing, smoke, swim, wait, walk*; Dowty (1979) and Horn (1988) posited that *un-*affixation can only happen with telic accomplishment verbs (invoking Vendler 1967's classifications of the lexical dimensions of aspect). In particular, Horn (1988) describes a profile of verbs that allow reversative *un-*prefixation – he argues they are

[2] Horn (2002) also studies another *un-* beast, the *un-*noun.

all telic accomplishment predicates that take a theme argument that undergoes a change-of-state with an optional causative agent present in the form of a second argument. States and activities are both ruled out by many of these works. Both Dowty (1979) and Horn (2002) emphasize the change-of-state nature of verbs that take *un-*. Studies in child language acquisition of affixation such as Clark et al. (2008) make the case that English-speaking children learn that *un-* applies primarily to verbs for change-of-state, and another class described as 'often for enclosing, covering and attaching' that they club under change-of-state.

Our investigations of reversative *un-* reveal some issues with these generalizations. We explore each of the properties – telicity, lexical aspect classifications, change-of-state – below.

2.1 Telicity, lexical aspect classes and *un-*

Previous work that analyzes the aspectual profile of verbs allowing *un*-prefixation argue that the prefix is selective towards verbs that have an endpoint inherent in the denoted action (Dowty 1979, Horn 1988, 2016). In this section, we present insights from the large body of work that has shown that many verbs cannot be straightforwardly deemed "telic" or "atelic" but as shuttling between the two interpretations because of a range of affecting factors, and argue that the description "telic" does not adequately cover the range of *un-*'s BASE verbs.

Telicity has been observed to not just be a property of verbs alone, but entire VPs and even whole sentences (see Filip 1999 for an overview). This is because the obligatory nominal arguments of the verb (crucially objects, but also subjects in some cases), optional arguments, adjuncts such as temporal, motion, and path adverbials, secondary predication such as resultatives, contextual information, and world knowledge can all affect the telicity of the complex verbal predicate. Citing a vast body of prior work, Filip (1999) notes that in particular, while some verbs lexically denote an endpoint (or telos), many verbs combine with other elements to generate a telic or atelic *construal* of the entire complex. For example, bare plurals (or cumulative nominals) as direct objects lead to an atelic reading, while quantized nominals as direct objects lead to a telic interpretation. The different construals are highlighted with the standard prepositional modifier test (Dowty 1979):

(5) a. John *shackled* horses ?in an hour/for an hour.
b. John *shackled* a horse in an hour/??for an hour.

(6) a. John *peeled* fruits ?in 5 minutes/for 5 minutes.
b. John *peeled* a fruit in 5 minutes/??for 5 minutes.

The verb *shackle*, which is an action leading to confinement or restriction on the object, brings to mind a natural endpoint, i.e. when the object is satisfyingly confined/restricted. However, depending on the quantization status of the objects in (5) the verb allows a telic or atelic construal. *Shackle* is an *un-* BASE verb (*unshackle*). So we can have cases where a verb fitting the criterion of inherent telicity allows atelic construals based on interactions with objects.

While interactions with objects are not well-discussed in the literature on *un-*, the atelic construal fact, however, is not problematic for the camp that views *un-* BASE verbs to be only telic lexically, since they technically do not posit restrictions on which *other* interpretations the telic verbs allow. More problematic for this camp would be if verbs that are lexically unspecified for the presence or absence of a telos (i.e. are neither telic nor atelic) allow *un-* prefixation. For example, the following BASE verbs all take *un-*, and they are all unspecified for telicity:

(7) a. I *scrambled* the jigsaw pieces for an hour/in an hour.
b. Joan *curled* her hair for an hour/in an hour.
c. Peter *packed* for an hour/in an hour.
d. Kim *braided* the ropes for 5 minutes/in 5 minutes.
e. John *coiled* the cables for an hour/in an hour.

The "telic-only" camp would predict such verbs to either not allow *un-* or possibly have to posit some kind of added coercion to explain this compatibility. We suggest that the "telic-only" label is too restrictive, and does not capture the whole distribution of *un-* BASE verbs. In fact, Filip (1999) concludes that "at the lexical level we have a large class of verbs that cannot be classified as either process-denoting (atelic) or event-denoting (atelic). " (p. 109). Thus, these labels applied to verbs paint only a very partial picture, and the properties of VPs (complex predicates) or entire sentences have to be taken into account when discussing affixation as well.

Other lexical aspect considerations assumed to play a role in *un*-prefixation can be subjected to additional scrutiny as well. As mentioned above, earlier authors have stressed that only accomplishment predicates allow *un-*, to the exclusion of activities, states, achievements (based on Vendler 1967, 2019). This generalization seems to be largely true; however, we have found some achievement BASE predicates that do allow *un-*, primarily verbs relating to technology whose actions involve just a click, some of which are exemplified below. The main differences between accomplishments and achievements lie in the presence of a process leading to a change of state and duration (achievements lack both). All the verbs below can be characterized as achievements given these properties and yet, they all allow *un-*.

(8) ACHIEVEMENT – where the action holds only for an instant of time
   a. Ali *muted* his microphone on zoom.
   b. Joan *subscribed* to the Youtube channel.
   c. Peter *friended* Joan on facebook.
   d. Rahul *blocked* Sita's number.

Horn (2016) notes that with advances in technology there have arisen more and more technology verbs whose actions involve just a click – some of his examples are *unitalicize, unbold, ununderline, uninstall, unselect, unsend* (an e-mail), *unpublish* (a blog entry), *unpause, unfriend, unfollow, unlike, untag, undelete* (photos), *unerase, unshuffle, unsort*, among many others. We note that all of the BASE verbs of these *un*-verbs are achievements, not accomplishments.

The fact that these are achievement predicates is confirmed by two distributional criteria targeting the internal structure of the events (Vendler 1967, Kenny 2003) – the *progressive* test, which looks for internal durativity[3], and the *for*-modifier test tuned into duration of the process. Achievements usually disallow progressive forms because there is no process necessarily included in the meaning of the verb, and in the following cases, there is infelicity with *for*-PPs.

(9) a. #Ali was muting his microphone on zoom.
   b. #Joan was subscribing to the Youtube channel.
   c. #Peter was friending Joan on facebook.
   d. #Rahul was blocking Sita's number.

The *un*-affixed counterparts of technology verbs sound similarly degraded in the progressive form.

(10) a. #Sofia was unsending the email.
   b. #Maya was unpublishing her blog entry.
   c. #Joan was untagging Peter from a picture.

In so far as the action of the verb is being described, all of these actions disallow the progressive form.[4]

(11) a. Ali muted his microphone on zoom ??for 5 minutes.
   b. Joan subscribed to the Youtube channel ??for an hour.
   c. Peter friended Joan on facebook ??for an hour.
   d. Rahul blocked Sita's number ??for an hour.

The degraded judgements are again related to the action itself and not the resulting state of the action. Ali may remain muted for 5 minutes *as a result* of the action of muting his microphone, and on this result reading

[3] A reviewer notes that plural objects are compatible such verbs, e.g. *Joan was subscribing to Youtube channels*, and we attribute that fact to the standard assumption that plurals interact with and change event structure (Schein 1993, Kratzer 2007, Lasersohn 2013), among many others.

[4] They can be marginally used as a type of reference to a point in time, which still indicates that the action itself is punctual but the progressive is simply providing a topic time instead of a duration:

(i) a. ?When I walked into the room, Peter was friending Joan on facebook.
   b. ?As Peter was friending Joan on facebook, I realized how fragile the human ego is.

This reading of the progressive, which with some verbs signals that the subject is not yet in the state described by the verb's action, has been called the 'preliminary circumstance' reading by Kearns (2003) and studied in Piñón (1997), Marín and McNally (2011), in contrast to the 'ordinary' progressive reading which entails the perfect.

(11)(a) with the *for*-PP can be felicitous (same for (b)-(d)). But crucially, on the *duration of the action* itself reading, all the sentences with the *for*-PP are infelicitous.

This section reexamined extant descriptions of the aktionsarten or lexical aspect properties that have been posited for *un-* BASE verbs in the literature. We concluded that previous generalizations such as only "telic accomplishment verbs allow *un*-prefixation" are inadequate, both because verbs lexically unspecified for telicity can take *un-* as well as several elements inside the VP or in the sentence can influence aspectual class features, and some achievements with result states allow *un-*. It seems clear that *un-* is sensitive to *some other property* of verbs/VPs/sentences that characterizes its entire distribution and cuts across these lexical aspect classes. We will propose in Section 2.2 that what *un-* is deeply sensitive to is the result states of actions and specifically whether they are reversible or not. Thus, any verbal root with a reversible result state is going to be a good candidate for being a BASE for *un*-prefixation. We will then formally propose what such a property of reversibility could look like.

2.2 Change-of-state and *un-*

The next crucial diagnostic property of verbs that allow *un*-affixation have to argued to be "change-of-state", or verbs whose actions result in a change in the state of the object, as posited in Dowty (1979), Horn (1988, 2016). This classification of *un-* BASE verbs is related to a general decompositional analysis of Vendlerian aspectual distinctions presented in Dowty (1979), where the presence of the BECOME layer (in addition to the CAUSE layer) inside the meaning postulates of verbs indicate that the action has a result state. The presence of the BECOME predicate has been posited as a sufficient analytical tool in explaining both *un-* and *re-*'s distribution (Marchand 1960, Dowty 1979, Marantz 2007, Csirmaz and Slade 2016). However, in Section 6 we show that such an analysis is problematic and vastly overgenerates due to an important reason: change-of-state is a very heterogeneous class of predicates, and crucial distinctions are lost if just an equivalence of BECOME = change-of-state is assumed instead of fine-grained, detailed analyses of sub-classes.

Depending on **the kind of change** the action brings about, dynamic change-of-state (COS) predicates have been categorized into a multitude of classes (based on Tenny 1992, Jackendoff 1996, Krifka 1998, Rappaport Hovav and Levin 2002, Rappaport Hovav 2008, Beavers 2011). If we just look at the bare verbs in isolation (without other VP-internal or external elements that may influence the grammaticality/felicity), we get the following results:[5]

(12)
a. **Causes a change in physical property** — *un*: *
*unpaint, *unclean, *unfix, *unbreak

b. **Transforms by altering integrity** — *un*: *
*unchange, *unturn, *uncarve, *untransform

c. **Causes a change in location** — *un*: *
*unpush, *unmove, *unangle

d. **Just affects the surface via surface contact** — *un*: ✓
unpin, unwrap, uncheck, untwist, unpack, unplug

e. **Brings about the creation of the object** — *un*: *
*undesign, *unbuild, *unconstruct, *uncreate, *unfashion

f. **Brings about the consumption of the object** — *un*: *
*undestroy, *uneat, *unconsume, *unreduce, *undevour

g. **Degree achievements** — *un*: *
*unfill, *undeepen, *unwarm, *unheat, *uncool, *unwiden, *undry, *unempty

h. **No change specified by the action** — *un*: *
*unswim, *unwalk, *unponder, *unplay, *unlaugh

If only a change in a state of an object was required to be an *un-*BASE verb, then the distributional facts of *un-* in (12) would remain a mystery, since all of them would arguably be predicted to be good. Instead the crucial generalization that emerges here is that, within the various sub-classes of COS verbs, *un-* only occurs with what has been called "surface contact/impact" verbs, to the exclusion of all others. Early work on *un-* presented this generalization as well; for example, Pullum (1999) cites Whorf (1956)'s observation about the *cryptotype*

[5] These judgements reported in (12) are the result of searches on the corpus (COCA), the internet (Google), and lexicographic sources (Merriam Webster and Oxford) for each word. These are the raw results from these searches, backed up by the availability of its usage in sentences or the lack thereof.

of *un*-verbs: "With the exception of a few words mostly semi-archaic, e.g. '*unsay, unthink, unmake*,' the use of *un-* as a reversative prefix in true verbs coincides with the centripetal enclosing and attaching meaning."

These labels thus appear to paint a neat picture. However, the picture is complicated when we look at VP-level or sentence-level meanings with *un*-verbs, i.e. structural levels at which other factors come into play, as described above in Section 2.1. In particular, two factors play a large role in bringing about felicitous uses of *un*-verbs cutting across the labels in (12): (i) the type of the direct object, and (ii) the role of enriched contexts.

Different types of direct objects (DOs) combining with the action of *un*-verb bring about variability in felicity with the same verb, as shown below. The brackets signify a minimal VP:

(13) a. ✓[unbreak a page in MS Word], but #[unbreak a limb]
b. ✓[unmake a table in MS Excel] but #[unmake a cake]
c. ✓[uncommit changes on Github] but #[uncommit crimes]
d. ✓[undo a stitch] but #[undo a Covid test].

This pattern of variable felicity results depending on the combinatorics of the verb and DO largely occurs with *re-* as well, as we will see in Section 3.

Apart from widespread usage of *un-* in technological jargon as described above, other kinds of contexts, especially enriched ones containing elements of wishes, desires, counterfactuals and other subjunctive contexts, and also negation, felicitously violate aspectual of change-of-state requirements we have discussed for far. To group these together under one umbrella, we can borrow the term "impossibilitative" contexts from Horn (2016).

(14) When embedded under negation, with or without idiomatic interpretations:
a. You cannot *unboil* an egg (Horn 2016: >40K raw google hits)
b. You can't *unring* a bell (Horn 2016: 162K raw google hits)
c. You cannot *unsee* a dog eating a squirrel.

(15) When embedded in wishes or irrealis contexts
a. I wish I could *unknow* these facts about him.
b. I wish I could *unsee* the dog eating that squirrel.
c. If only I could *unbelieve* everything he'd said, I'd be much happier.
d. I wanted to *unrun* all those extra miles that made my joints weak.

(16) Poetic or media licenses (italicization added):
a. 1996 song by Toni Braxton: "*Unbreak* my heart"
b. 1971 song by Lynn Anderson: "How can I *unlove* you?"
c. July 2022 BBC headline: "Cameron Diaz to '*un-retire*' from acting with Jamie Foxx film"[6]
d. December 2020 The Guardian headline: "Hunting Ghislaine: *unpicking* truth from conspiracy in the Epstein saga"[7]
e. From a March 2022 TMZ article: "At Aryn's request, the judge agreed the actor can't cancel and then "*uncancel*" his scheduled daddy time."[8]

Other kinds of enriched contexts can also host otherwise infelicitous *un*-verbs – such as back and forth dialogues and conversations, as Horn (2016) shows, where the *un*-verb follows the BASE verb and is thus primed; examples would be longer versions of (16)(e). We concur with Horn (2016)'s critique of the Pullum-Whorf hypothesis mentioned above – which states that the cryptotype of *un*-verbs make them mostly limited to attachment and covering/enclosing verbs – as not being able to capture these variable felicity results. Similarly, we contend that *within* COS classes, *un-* overwhelmingly prefers the surface contact sub-class, but the whole distribution of *un-* is much larger that just surface contact verbs.

Our contention is that the crucial factor that *un-* is sensitive to is whether or not **the state of the object** after the action of the base verb is one that permits a reversal to the state of the object before the action (see also Gaeta 2015). Thus, it is not strictly the interaction of lexical properties of the verb with aspectual and

[6] https://www.bbc.com/news/entertainment-arts-61992214. In digital writing, often a hyphenated *un*-verb is used with quotation marks around it like this to signify the suspension of usual unacceptability.
[7] https://www.theguardian.com/tv-and-radio/2020/dec/23/hunting-ghislaine-podcast-john-sweeney.
[8] https://www.tmz.com/2022/03/01/jesse-williams-ex-wife-settle-child-custody-battle/.

temporal modifiers, or whether a change of the state of the object is entailed by the verb or not, but the *effect of the action on the object*, whether or not that effect results in irreversible change/transformation/alteration.

2.3 Different paradigms of ill-formedness

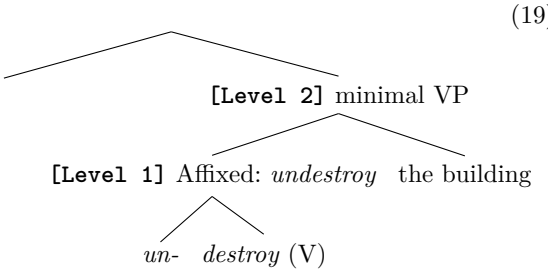
As detailed above, our approach consists of taking into account not just the verb roots but also variable felicity and well-formedness of affixation patterns with respect to direct objects. A question arises here: how do we relate affixation (which is a morphological phenomenon) to higher level (higher in the tree) computations of (morphosemantic) felicity? And where do morphosyntactic considerations such as categories, transitivity, orders of derivation, etc. come into play? We argue that these seemingly opposing forces can be better understood as consequences of the compositional semantics at the affixed level and then at the higher VP level.

First, we observed above that there are basically what can be called two paradigms of ill-formedness when it comes to affixation:

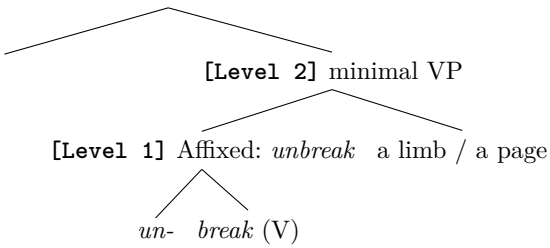
(17) Paradigm A: *undestroy, *uneat, *unconsume
Paradigm B: #[unbreak a limb] but ✓[unbreak a page in MS Word]

Paradigm A shows word-level ungrammaticality while Paradigm B shows minimal VP level contrasts in felicity. By a minimal VP, we mean just the verb and only its direct object, to the exclusion of extended projections or other objects. If compatibility was only checked at the minimal VP level to yield contrasts like Paradigm B, then Paradigm A would not exist; in contrast, if only word-level attachment restrictions were in place, then direct objects would not be able to make any difference in well-formedness. Our proposal is that these are not opposing considerations but actually the result of differing levels of compositionality; we label them as **[Level 1]** and **[Level 2]** in the schematic structures below:

(18)



(19)



[Level 1] is the morphosyntactic level while **[Level 2]** is the (morpho)semantic level at the minimal VP stage. We consider the latter as a "morpho-" level still precisely because the direct object can make or break the possibility of that particular affixation. Crucially, world knowledge and general cognitive reasoning operate at both levels. This includes world knowledge about verb *roots* vs. verb *frames*, i.e. the content of the root itself vs. the verb's sub-categorization information. This distinction and the role of general reasoning abilities in word learning is supported by many decades of research on verb learning in acquisition research. For example, Pinker (1994), building on much previous work, argues that there are constraints on a child's possible hypotheses when it comes to inferring word meanings, where not all logically possible hypotheses given an input data set are psychologically possible. Kelly et al. (2014) show how in polysynthetic languages such as Quechua and Navajo, morphological factors drive acquisition with roots/stems being extracted in early verb forms irrespective of their perceptual salience in the environment. Many affixes in English show sensitivity to general knowledge; for example, consider *pre-determine*, *pre-order*, etc. but **pre-stabilize*, **pre-understand*, etc. Similarly, *unpin* is good while a possible close cousin *depin* is *. Thus, we notice over and over that general reasoning (informed by world knowledge and environmental factors) about roots vis à vis argument structure plays a big role in acquisition of morphology and its interfaces.

This insight is what we model in our approach to semantically-informed morphological affixation. In (18), **[Level 1]** already gives *undestroy* a *, because the content of the BASE verb root describes an action that cannot satisfy *un-*'s requirement of reversability. The affixation fails at the first level. Thus, *undestroy* lands in Paradigm A. Moving up, there's also failure at **[Level 2]**, with [undestroy the building] receiving a #, because there exists no plausible object which can combine with the affixed verb to satisfy the morphosemantic restrictions of *un-*. In contrast, in a structure like (19), there is success at **[Level 1]** because cognitive reasoning allows the plausibility of *some* breaking actions to be reversed, albeit dependent on surfaces and forces (which are all part of world knowledge). Thus, *unbreak* is not a part of Paradigm A. Moving up, *unbreak a limb* does not pass the felicity restrictions at the minimal VP level and is #, while *unbreak a page* is completely acceptable as part of our knowledge of technological jargon, thus yielding success at **[Level 2]**. This variable

felicity as mediated by direct objects lands the [*unbreak* + object] unit in Paradigm B. Note that a * or # evaluation at any of the levels would automatically yield ill-formedness (ungrammaticality or infelicity) for the entire sentence that contains the structure (with the exception of the select configurations we classified as 'impossibilitative' above that we analyze later in the paper, i.e. modals or negation that can occur higher above the labels and coerce felicity/well-formedness of a specific kind back into these structures). Overall, we put forward the view that the different levels of compositionality allow different paradigms of success in affixation, and these should hold cross-linguistically as well, insofar as paradigms like in (17) can be found within and across languages extensively. It is also important to note that in different languages the concepts of reversal and restitution might be expressed completely outside the morphological paradigm altogether – e.g. adverbially, periphrastically or via derivationally unrelated lexical items.

2.4 State of the direct object

2.4.1 Integral change

Exploring the notion of change-of-state from the viewpoint of the *affectedness* of the object is undertaken in Beavers (2011) (inspired by a vast body of related work, see Beavers 2011 for a list of applications of the concept in different domains), who presents a classification of predicates along an 'Affectedness Hierarchy'. The scalar hierarchy encodes degrees of change in the object, depending upon scalar properties of the predicate.

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*)

Fig. 1: The Affectedness Hierarchy (Beavers 2011: (62))

The verb classes in (12) can be subsumed under these categories (Beavers 2011):

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

b. 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.*

c. 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.

d. The remaining category is **potential for change**, where reaching a specific result state is possible but not necessary; examples – *wrap, furl, clip, chain*, etc. This is where the *re-* and *un-* overlap lies, which we map out in detail in (60-e) and Section 5.2.

Right now, let us first get into the details of this 'potential for change' category. Beavers states that the class of potential-for-change (henceforth, **PFC**) predicates overwhelmingly contain "surface contact/impact predicates" (Fillmore 1970, Rappaport Hovav and Levin 2002, Beavers 2011). Crucially, the defining property is that the objects of such predicates do not have to reach any defined result state as a result of the action. Some examples we collected are *tangle, tie, coil, bend, attach, twist, roll, furl, harness, leash, cross, braid, anchor, wrap, veil, straighten, plug*, etc., and all the technology verbs discussed above (*friend, subscribe, follow*) etc. *Un-* and *re-* are both very compatible with the potential-for-change class (albeit with further refinements in distribution for *re-* which we analyze below):

(21) Rahul un/re-(tied/ attached/ twisted/ braided/ wrapped/ learnt / latched/ fastened) the object.

Surface contact/impact predicates depict the transmission of force on an object (cf. force dynamics in Croft 1990, 1991, a.o.), and the objects are consequently *force recipients* (Rappaport Hovav and Levin 2001). These verbs then pass the *What happened to x* test that picks out force recipients (Cruse 1973, Lakoff 1976, Jackendoff 1990, Rappaport Hovav and Levin 2001), as shown in (22). In contrast, note that verbs whose objects are not force recipients, such as *claim, think, believe, hear, see*, etc., do not pass the *What happened to x* test ((22)c).

(22) **Force recipient detection:** *What happened to x is y* test

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

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

c. #What happened to (the claim that) Voldemort has returned is that Harry claimed it.

But crucially, PFC verbs do not entail **a lexically specified** outcome, as seen with multiple possible causative alternations (cf. Kac 1976) in (23).

(23) **Lexical causation:** *that (action x) caused / allowed y* test

a. John coiled the rope and that caused the rope to be knotted up.

b. John coiled the rope and that caused the rope to tear.

c. John coiled the rope and that caused the rope to break.

d. John coiled the rope and that caused the rope to disintegrate.

e. John coiled the rope and that caused the rope to come loose.

f. John coiled the rope and that caused the rope to tighten.

g. John coiled the rope and that allowed the rope to remain undamaged.

No change in the object is entailed nor is any specific and targeted result state entailed by the PFC predicate *coil*. Note that all the causative alternations described in (23) are related to the action of the verb *coil* – i.e. coiling a rope can plausibly cause any of these states of the object to come about or allow to remain intact, but none are lexically entailed. 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, Rappaport Hovav and Levin 2002, a.o.) which are verbs that lexically entail some change in the object.

Now, all of these types of changes in (20), whether already lexicalized or potential, are changes in the *integrity* of the object itself, i.e. some internal change that affects parts or the whole of the object (what Hale and Keyser 1997 would call 'material integrity'). Let's call such alteration in the integrity of the object 'integral change'. See our Figure 2 below for a clear representation of how we visualize different parts of an object. Integral change leads to entailments, which can be diagnosed with some tests (Beavers 2011). One diagnostic test is the *What happened to y* test shown above in (22), another test is the contradictory result when continued with negation (see also Tenny 1992, Kratzer (2000)), shown below. The point of this test is to show that a target state (related to integral change or impingement) can be lexically or potentially entailed. This test is not to isolate a class, but to show that the lexical or potential change (e.g. in the case of *coil*, a PFC verb) entailment cannot be cancelled.

(24) **Affectedness detection:** contradictory negation test

a. John coiled the rope, #but it is not coiled.

b. John scrambled the letters, #but they are not scrambled.

c. John consumed the apple, #but it is not consumed.

So we can say that the 'change' part in the PFC title means potential for integral change. The other part of the PFC classification – the 'potential' part – has another consequence. Since integral change is not lexically 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 (see Sections 4 and 5 for detailed discussion on and implementation of reversal). *Un-* is sensitive to exactly this information about verbs and their results. In essence, any verb can contextually and lexically allow *un*-prefixation as long as the possible change in the state of the object after the action of the BASE verb has not resulted in alteration that precludes the attainment of the initial state of the object before that action. Thus, the crucial point is that it is not about the label pertaining to the types of changes, but about the bigger, all encompassing label of a "reversible result state" in the condition of the object. We will show in Section 5.2 that although this concept can seem hard to pin down in its magnitude, it can be formally analyzed and predicted.

In order to make clear our proposal to understand surface-level alterations (next section) distinctly from integral-level alternations (internal parts, this section) which are both distinct from treating the object as a whole, we use the following figure as an example:

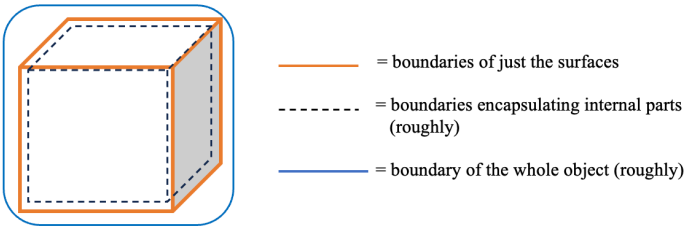


Fig. 2: A cube object showing surfaces separate from internal parts and the whole

The boundaries of just the surfaces is shown with orange lines, the boundaries encapsulating the internal/integral parts are shown with black dashed lines (in a rough approximation, with white space included to distinguish the lines), and the whole object is encased within blue lines (again, a rough approximation containing white space). The integral changes discussed in this section are changes that occur (actually or potentially) inside the black dashed lines. And in the case of consumption/creation verbs, whereby the whole object is affected, the change affects everything within the blue boundaries of the whole object, which is still called integral change in the literature. In the next section, we make a case for a type of change that affect only the surfaces (contained by orange lines) to the exclusion of the area within the dashed lines.

2.4.2 Impingement

While talking about surface contact predicates, we need to discuss a special set of contact verbs that have been included under the PFC category by Beavers (2011) and under 'potential or latent incremental theme verbs' by Rappaport Hovav and Levin (2002). Some of these are *hit, wipe, kick, punch, slap, scrub, scratch, shovel, rub, sweep, comb, scrape, whack*. However, these verbs all disallow *un-* and also *re*-prefixation:[9]

(25) Rahul *un/*re-(hit/ wiped/ kicked/ punched/ slapped/ scrubbed/ scratched/ shovelled[10]/ rubbed/ swept/ combed/ scraped) the object.

We claim that 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. We call these verbs *impingement-effecting predicates* (IE, for short). Impingement we use as a technical term to denote surface-level alteration only, while integral change as described above affects deeper parts or wholes of the object. Given the representation in Fig. 2 above, these are lexically understood to target only the space contained within the orange lines, and not the area inside the dashed lines or the entirety of the object as a whole. It is a nuanced distinction, but one that the affixes track – in that they attach to PFCs but not to IEs.

Firstly, IE predicates entail affectedness of the object, as we show here with the contradictory negation test used to detect affectedness:

(26) 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 as described and represented above, we shape the *What happened to y* test to focus just on the surface – a *What happened to the surface of y* test. The minimal pairs below show that IE predicates pass this diagnostic test of surface-level imposition, while with PFC predicates it leads to strangeness.

(27) **Impingement detection:** *What happened to the surface / face of y* test
a. IE: What happened to the surface of the car is that Rahul scratched it.

[9] We will get to *re-* in more detail in Section 3.

[10] Neither COCA nor our lexicographic sources accept *reshovel* as a word, but some speakers may find *reshovel* acceptable with some objects only – *John reshoveled the driveway* – and very unnatural with others – ??*John reshoveled pasta into his mouth/ ??Mary reshoveled coal into the fire* (where the strange implication is that the object is shared across the two events, i.e. John spat out the pasta and reshoveled that same pasta back into his mouth).

b. PFC: #What happened to the surface of the rope is that John coiled it.

(28) a. IE: What happened to the surface of the meat is that Rahul rubbed it.

b. PFC: #What happened to the surface of the envelope is that John sealed it.

(29) a. IE: What happened to the surface of the driveway is that Rahul shovelled it.

b. PFC: #What happened to the surface of the wire is that John twisted it.

The PFC verbs cannot pass this test felicitously precisely because they signal possible integral change – a twisting of a wire potentially affects the entire wire, a sealing of an envelope potentially affects the entire envelope, a coiling of a rope potentially affects the entirety of the rope, etc. In contrast, the actions in IE saliently target the surfaces of the objects. The preference of *un-* and *re-* for PFC predicates but dispreference for IE predicates points to the property of irreversibility associated with surface alteration that the potentiality of integral change does not have, leading to different entailments of the verbs.

If we reverse the way of thinking about this, IE verbs can induce some conceptual or visible (dependent on the object) shift in the *exterior* of the object between the left and right boundaries of the action that PFC verbs do not. To capture these differences in entailments, we have devised the "*the face/exterior of x wasn't impacted at all*" test. In most cases, IE verbs fail to pass this test, while PFCs have no infelicity with them ((30)-(31)). In cases where IEs pass the test, the properties of the object come into salience: for example, the stains in the carpet are too deep in (32), or a cat scratched the surface of the car so lightly that it's not really visible.

(30) a. IE: #Rahul shovelled the driveway, but the face of the driveway wasn't impacted at all.

b. PFC: John attached the harness to the horse, but the exterior of the harness wasn't impacted at all.

(31) a. IE: #Rahul combed his hair, but (the exterior/surface of his hair) wasn't impacted at all.

b. PFC: John unscrewed the bottle, but the exterior of the bottle wasn't impacted at all.

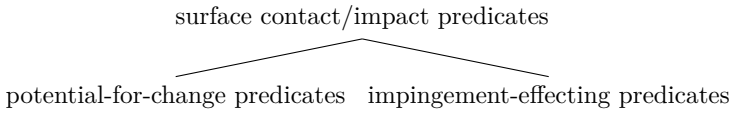
(32) a. IE: Rahul scrubbed the carpet, but the face of the carpet was not impacted at all.

b. IE: My cat scratched my car, but the exterior of the car wasn't impacted at all.

While this test and thereby the entailments are definitely subject to contextual manipulation whereby the variability in the force applied on the force recipient can enrich and alter the results, the main observation across the different tests is that PFC and IE predicates form somewhat of an opposition – the former naturally affects deeper parts or wholes (if at all), while the latter naturally affects surfaces (if at all). This divide comes naturally from our technical use of the terms 'integral change' and 'impingement'. Again, this is not to discount the fact that extremely enriched contexts cannot license IEs damaging entire objects or PFCs scratching only surfaces; we provide the fundamental distinctions here based on which such enrichments can be further studied.

Overall, we have put forward the proposal that the large class of verbs that has been deemed as 'surface contact/impact predicates' actually contains further sub-divisions:

(33)



We thus advocate for keeping the notions of impingement and integral change distinct, and we can visualize a cline base on how much imposition the object/force recipient goes through:

(34) integral change not entailed, impingement not effected > impingement effected > integral change entailed

The category 'integral change not entailed, impingement not effected' contains the entire set of PFC verbs, since they do not lexicalize a fixed result and neither do they affect only surfaces/exteriors. The other two categories contain IE verbs and other COS verbs (ranges of verbs with lexicalized changes, as described in Section 2.2) respectively.

As before, telicity does not help isolate this class of IE predicates (cf. Horn 2002, who attributes **unhit* to the base verb *hit* being an atelic activity). For example, Rappaport Hovav and Levin (2002)(274) note that 'surface contact verbs may pattern as telic or atelic with respect to standard telicity tests.' Their examples (Rappaport Hovav and Levin 2002: 17, 18):

(35) a. Lee scrubbed the tub for hours. (ATELIC)
b. Lee scrubbed the tub in three minutes flat. (TELIC)

(36) 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, the following properties can be attributed to the distinct types of force-transmitting verbs, precisely because affixes are sensitive to such differences:

PFC	IE	COS
✓ force transmission occurs	✓ force transmission occurs	✓ force transmission occurs
✗ integral change entailed	✗ integral change entailed	✓ integral change entailed
✗ impingement effected	✓ impingement effected	✓/✗ impingement effected

Table 1: Classes of force-transmitting verbs

COS verbs may or may not affect the surfaces of an object in the process of affecting integral change to its parts, signified here by ✓/✗ for effecting impingement. Next, after studying the distribution of *re-*, we will be in a position to compare the distribution of *un-* and *re-* vis-à-vis these distinct classes and other classes of verbs.

3 The distribution of *re-*

Re- is a very productive prefix in English, and its wide usage is evident in historical records as well as in new digital and technological domains. *Re-*'s sensitivity to the result state of the action of the base verbs it attaches to has been well observed as well. In this section, we explore *re-*'s distribution and observe crucial overlaps with *un-* both in compatibility with the various classes of predicates discussed above as well as in meaning, including how the meaning of the adverb *again* has been compared with it. We will see that *re-*'s core meaning and use can be affected by the type of direct object the verb stem takes and the enrichment of contexts, just like with *un-*.

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

(37) a. John rebuilt the house.
b. John restarted a car.
c. #John remasked his feelings.
d. #John reconsumed the information.

What does *re-* denote? The answer to this question has been divided, especially in direct comparison with the adverb *again*:

(38) 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) has a range of interpretations (McCawley 1968, Dowty 1979, Stechow 1996, Fabricius-Hansen 2001, Jäger and Blutner 2000, Beck 2005, Beck et al. 2009, among many others):

(39) a. repetitive: The *action* of opening happened again.
b. restitutive: The *state* of being open was restored.
c. counterdirectional[11]: The state of being open occurred, followed by closing, followed by an opening.

Many authors – Marchand (1960), Dowty (1979), Keyser and Roeper (1992), Williams (2006), Marantz (2007), Beck et al. (2009), Alexiadou et al. (2014a), Csirmaz and Slade (2016), Blackham (2017), Stockall et al. (2019)

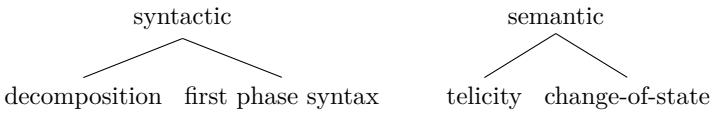
[11] Old English had this interpretation of *again* which has since been lost (Beck 2005, Gergel and Beck 2015, Blackham 2017).

– have argued that *re-* only has a restitutive interpretation. The contrasting view is Lieber (2004), who argues *re-* is purely repetitive, and not restitutive. We concur with the majoritarian restitutive view, and agree with the fact that *re-* is not just an affixal counterpart of *again*, but has its own distinct distribution.

Re- has been well-studied in the syntactic literature, resulting in formulations of explicit restrictions in syntactic selection as well as some remarks about possible semantic considerations *re-* is sensitive to. For example, Carlson and Roeper (1980) argue that *re-* can only attach to transitive verbs with an NP complement, and not ditransitives; in the same vein, Wechsler (1989) argues that *re-* obeys the 'Sole Complement Generalization' in not occurring with two obligatory arguments; Keyser and Roeper (1992) echo this ban on ditransitives with *re-* and attribute it to *re-*'s clitic status, placing it in the same syntactic slot as indirect objects, argumental resultatives, and causatives – ensuring the incompatibility of *re-* with all of these elements; Marantz (2007) argues that, out of a higher "causer" event and a lower "caused" event in a verbal spine, *re-* scopes over the lower event, resulting in a "become-state". All of these authors point out *re-*'s incompatibility with small clauses, ditransitive verbs, intransitive verbs, causatives, etc. Lieber (2004) points out, however, that certain verbs in the intransitive category such as some unaccusative/inchoative verbs do allow *re-* attachment (*reascend, redescend, regrow*), while some others in the same category do not (**reexplode, *rearrive*).

Fewer works have examined *re-*'s sensitivity to aspectual and other semantic considerations in detail. Levin and Rapoport (1988) first noted that "it seems clear that there are aspectual constraints on the meaning of the verb that *re-* can attach to", but they do not specify what these constraints may be or whether they are related to grammatical or lexical aspect, and Keyser and Roeper (1992) followed their insight in arguing that a concrete, repeatable "sub-event is a natural precondition" for *re-*. These ideas are not cashed out in formal semantic terms in these works. Keyser and Roeper (1992) do stress that *re-* requires a telic event; this claim of telicity of *re-* is also found in Smith (2013). Csirmaz and Slade (2016) argue that *re-* necessarily requires a result state.

Thus, in the existing literature, two main camps of explanations can be distinguished:



Again, we will examine telicity and change-of-state properties of *re-*'s BASE verbs below, and note that a single-minded pursuit of any of these properties does not accurately capture the whole distribution of *re-*. In Section 6.2, we provide a brief overview of the syntactic explanations and point out how those make some incorrect predictions.

3.1 Telicity, lexical aspect and *re-*

The first point of overlap between *un-* and *re-* is that the meaning of *re-* also requires a prior event (the BASE verb) with a result state, just like *un-*. The difference arises in *re-*'s assertion that this result state is achieved again through the action of the *re-*verb, while *un-* demands a reversal of the result state. This crucial difference, we argue, leads to *re-* having a more diverse distribution in terms of verb classes than *un-*, since more classes of predicates putatively leave the object in some result state that can be achieved again than in one that can be reversed.

Smith (1997) terms *re-* as a telic prefix. Lieber (2004) contests this position, arguing that *re-* can attach to verbs with atelic interpretations (shown as (40)(a)), whereby the atelic interpretation is retained given the *for*-PP modifier. Conversely, Lieber notes that *re-* does not attach to many typical telic verbs, an example of which is (40)(b).

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

Thus, Lieber (2004) concludes that telicity cannot be the property that accurately delimits *re-*'s domain of affixation. We add to this conclusion the fact about variably telic verbs as well, as discussed in Section 2.1 above. Verbs that are lexically unspecified for the presence or absence of a telos (i.e. are neither telic nor atelic) allow *re-* prefixation. For example, all the verbs in (7) that are unspecified for telicity and took *un-*, also take *re-*: *rescramble the jigsaw pieces, recurl my hair, repack the stuff, rebraid the ropes, recoil the cables*, etc. The "telic-only" camp again would predict such verbs to either not allow *re-* or have to posit some coercion somewhere, which comes with its own issues of overgeneration.

Coming to lexical aspect, *re-* is compatible with many accomplishment as well as achievement verbs, and thus overlaps greatly with *un-* as described in Section 2.1. Within each class, however, *re-* and *un-* have differences in which verbs they accept as BASE. For example, *re-* can attach to many of the technological achievement verbs *un-* can:

(41) *reitalicize, reinstall, reselect, resend, republish, repause, refriend, refollow, relike, retag, reshuffle, resort*

But not just to technological achievements, *re-* can also attach to traditionally classified achievements (Vendler 1967, Mittwoch 1991). We provide some examples below:

(42) a. John *recrossed* the border.
b. Anu *restarted* the motor.
c. Cookies are a way to not have to *reidentify* ourselves on websites.
d. The ball needs to be *respotted* by an official after a penalty is called.

While many degree achievement verbs disallow *re-*prefixation, some allow it:

(43) a. #John *reripened* the mango.
b. #We *redarkened* the colors on our walls.
c. Some forces *relengthen* the cell.[12]
d. ...As the glass *recooled*, the surface was pulled tight. [COCA]

Coming to other aspectual classes, some authors have suggested that *re-* decompositionally scopes over a BECOME predicate only (Dowty 1979, Marchand 1960, Marantz 2007), and thus cannot occur with verb classes like activities/processes since they do not have a BECOME predicate, i.e. no result states per se. The empirical generalization about *re-*'s incompatibility with only result state verbs largely holds; however, we have been able to find *re-*prefixation with a few activities/processes as well. Some examples are below:

(44) a. *Relook* at an issue with sort of a more objective eye. [COCA]
b. *Reroll* the dough as long as you want. [COCA]
c. You're *rewriting* history. [COCA]

Thus, insofar as activities/processes are not associated with a result state (see Levin 1999 for lexical semantic representations of the major verb classes), it is hard to see how the decompositional route can explain examples such as (44). We also discuss a few more issues with the decomposition approach in Sections 3.2 and 6.2.1. In direct comparison to *re-*, note that *un-*prefixation is disallowed with all of the verbs in (42)-(44). Thus, the conditions on *re-*attachment appear to be much less restrictive than those on *un-*attachment.

3.2 Change-of-state and *re-*

Coming to the various classifications of COS verbs (including the bifurcation between integral change classes) and the class of impingement-effecting verbs we delineated above in Section 2.4, *re-* appears at first glance to show a mixed bag of compatibility across classes. For example, looking at just the verbs themselves (without objects or other influencing elements) like we did for *un-* in (12) yields the following patterns for *re-*:[13], [14]

(45) a. **Causes a change in physical property** *re*: ✓
repaint, reclean, refix, rebreak
b. **Transforms by altering integrity** *re*: *
*rechange, *return[15], *recarve, *retransform

[12] https://www.google.com/books/edition/Some-Mathematical-Questions-in-Biology-m/JgoKEjCccCwC?hl=engbpv=1dq=relengthenpg=PA190printsec=frontcover

[13] These judgements reported in (45) are the result of searches on COCA, Google, Merriam Webster, and Oxford Dictionary for each word below. These are the raw results from these searches, backed up by the availability of its usage in sentences or the lack thereof.

[14] We are using the symbol ⊳ to signal compatibility with *most* members of a class, if not with all.

[15] Where the intended meaning is to make a turn again.

c. **Causes a change in location** *re*: *
*repush, *remove[16], *reangle

d. **Just affects the surface via surface contact** *re*: ✓
repin, rewrap, recheck, retwist, repack, replug

e. **Brings about the creation of the object** *re*: ✓
redesign, rebuild, reconstruct, recreate, refashion

f. **Brings about the consumption of the object** *re*: *
*redestroy, *reeat, *reconsume, *rereduce, *redevour

g. **Degree achievements** *re*: ▻
refill, *redeepen, rewarm, reheat, recool, *reripen, *redarken, redry

h. **No change specified by the action** *re*: *
*reswim, *rewalk, *reponder, *relaugh, *recough

If just the existence of a result state from the base action was required for *re-* to attach (as has been claimed in Marantz 2007, Csirmaz and Slade 2016), then it remains a mystery why *re-* is not good with all of the verbs from (a)-(g) that have result states. Instead, *re-* seems to be sensitive to the nature of the result, and what state the object is in as a consequence.

As we learnt in Section 2, looking at the interaction of syntactic and contextual factors leads to felicity/grammaticality that the lexical item itself may not have. For example, depending upon the type of object, some verbs designated as not having a dictionary entry above in (45) have acceptable uses:

(46) a. ✓[rebreak a limb][17], but #[rebreak a sewer]
b. ✓[recarve a space (in geometry)], but #[recarve a pumpkin]
c. ✓[redeepen the tear (in cataract surgery)], but #[redeepen our bond]

Thus, the combinatorics of the verb and the DO affects felicitous uses. Additionally, many enriched impossibilitative contexts such as those containing negation (similar to (14)) or irrealis constructions (similar to (15)) also host otherwise infelicitous *re*-verbs, just like with *un-*. For example: *You cannot reconsume a burger, You cannot reripen a mango, I wish I could relaugh at her joke*, etc., all have varying levels of acceptability in tandem with the impossibilitative operators. These configurations coerce felicity with *re-* (and also *un-*) where the prefix is otherwise ruled out (we provide an explanation for these in Section 5.2).

Coming to integral change vs. impingement, and looking at the affectedness of the object first through the distinctions within the Affectedness Hierarchy, we can already see how *re-* would fare, given (45), now arranged along the hierarchy:

(47) a. Quantized change: #redestroy the painting, #reshatter the vase, redevelop the infrastructure
b. Non-quantized change: #reslice the fruit, #recut the cloth, restraighten his teeth
c. Unspecified for change: #resmile, #resee the point
d. Potential for change: retangle the wires, reanchor the boat, readjust the volume, rebend the metal

Re-affixation is overwhelmingly felicitous with all PFC predicates, it is acceptable with many non-quantized change predicates (such as some degree achievements), with some quantized change predicates (such as creation predicates). *Re-* appears incompatible with some other quantized change predicates (such as consumption predicates), some other non-quantized change predicates (some other degree achievements), and with all predicates unspecified for change. Thus, while with *un-*, we had been able to demarcate a class cleanly (PFC only), *re-* cuts across classes within the Affectedness Hierarchy whereby several members of one class allow *re-* while other members do not. Thus, these classifications do not provide a homogeneous set of verbs.

Moving to impingement, *re-* is incompatible with all impingement effecting predicates, as we already saw in (25), repeated below:

(48) Rahul #re-(hit/ wiped/ kicked/ punched/ slapped/ scrubbed/ scratched/ shovelled/ rubbed/ swept/ combed) the object.

The crucial point of overlap between *re-* and *un-* that emerges from this landscape falls on one class – the class of PFC predicates. So a theory of meaning that captures the morphosemantic behavior of the two affixes

[16] Where the intended meaning is to move again.
[17] Thanks to Bronwyn Bjorkman for this example.

have to pay special attention to how to define this class and explain what properties of it attract both affixes. Before providing some answers to these questions, we first comparatively summarize everything we have learnt so far about the distribution of *un-* and *re-*.

4 Comparative summary: overlap and non-overlap

We have seen that different factors matter in determining the boundaries of *un-* and *re-*'s distribution so far. Now let's explore what the affixes themselves denote.

What does reversative *un-* denote? As we indicated above in Section 2.2, *un-* is sensitive to is whether or not the state of the object after the action of the base verb is one that permits a reversal to the state of the object before the action. Thus, it is the effect of the action on the object, and whether or not the result is an irreversible change. This property can be pictorially represented, as shown in Figure 3. **Equivalence** is denoted with bidirectional arrows in the figure. We will formally define what the notion of "equivalence" between states (and properties) could be in the next section, where we develop the formal analysis.

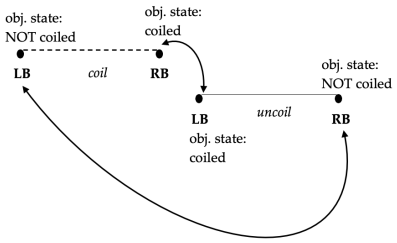


Fig. 3: Internal structure of an *un*-verb

Taking for example the verb *uncoil*, two sets of boundaries of two events can be determined. The left and right boundaries of the BASE event *coil*, and the left and right boundaries of the prefixed event *uncoil* (LB and RB for shorthand). Temporally, the BASE event precedes the prefixed/derived event, but the prefix itself places some stringent restrictions on successful affixation.

Crucially, two conditions need to hold for the successful derivation of an *un*-verb:

(49) a. The result state of the BASE verb's action, as manifested on the object, at the right boundary of the BASE action is equivalent to the initial state of the object at the left boundary of the *un*-verb's action.

b. The result state of the object due to the *un*-verb's action is equivalent in some salient property/outcome to the initial state of the object before the action of the BASE verb.

In comparison, what does *re-* denote? The restitutive meaning of *re-* restores the result state of the BASE verb:

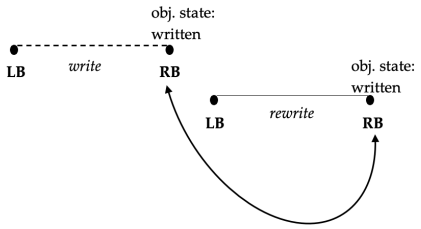


Fig. 4: Internal structure of a *re*-verb

Crucially, one condition needs to hold for the successful derivation of a *re*-verb:

(50) The result state of the *re*-verb's action is equivalent in some salient property/outcome to the result state of the BASE verb's action.

The principles of compositional semantics below the level of the word then require that these affixes only attach to items that fulfill these conditions. To be clear, we are in the domain of morphology, so the affixal morphemes attach to the BASE verbs as expected, and consequently when the objects appear that is when VP-level felicity or infelicity is computed. In the conditions we have formulated in (49) and (50), it is evident that properties of result states are taken as the defining properties. A question may then be asked about telicity and/or lexical aspect classes – how do those factors get included in the selection process? As we hoped to have shown in detail in Sections 2.1 and 3.1, there is no one single telicity descriptor or one single lexical aspect class that can accurately capture the whole set of facts. Thus, we depart from previous work in not using these descriptions in explaining the mechanics of *un-* and *re-*. Instead, it is important to note that all the aspectual distinctions are automatically subsumed within our classes of predicates based on change and result states, i.e. inside and across all the categories in Figure 5 are included telic, atelic, variably telic, accomplishment, achievement, activity verbs.

The statements of equivalence as conditions on successful affixation have another important consequence. The equivalence is stated to hold between properties or outcomes at the end of the verb's action on the object. As a result, the equivalence is not about the *content* of the action, but some salient property of the result state. For example, when a poem is rewritten, its lifespan property after the *rewrite* action is that it is finished, just as it was also finished after the BASE action *write*. So the lifespan properties of the poem after *write* and *rewrite* are equivalent (again, not necessarily in content). This kind of lifespan property-based equivalence is all that the affixes are looking for, as codified in (49) and (50). The content of the changes or additions across the two versions of the poems are not relevant. This is because, as we discussed above, a given object can have many different properties along different dimensions at a lifespan point; not all of them have to be impacted by an action or calculated for equivalence across result states. Similarly, *Joan uncurled her hair* denotes that only the curling property of the hair is reversed, not color, length, etc. Same for *I repositioned the picture on the page* – only the position outcome changed, not any other properties of the picture. Additionally, take very specialized contexts (which can be very dynamically enriched) of use where exact equivalence between states is intentionally blocked. For example, in the context of someone doing origami[18], there can be lots of folding and unfolding and refolding that does not lead to exact equivalence among the various states and lifespan points of the paper (and indeed the origami-doer might want it that way). However, since lifespan properties related to being folded (in a certain way) across multiple actions (notwithstanding additional creases or bends due to the content of the actions) can be compared for equivalence as per (49) and (50), there can be successful *un-* and *re-* prefixation.

We are now in a position to provide a comparative distribution of the two affixes, demonstrating compatibility with verb classes whose properties fully or partially fulfill the conditions posed by the affixes ((49) and (50)). As described above, the some non-quantized change verbs that allow *re-* are degree achievements (examples (43), (47-b)), and the some quantized change that allow *re-* are creation verbs only (examples (45-e), (47-a)).

un-	***re-***
✗ unspecified for change	✗ unspecified for change
✓ potential for change	✓ potential for change
✗ impingement-effecting	✗ impingement-effecting
✗ non-quantized change	$\checkmark_{some}$ non-quantized change
✗ quantized change	$\checkmark_{some}$ quantized change

Fig. 5: The distribution of *un-* and *re-*

Keeping all of these moving parts related to the distribution of the affixes in mind, we lay out our formal analysis in the next section, where we undertake the tasks of explaining how affixes find the information they need, what kinds of information verb roots encode, and how argument structure plays out compositionally at the morphosemantic level.

[18] Thanks to Mark Baker for this example.

5 Analysis

5.1 Part I: Verb roots encode sets of outcomes

Beavers et al. (2021)(p. 452) makes an interesting observation: "the states described by result roots are not dissociable from an entailment of change. Any time a word is formed from a result root, change is entailed. Thus, perhaps the root itself introduces change." We are going to propose a semantics that embodies this outlook towards verb meaning. We have argued that prefixes like *un-* and *re-* 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? We propose that this information is partially stored inside the lexical meaning of a verb, and that consequently determines verb-affix compatibility at the morphosemantics interface.

5.1.1 Lifespans

First, we propose viewing the lifespan of an entity as composed of discrete units, or *lifespan points*, that are points in the existence of the entity. Formally, *lifespans* are intervals, defined on a totally ordered set of lifespan points. To capture the vast diversity in types of objects, we define three distinct types of lifespan intervals: closed lifespan intervals, open lifespan intervals, left-closed right-unbounded lifespan intervals. While lifespans are intervals, lifespan points are bundles of properties that an object has at the smallest discrete linearly ordered point in a lifespan. Crucially, the numbers attached to lifespan points are numerical tags denoting linearization within the lifespan interval, and they are all members of $\mathbb{N}$ (the set of natural numbers). That means that a lifespan point tagged 0 corresponds to the very beginning of the lifespan and n amounts to a numerical variable that corresponds to the end of the lifespan. Thus, lifespan points are thus linearly and totally ordered with respect to each other, and encode relationships such as precedence. For example, lifespan point 12 would precede lifespan point 13, etc. However, lifespan points are not tied to points in time in a given world and cannot be used for temporal specification in an intensional sense. Thus, lifespan points are not temporal elements, i.e. they do not correspond to units of temporal reference such as speech time, topic time, past/present/future etc.

Taking l to be a variable over the smallest discrete unit in the existence of an entity that is a lifespan point:

(51) a. A closed lifespan interval of an object $x := [l_0(x),\ l_n(x)]$
$= \{l(x) \mid l_0(x) \leqslant l(x) \leqslant l_n(x)\}$

b. An open lifespan interval of an object $x := (l_0(x),\ l_n(x))$
$= \{l(x) \mid l_0(x) < l(x) < l_n(x)\}$

c. A left-closed, right-unbounded lifespan interval of an object $x := [l_0(x),\ +\infty)$
$= \{l(x) \mid l(x) \geqslant l_0(x)\}$

Intervals are a computing technique in mathematics that provide guaranteed enclosures. A closed interval (denoted with [ ]) includes all its limit points, thus ranging from the first to last lifespan points of an object. Examples of objects with closed lifespan intervals, i.e. with a beginning and an end, are *human, dog, chair, tree,* etc. An open lifespan interval (denoted with ( )) does not include its endpoints, i.e. they can be abstract objects or concepts that can transcend beginnings and endings. Examples of such objects include *freedom, liberty, leisure, power,* etc. A left-closed, right-unbounded lifespan interval (denoted with [ )) includes the leftmost limit point or the conception point, while allowing an infinite endpoint on the right. Examples of such objects and concepts, i.e. those with included and defined beginnings but infinite life after $l_0(x)$ without a defined end, include *democracy, capitalism, culture, communism, politics*, etc. The direct opposite of (51-c) would be a right-closed left-unbounded interval with negative infinity such as $(-\infty, l_n(x)]$. While mathematically nothing rules out such a lifespan interval, it is very difficult to find real-world objects/concepts that would not have a beginning but would have an end, and thus we leave this particular type of interval out of the formal paradigm. Similarly, we leave out an interval such as $(-\infty),\ +\infty)$ out of the paradigm since it's very difficult to think of objects without a beginning and ending. Note that nothing precludes the inclusion and usage of these types of lifespan intervals if corresponding objects are available.

As we said, lifespan points are essentially bundles of properties. At each of its lifespan points $l(x)$, an entity x can have 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 or more or less:

(52) l_{22} (shirt) = {*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; take for example, *Tom dyed the shirt* vs. *Tom cut up the shirt*. At a lifespan point corresponding to the end of the event of *dyeing*, the property of being the color white has been altered, with no change entailed to the dimensions of size or collars or material, etc. Conversely, at a lifespan point corresponding to the end of the event *cutting up*, there is alteration in the size or dimensions of the shirt but no change to colors or manufacturing, etc.

5.1.2 Outcomes and Thresholds

Verbs that lexically entail integral change in objects (COS verbs; i.e. quantized and non-quantized change verbs) or the possibility of change (PFC verbs) or impingement effecting (IE) verbs affect some or all properties of the objects associated with some or all lifespan points of the object. For e.g. the COS verb *evaporate* entails that the integrity of the object be fundamentally altered, while the PFC verb *attach* does not entail any change, but leaves open the possibility of integral change.

We postulate that all verb roots in all languages come lexically equipped with a **set of *outcomes*** along the dimension supplied by the property in the verb. Let's call this the Verb-Root-Outcomes framework, VRO for short, for easy reference. This set of outcomes consists of possible *states* that the object can be in when it undergoes the action of the verb. Every outcome is a state, while every state is a function.

A *state* k is a function from the set of times/time points (denoted as I) to a set of lifespan points (which could be any of the intervals in (51)):

(53) A state $k :=$
$t \longmapsto l(\mathrm{x})$,
where $t \in \mathrm{I}$ and $l(x) \in [l_0(x),\ l_n(x)]$ or $(l_0(x),\ l_n(x))$ or $[l_0(x),\ +\infty)$

States are what bring in temporality by connecting time points to lifespan points in this definition (see also Maienborn 2011's general argument that states are spatiotemporal entities). The state function thus yields the properties that an object has at a salient time point. For example, the lifespan point l_{22} above can be an output of the state function when it takes the time point k' as input that corresponds to a time it is being displayed at a store.

Our proposal is that every outcome is a state. A set of outcomes is thus a set whose members are individual functions that output 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. This concept of 'potentiality' has been difficult to pin down in the literature. Three main views exist, two of which are presented in very different frameworks: Copley and Harley (2011) present a branching futures analysis; Rappaport Hovav and Levin (2001) present a force-dynamic view based on Croft (1990), Croft (1991); Beavers (2011) uses Tenny (1992)'s Latent Aspectual Structure. In Section 6.1 below, we describe and compare these approaches in more detail. In this paper, one of our goals is to pin down this notion formally as well as compositionally, especially given its role in argument structure.

For an object x, say a piece of wire that undergoes the action of the verb root *fold* associated with event e:

(54) Set of **Outcomes** $(fold(e)) =$

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

There are manifestly many other properties of an object at every lifespan point, as exemplified in (52); the set of outcomes contains only those lifespan properties that are brought about or changed by the verb's depicted action on the object.

Along with this lexically encoded set of outcomes in the verb (verb meanings formally defined below), another important piece of the puzzle is **a set of thresholds** that is contextually available. Every threshold, just like every outcome, is a state; i.e. a function from a time point to a lifespan point. The set of thresholds component, is not part of the verb meaning, but is still crucial for argument structure considerations. A *threshold* is the state of the object at a moment in time **diametrically opposed** to the time of outcome – right at the start of the action of the verb on the object. The set of thresholds then reflects possible states an object (say, a shirt) can be in at the start of the action.

(55) Set of **Thresholds** ($fold(e)$) =

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

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 unpredictability of the set of thresholds arises from the fact that it is not linked to the verb root in any way, since an object can be in any contextually relevant state before the force transmission of the verb commences on it. 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), we can define boundaries of events as well as sets of outcomes and thresholds. The starting and ending point of the run-time are deemed the left and right boundary of the event e – LB($\tau(e)$) and RB($\tau(e)$), respectively. Boundaries of events are instantaneous, in the sense of Piñón (1997) and Marín and McNally (2011). They do not add to the length interval of events, and their temporal traces are points rather than intervals.

(56) a. the Set of Outcomes of e (O_e) =
contains state(s) of the object that are functions from RB($\tau(e)$) to a lifespan point of the object

b. the Set of Thresholds of e (T_e) =
contains state(s) of the object that are functions from LB($\tau(e)$) to a lifespan point of the object

Importantly then, the set of outcomes and set of thresholds associated with a predicate directly coincide with the beginning and end of the action of the predicate. For e.g. the duration of a folding event e is $\tau(fold(e))$; the boundaries are LB($\tau(fold(e))$) and RB($\tau(fold(e))$). We formulate that the time point every state in a set of thresholds of an event e maps to a lifespan point from is LB($\tau(fold(e))$), and the time point every state in a set of outcomes maps to a lifespan point from is RB($\tau(fold(e))$). Let's work out an example. For a PFC predicate like *wrap*, for an object like *the rope*, let's examine the minimal core VP level (verb + direct object) meaning:

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

(58) Set of Thresholds ($wrap(e)$) =

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

Set of Outcomes ($wrap(e)$) =

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

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. Since objects can be in many unpredictable threshold states not related to the verb root before the action starts, and since outcomes can vary widely depending on the amount of force and many properties of the objects, the two sets (the set of outcomes and the set of thresholds) can vary widely in size – one may be larger or smaller than the other, or they may be equal in size. This kind of comparison of size is not necessary for the semantics though, since many of these considerations come from the natural world and nothing in the semantics depends on the comparison of set size between thresholds and outcomes.

The nature and degree of the *force* associated with an event can interact in unique ways with the object of the force, as governed by natural laws. Copley and Harley (2011) synthesize the insights on force from the main viewpoints in physics – where there is gravity and an object with mass, a force does arise, and this force results in an event if there are no stronger intervening factors. This physical fact of force is important – the action/force transmission of dynamic verbs applies to the object. This fact can be modeled via a meta-predicate APPLIES that captures force transmission on a force recipient:

(59) $[\![\text{APPLIES}]\!](e)(x)$ = the force associated with the action e is being exerted on x

This would ensure that the dynamic process happened on x, and it would not apply for stative verbs. The application of force on x would lead to some result state of the object x, with or without integral change or impingement, depending on the type of force associated with the event. The formal definition of a dynamic transitive verb root thus is as follows (prior to existential closure over the event):

(60) a. $[\![\textit{wrap}]\!]^g = \lambda x_e \lambda e_v.[\text{wrap}(e)(x) \wedge \text{O}_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$
b. $[\![\textit{fold}]\!]^g = \lambda x_e \lambda e_v[\text{fold}(e)(x) \wedge \text{O}_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$
c. $[\![\textit{twist}]\!]^g = \lambda x_e \lambda e_v[\text{twist}(e)(x) \wedge \text{O}_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$
d. $[\![\textit{zip}]\!]^g = \lambda x_e \lambda e_v[\text{zip}(e)(x) \wedge \text{O}_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$
e. $[\![\textit{seal}]\!]^g = \lambda x_e \lambda e_v[\text{seal}(e)(x) \wedge \text{O}_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$

These are all PFC verbs. The variable k ranges over result states of the object once the force designated by the action/event of the verb has been applied on them. The set of outcomes O for events corresponding to verbs like *wrap, fold, twist, zip, seal*, etc. is a multi-membered set, such as in (58).

A multi-membered set of outcomes is the hallmark of a PFC verb. We propose that such a multi-membered set is how the system determines 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 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.[19] The sets of outcomes of the events are included in the semantics, containing as members states taking the right temporal boundaries of events as arguments and yielding the corresponding lifespan points as output:

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

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

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

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

[19] We have provided the truth-conditional semantics here. The context determines exactly what kind of brokenness, transformation, displacement, etc. is salient for computing the truth-conditions correctly.

where $O_e = \{k \mid k(RB(\tau(destroy(e)))) = l(x)_{\text{cease to exist}}\}$

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

f. Degree achievement verbs (*fill, heat, cool*, etc.)[20]
$[\![cool]\!]^g = \lambda x_e \lambda e_v[\text{cool}(e)(x) \wedge O_e = \{k \mid k = \text{APPLIES}(e)(x)\}]$,
where $O_e = \{k \mid k(RB(\tau(cool(e)))) = l(x)_{\text{attain a contextually salient degree in temperature}}\}$

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

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

Thus, given the VRO approach to verb root semantics, we have the following hierarchy of outcome sets depending on verb class, where the COS label includes quantized and non-quantized change verbs:

(62) multi-membered sets (PFC) > singleton sets (IE, COS) > empty sets (no change specified)

5.1.3 What's not an outcome? Lexical vs. logical entailments of verbs

We have discussed lexical entailments a fair bit above, given our proposal that verb roots encode sets of outcomes. It is important though to make clear what kind of state does not fulfill the definition of being an 'outcome'. Here comes in an important distinction between lexical entailment and logical entailment of verbs. Only lexical entailments qualify as outcomes, while logical entailments do not.

Every single verb will be such as to entail a state of the object that is *logically* related to the verb's action, or, if there is no object, a state of affairs that logically holds by virtue of the action having taken place in the world. These states are logical entailments of verbs. Even unspecified for change verbs have logical entailments. For example, all *knowing* logically entails a state of having known, all *running* logically entails a state of having run, all *hitting* logically entails a state of having been hit, all *dancing* entails a state of having danced, all *smiling* logically entails a state of having smiled, and so on. Each directly related state is a logical entailment of each verb. While lexical entailments are attained only by understanding the application of force on the object and consequently the entailed (or potential) states of the object, logical entailments are not informative result states revealing any state of affairs in the world that is a consequence of the action per se. Thus, logical entailments should not be confused with lexical entailments, and the former are not included in the set of possible outcomes. That is why verbs unspecified for change or mental state verbs have empty possible outcome sets. Possible outcomes as formally defined above include possible result states that are informative, given the information about the verb's action on the direct object. For more on lexical and sublexical entailments of change in stative forms, see Beavers et al. (2021).

Other states that are not outcomes are ones which are completely unrelated to the action depicted by the verb. For example, applying the causative alternations test we posited in (23) above (the lexical causation test), we can see that apart from the first result state none of them can be felicitous outcomes, since none of the others in (b)-(e) are the direct results of the force of the action on the object as described by [*build + the bridge*], thus lacking the important lexical causal link:

(63) a. The engineers *built* the bridge and that caused it to come into being.
b. #The engineers *built* the bridge and that allowed it to remain intact.
c. #The engineers *built* the bridge and that caused it to suffer damage.
d. #The engineers *built* the bridge and that caused it to partially come into being.
e. #The engineers *built* the bridge and that caused it to become unstable.[21]

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

[21] For native speakers, this one is only acceptable when some other event *after* the building event made the bridge unstable; i.e. maybe some other mechanical operation was done on it after it was already built. With the causal link we are testing here – that the building event itself has to have caused the instability – our speakers did not accept this example.

5.2 Part II: *Un-* and *re-* are result state modifiers

The set of outcomes of the verb's action being built into the meaning of every verb root has a direct consequence in compositionality – automatic productive and impossible combinatorics as mandated by the argument structure of verbal affixes as they attempt to combine with the verb root.

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, underline added).

We propose that 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:

(64) $[\![\texttt{res}(\text{e})(\text{x})]\!] := \text{k}_e(t')(l(x)) = 1,$
where $t' = \text{RB}(\tau(e))$ and $l(x) \in [l_0(x),\ l_n(x)]$ or $(l_0(x),\ l_n(x))$ or $[l_0(x),\ +\infty)$

(65) $[\![\texttt{pre}(\text{e})(\text{x})]\!] := \text{k}_e(t')(l(x)) = 1,$
where $t' = \text{LB}(\tau(e))$ and $l(x) \in [l_0(x),\ l_n(x)]$ or $(l_0(x),\ l_n(x))$ or $[l_0(x),\ +\infty)$

`res` and `pre` are thus operators that yield the state $(t \longmapsto l(x))$ 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 should be highlighted here. `res` and `pre` are not temporal operators, i.e. they do not yield the temporal boundaries of events, but yield states of the object. These operators allow us to compute **equivalence** (=) between states and even events. This concept of how to understand the equivalence between two events has been a sticky topic in event semantics (cf. Lemmon 1967, Parsons 1990, Maienborn 2011, a.o). The operators in (64)-(65) provide a way to chart out similarities and differences in conditions imposed by and on events and objects.

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

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

Let us see this semantics in action, with a sentence such as *Veena unfolded the parchment.* The meaning of *un-* is defined iff:
(i) 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. Then *un-* asserts that the result of the *unfolding* action renders the parchment in a state with the same salient 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.
(ii) *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 semantics formally captures the "inverseness/contrast at the heart of *un-*'s meaning" (Horn 1988).[22] This inverseness is the reversability that we had depicted pictorially above with bidirectional arrows for equivalence,

[22] A possible objection to our analysis may be raised from the viewpoint of *un*-verb usage in contexts where there might not be an eventive prior event per se. For example:

(i) a. The child's nose was congenitally *blocked*, but the surgeon managed to *unblock* it.
b. Some linguists *uncovered* a generalization about *un-* and *re-*.
c. A paper set out to *untangle* the factors that govern the distribution of pronouns.

Although such uses where the BASE event is assumed to occur without human intervention or where the objects are produced/encountered were less frequent than the productive uses of *un-* we have been studying so far, it is important to see if such cases can be accounted for with the same theory. The main issue these cases can be argued to pose is that there is no blocking event per se in (a), since the child was born with a blocked nose. Similarly, in (b) there cannot be assumed to have a been a prior event of covering the generalization, and in (c) no prior event of tangling the factors. We suggest that these cases can be subsumed by the analysis in (66) as well. The lambda term abstracts over an event that results in a state serving as the pre-state to the *un*-verb, but this event is standardly assumed to be closed off by an existential closure operator in order for the whole sentence to have a propositional extension. In cases like (i), the context will accommodate the fact that the existential closure might be vacuous or non-eventive, i.e. a value that does not refer to any event per se.

repeated here. Reversability is thus equivalence between pre-states and result states of prior and later events applied to the same object.

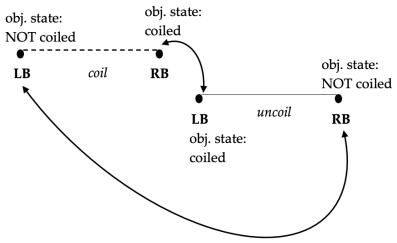


Fig. 6: Repeated from Fig. 3 above: Internal structure of an *un*-verb

(67) **The distribution of reversative *un-*:**
un- demands two properties in a BASE verb: the possibility of inverse equivalence between *res* and *pre* states (the property of reversability), and a multi-membered outcome set (the property where the cardinality of outcome sets > 1).

The semantics in (66) builds in these two properties: reversability as a combination of both the presuppositional content/definedness conditions and assertive content, and the cardinality of outcome sets > 1 as presuppositional content. It is important to note that that the properties of reversability and the cardinality of outcome sets are not inherently connected, i.e. singleton outcome sets can have such outcome states in them that are able to satisfy the inverse equivalence conditions. These are two properties that *un-* is sensitive to, and furthermore, only accepts verb roots that satisfy *both* conditions. PFC verbs are a natural class that satisfy both conditions and thus overwhelmingly allow *un*-prefixation with different kinds of objects. At the end of this section, we discuss how the impossibilitative contexts allow the loosening of some of these restrictions, thus allowing some cases of otherwise disallowed *un*-prefixation.

We can provide a semantics for *re-* with the same tools as for *un-*. *Re-* also presupposes a core fact about the result state of a prior event.

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

The meaning of *re-* is defined iff:
(i) a presupposition stating that the result state the object is in at the right boundary of the BASE event be equivalent to the result state the object is in at the right boundary of the *re*-verb event is satisfied
(ii) *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 (denoted with the logical symbol $\bot$).
To see this analysis in action, consider the minimal pair below.

(69) a. Raj reloaded the truck.
b. #The children reshattered the mirror.

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

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

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*:

(71) $[\![shatter]\!]^g = \lambda x_e \lambda e_v[\mathrm{shatter}(e)(x) \wedge \mathrm{O}_e = \{k \mid k{=}\textsc{applies}(e)(x)\}]$,
where $\mathrm{O}_e = \{k \mid k(RB(\tau(shatter(e)))) = l(x)_{\text{integrally break apart into pieces}}\}$

This explanation can also cover similar cases with *re-* where the event depicted by the base verb may not have happened; e.g. from Marantz (2007) – a door was built open and hasn't been touched since, and John just closed the door and then:

(ii) John reopened the door. (the state of openness was restored without a prior opening event per se)

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 (68) 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 (50) was a necessary but not sufficient condition; the semantics in (68) now gives us all the necessary and sufficient conditions to capture the restitution at the heart of a *re*-verb (which we had depicted pictorially above with bidirectional arrows, repeated below). Restitution is thus equivalence between result states of prior and later events applied to the same object.

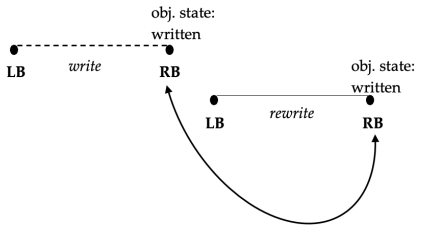


Fig. 7: : Repeated from Fig. 4 above: Internal structure of a *re*-verb

(72) **The distribution of cyclic *re-*:**
re- demands that there the object not be in a state at the end of the BASE verb action whereby the result of the BASE action cannot be restored via the putative *re-* + BASE action.

An important semantic difference between the two affixes is that *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 attach productively to many types of predicate categories, whether they be multi-membered outcome sets (like PFC predicates) or singleton outcome sets (like sub-types of quantized or non-quantized change).

The semantics for the affixes allow direct explanations for some of the empirical contrasts we laid out in Sections 2.2 and 3.2, which have to do with differences in interaction with direct objects both across the distributions of the affixes and within their own distributions. The contrasts are repeated below:

(73) a. ✓[rebreak a limb], but #[rebreak a sewer]
b. ✓[unbreak a page in MS word], but #[unbreak a limb]

First, with the same verbs in each case (*unbreak* and *rebreak*), a difference in the choice of the direct object results in a difference of felicity/well-formedness of the VPs. That is to say, at the minimal VP level `[Level 2]` (as described in Section 2.3, the second member of each pair would fail to pass. Secondly, across the two verbs the object makes a difference – limbs can be *rebroken* but not **unbroken*. In essence, the semantics we posit for the two affixes already has room for the variability of the object built in. The object variable x is a core part of the computation of `res` and `pre` states, and in cases of force transmission, as the force recipient in computing outcomes. Thus, even within the morphological domain of affixation, [verb + object] units/minimal VPs get represented in the semantics.

Let's start with ✓[rebreak a limb], but #[rebreak a sewer]. The definition of *re-* has the well-definedness restriction that needs to be satisfied for compatibility in affixation: $\texttt{res}(e)(x) = \texttt{res}(e')(x)$, which demands that the result state arising out of the force of the prior action (the BASE e') on the object x be equivalent in salient lifespan properties to the result state of the affixed *re*+BASE action (e) on the same object x. In this case, the sewer is already broken at the lifespan point *l(x)* at the right boundary of the BASE *break*-ing event. *Break* as a verb lexicalizes a salient outcome of breakage (see the definition in (61-a)) which has already been reached by *break*(*sewer*). Now, *rebreak*(*sewer*) does not contribute any new relevant state or property in the lifespan of the sewer. Even if it is broken in different spots across the two events, the consequences of the breakage of a sewer are very similar. This lack of new information or outcomes leads to a redundancy (and thus infelicity). In contrast, depending on the amount of force and location of breakage, the breaking of a limb can have very different properties. For example, breaking one's femur leads to a lifespan point with very serious damage – artery damage, tissue damage, extensive bleeding. It is also the most difficult bone to break in a limb. On the other hand, a thin hairline fracture is the outcome of much less force and causes much less damage. The lifespan of a limb can thus have multiple breaking actions with different levels of causal forces

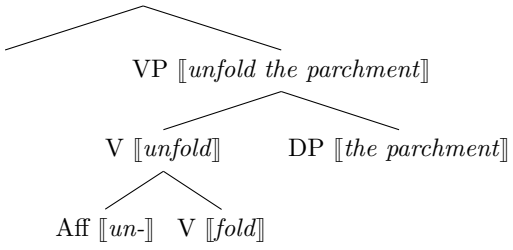
and very different outcomes (not to mention many possible thresholds given prior contextual information). Thus, the condition in *re-*'s semantics – $\texttt{res}(e)(x) = \texttt{res}(e')(x)$ – would still hold for [rebreak a limb], since both are broken result states and *re-* does not need to specify any more detail about the breakages. But in this [action + object] unit, there is no redundancy given our knowledge of the type of force on the type of object, and thus no infelicity.

Next let's compare the minimal pair ✓[rebreak a limb] but #[unbreak a limb]. The definition of *un-* is formalized in a way where the assertive content and the presuppositional content work together to yield reversability. The $\texttt{res}(e')(x)$ function, where e' is the prior event of *break*-ing a limb, will pull out a particular point in the lifespan of a limb such that a bone (or more) is broken in the limb in some salient way. It would be impossible, given the mechanics of limb-breaking as we discussed above, to meet the claim in the assertive component of the semantics: $\texttt{res}(e)(x) = \texttt{pre}(e')(x)$. No matter what kind of "unbreaking" action we can visualize – putting the pieces back together surgically, rearranging them with medical glue – the result state of "unbreaking" that is equivalent in lifespan properties to a state prior to/at the left boundary of the "breaking" action is unachievable, precisely because of the outcome lexicalized by *break* as applied to an object like *a limb*. Thus, while [rebreak a limb] is possible since the result state of breaking can be achieved again, with different lifespan properties after each outcome; i.e. the breaking event damaged bone A in the limb, the rebreaking event damaged bone B in the limb, but both amount to the same result state of 'broken'[23]; *un-* however, wants inverse equivalence of `pre` and `res` states and thus [unbreak a limb] is not possible, given our world knowledge of the force mechanics of actions on objects, and that is what the semantics predicts.

Lastly, [unbreak a page in MS word] is possible in contrast to #[unbreak a limb]. The force/action of *break*-ing as understood to be applied to an object like a page in a computer application is vastly different from that force applied on a limb or other objects of different fragility. The action + object unit of [unbreak a page in MS word] does not result in an outcome that alters the lifespan of the object in a way as to preclude the validity of the assertive statement $\texttt{res}(\textit{unbreak}(e))(\textit{a-MS-word-page}) = \texttt{pre}(\textit{break}(e))(\textit{a-MS-word-page})$. Interestingly, there is another nuance with such technological verbs. The traditional notion of force as we defined with the meta-predicate APPLIES in (59) is applied on a mouse or a key to bring about the page break, for instance, and thus the force itself is not directly applied to the page. These technological verbs thus all change the objects in the expected way, but all of them involve the implied notion of instruments – the mediation of a mouse or stick or a keyboard key are required as crucial instruments, and we assume that this is information supplied by world knowledge.

The comparative distribution of both affixes as laid out in Figure 5 has now been captured. In keeping with the wholly compositional spirit of our enquiry, we can see how sub-lexical and lexical composition would work with these affixes and the verb semantics we have formulated. Sample derivations with both *un-* and *re-* are provided below; we show a PFC BASE verb with *un-* and a quantized change BASE verb with *re-*. Both treelets exclude the subject, showing till `CC2`, i.e. the minimal VP, and both show the derivation prior to existential closure:[24]

(74)



[23] A reviewer notes that with *rebreak a limb*, they cannot get an interpretation where different bones are broken across the *break* and *rebreak* events or even different fractures in the same bone are happening across the *break* and *rebreak* events; for them it has to be the same fracture in the same bone in order for *rebreak a limb* to be felicitous, and for the other scenarios they would use *break a limb again*. This may very well be the case for many speakers, and our analysis is very much compatible with both readings, since we predict that *re-* just cares about the result state of 'broken' being achieved again, no matter where in the limb.

[24] A reviewer notes that with our analysis it may also be possible to capture cases of 'entropy' or 'expletive' *un-* discussed in Horn (1988). Examples of such cases are rare; some are *unthaw, unloosen* and archaic ones like *unrid, unrip* (Wright 1961), all of which are equivalent in meaning to their base verbs; e.g. *unloosen* = *loosen* and *unthaw* = *thaw*. The use of this *un-* is not reversative, but entropic, whereby Horn argues that the *thawing* event restores an object to the natural state of nature (liquid) and thus cannot be undone. *Un-* in these uses is pleonastic in that it is not performing any function of reversal. Our suggestion is that in these entropic cases, world knowledge about force on intrinsic properties of objects determines what the `pre` would be – i.e. a state of naturalness that does not need reversal (e.g. *thawed* is the natural state of something when external force is not applied). Thus $\texttt{res}(e)(x) = \texttt{pre}(e')(x)$ would still hold, but built in with the knowledge that $\texttt{pre}(e')(x)$ is the natural entropic state of x.

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

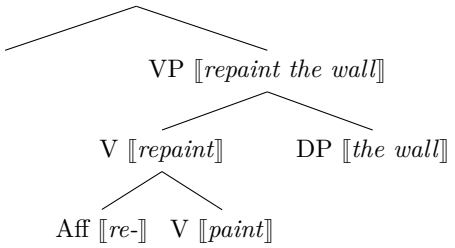
b. $[\![\textit{fold}]\!]^g = \lambda \mathrm{x}_e \lambda \mathrm{e}_v[\mathrm{fold}(e)(x) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(x)\}]$

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

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

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

(76)



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

b. $[\![\textit{paint}]\!]^g = \lambda \mathrm{x}_e \lambda \mathrm{e}_v[\mathrm{paint}(e)(x) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(x)\}]$,
where $\mathrm{O}_e = \{k \mid k(RB(\tau(\textit{paint}(e)))) = l(x)_{\text{physical property of color altered}}\}$

c. $[\![\textit{repaint}]\!]^g = \lambda x \lambda e \exists e'$: $[\mathrm{paint}(e')(x) \wedge \mathrm{O}_{e'} = \{k \mid k = \textsc{applies}(e')(x)\} \wedge \tau(e') \ll \tau(e) \wedge \mathtt{res}(e)(x) = \mathtt{res}(e')(x) \wedge \neg\exists k' \in \mathrm{T}_e \text{ s.t. } k' \in \mathrm{O}_{e'} \rightarrow \mathrm{paint}(e)(x) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(x)\} = \bot].\ \mathrm{paint}(e)(x) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(x)\}$,
where $\mathrm{O}_e = \{k \mid k(RB(\tau(\textit{paint}(e)))) = l(x)_{\text{physical property of color altered}}\}$,
and $\mathrm{O}_{e'} = \{k \mid k(RB(\tau(\textit{paint}(e')))) = l(x)_{\text{physical property of color altered}}\}$

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

e. $[\![\textit{repaint the wall}]\!]^g = \lambda e \exists e'$: $[\mathrm{paint}(e')(\iota x.\mathrm{wall}(x)) \wedge \mathrm{O}_{e'} = \{k \mid k = \textsc{applies}(e')(\iota x.\mathrm{wall}(x))\} \wedge \tau(e') \ll \tau(e) \wedge \mathtt{res}(e)(\iota x.\mathrm{wall}(x)) = \mathtt{res}(e')(\iota x.\mathrm{wall}(x)) \wedge \neg\exists k' \in \mathrm{T}_e \text{ s.t. } k' \in \mathrm{O}_{e'} \rightarrow \mathrm{paint}(e)(\iota x.\mathrm{wall}(x)) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(\iota x.\mathrm{wall}(x))\} = \bot].\ \mathrm{paint}(e)(\iota x.\mathrm{wall}(x)) \wedge \mathrm{O}_e = \{k \mid k = \textsc{applies}(e)(\iota x.\mathrm{wall}(x))\}$,
where $\mathrm{O}_e = \{k \mid k(RB(\tau(\textit{paint}(\mathrm{e})))) = \mathrm{l}(\iota x.\mathrm{wall}(x))_{\text{physical property of color altered}}\}$,
and $\mathrm{O}_{e'} = \{k \mid k(RB(\tau(\textit{paint}(e')))) = \mathrm{l}(\iota x.\mathrm{wall}(x))_{\text{physical property of color altered}}\}$

The compositional mechanics yield exactly the results we expect. *Un-* affixed to a verb and consequently the affixed verb combined with a direct object yields statements that the result states and pre-states of the actions in question (folding and unfolding) lead to lifespan points of the object that are equivalent in the salient properties (to give us reversability) and that the cardinality of the BASE verb's outcome set is more than 1. *Re-* affixed to a verb and consequently the affixed verb combined with a direct object yields the statements that the result of both the actions of painting lead to lifespan points of the object that are equivalent in the salient property, and that there is no threshold that prevents the result of the BASE action being restored on the object via the affixed action in terms of the salient lifespan property.

A note of clarity about the limits of the presuppositional meaning inside the affixes is in order. It is important to remember when comparing result states to not compare the identity of every possible property or manner (for example, the first action might have been very quick and the second very slow), but the overarching *result* of the action. As long as this most general property is shared between the two events, *re-* can be felicitously affixed to a verb. Other aspects of the action can be expressed with modifiers, which are often not presupposed by the verb as belonging to both actions. The same entailment patterns hold for *un-*.

(78) Pam **rezipped** the bag all the way up.

a. $\nvdash$ The presupposed first zipping action on the bag resulted in the bag being zipped all the way up; could have been partially zipped.

b. $\vdash$ The asserted second zipping action on the bag resulted in the bag being zipped all the way up.

c. What is common between the two zipping actions: both resulted in the bag *being zipped* in some form.

(79) Oscar **unsealed** the envelope very carefully.

a. $\nvdash$ The presupposed first sealing action was done very carefully – i.e., the result state of the envelope being sealed could have been brought about very carelessly.

b. $\vdash$ The asserted second action reversing the state of the envelope being sealed was done carefully – i.e. the result state of the envelope returning to the state prior the sealing action was brought about very carefully.

(80) a. Dwight painted the barn blue again.
$\vdash$ The barn was painted *blue* before; thus, *blue* is in the scope of the presupposition of *again*.

b. Dwight **repainted** the barn blue.
$\nvdash$ The barn was blue before; i.e. the barn could have never been blue. Thus, *blue* is not in the scope of *re-*'s presupposition.

Thus, manner, temporal, completive, frequency adverbs can all modify *un-* and *re-*verbs as expected, but they are not part of the presupposed information in the denotation of these verbs. In adjectival resultatives, as seen with *re-* in (80) and compared to *again*, the resultative property is similarly outside the scope of *re-*'s presupposition (see also Marantz (2007) for a similar observation).

Finally, in the light of the formal proposals, we would like to go back to some of the empirical patterns relating to impossibilitative operators/contexts discussed in Section 2.2 and examine their causes. These enriched contexts, containing a mixed bag of things like subjunctives, bouletics, counterfactuals, ability designators in the modal domain, poetic or media licenses, and negation, allow felicitous violation of some restrictions that appear to be rigid otherwise. While analyses of each individual construction will take us too far afield out of the scope of the paper, we will highlight two common themes. Some examples repeated below:

(81) a. You cannot unboil an egg.

b. I wish I could unrun those extra miles.

c. If we could reeat the burger, we could do another taste test.

d. I want to relaugh at his joke, this time in a higher pitch.

Why do these contexts/operators make otherwise unacceptable affixation combinations possible? We suggest that these contexts *coerce* reversability in the case of *un-* and repeatability in the case of *re-*. Both of these properties are already in the definitions of the affixes, but not solely. Concretely, we have pulled out some relevant fragments from the formal definitions to compare them in tandem:

(82) a. For *un-*, a part of the presuppositional content, where e' is the *run* event and e is the *unrun* event:
$\boxed{\texttt{res}(e')(\text{those-miles}) = \texttt{pre}(e)(\text{those-miles})} \wedge [|\mathrm{O}_{\mathbf{run(e')}}| > 1]$
a part of the assertive content: $\boxed{\texttt{res}(e)(\text{those-miles}) = \texttt{pre}(e')(\text{those-miles})}$

b. For *re-*, a part of the presuppositional content, where e' is the *eat* event and e is the *reeat* event:
$\boxed{\texttt{res}(e)(\text{the-burger}) = \texttt{res}(e')(\text{the-burger})} \wedge \neg\exists k' \in \mathrm{T}_{reeat(e)}$ s.t. $k' \in \mathrm{O}_{eat(e')} \rightarrow \text{eat}(\text{burger}) = \bot$

The boxed parts are the minimal signifiers of reversability with *un-* (a combination of presuppositional and assertive meaning) and of repeatability with *re-*. We know that there are other restrictions in their meaning, notably the multi-membered outcome sets with *un-* and the lack of any threshold state preventing the occurrence of the same result state with *re-*, as shown above. The impossibilitative operators ignore those components and only emphasize the reversability and repeatability aspects of these affixes in different ways. As a first example, let's discuss the modal operators. These operators presumably transpose world arguments into the semantics, making the validity and satisfaction of the assertive and presuppositional meanings relative to possible worlds where reversability and repeatability would hold. Now these sets of worlds that may not include the current world (where the other restrictions would presumably hold). In contrast, in the poetic/media license cases, it is not so much invoking possible worlds as it is coercing the outcomes of the BASE verb to not have the expected effect on the lifespan of the object whereby reversability or repeatability would be hampered. For the cases with negation, the negative operator functions as an impossibilitative operator because it reverses the validity of the boxed claims from a 0 (i.e. when the conditions on affixation are not met) to 1 (when the conditions are purportedly met). Thus, overall, there is no *one* underlying reason why all of these configurations allow

the suspension of the usual well-formedness restrictions. But all of them share one property – by focusing on only certain aspects of meanings of these affixes to the disregard of others, impossibilitative operators reverse the acceptability of some [verb + objects] units with *un-* and *re-*.

6 Some previous explanations, definitions, and some issues

6.1 How has the concept of 'potential for change' been treated in the literature?

As we mentioned above, there have been three main avenues of definitions and analyses. We discuss each in turn below.

Copley and Harley (2011) argue for branching futures, which is the result of several different possible *net forces* associated with *situations* that could lead to several different potential outcomes. They call situations that are well-enough specified to fully determine what's coming next *efficacious*. Therefore, branching is the result of a non-efficacious initial situation. When does the expected change happen? "In languages or forms where accomplishments culminate, we propose that there is a presupposition that the topic situation s0 is efficacious." They explicitly state: "there is no need for a modal operator to account for the non-culmination cases, as the absence of culmination follows from the absence of any presupposition of efficacy, rather than from any additional operator that removes the culmination entailment from the sentence." (page 24). This presupposition of efficacy is attached to the vP. This analysis operates within a different formal domain than the compositional one that we have pursued here, and we leave a more detailed comparison for future work.

Rappaport Hovav and Levin (2001)'s force dynamic view is based on Croft (1990, 1991)'s notion of event structure and Talmy (1976, 1985, 1988)'s work on causal chains. The events a verb represents may be represented as a CAUSAL CHAIN, where participants are linked together with respect to force. Beavers (2011), p. 357, notes that Rappaport Hovav and Levin (2001) signify potential for change as being the "endpoint of a non-branching chain of force transmission, upon which a new force-dynamic link can be added" when change actually occurs. If we look at the diagrams of causal chains in Rappaport Hovav and Levin (2001), p. 788 for example, we notice that arrows are visually added linking the source of the action and the element that potentially undergoes change. The presence or absence of the arrows themselves thus predict the presence of change, but nothing technically depicts the notion of *potential* for change, or what the arrows in this case would formally denote.

Then we come to Beavers (2011)'s adoption of Tenny's latent scale. Tenny (1992)'s (20: (42)) Latent Aspectual Structure says the following: "All verbs of change (simple nonstative verbs) have latent in them the aspectual structure in which an internal argument can measure out the event." Beavers (2011) adopts this notion and adds that "potential for change" implies the existence of a scale argument inside the latent aspectual structure of verbs, whereby transition is not entailed and the scale itself is also left latent (p. 358). This is, to our knowledge, the only formulation of this notion in compositional terms in the previous literature, and thus we go into the details of a possible application to our empirical domain below. Here is Beavers (2011)'s definition:

(83) x has potential for change iff $\phi \rightarrow \exists e \exists s \exists \theta[\theta(x,\ s,\ e)]$

Given that Beavers considers all "change" to be relational (between a theme and a scale of change), then this definition means that there exists a particular relation between these elements, which when reached, constitutes the fact that "change" has taken place. If it is not reached, then change has not happened. The *potentiality* of change then = the potential ability of reaching this exact θ-relation.

We believe that such a conception of potentiality could possibly encounter a few issues when it comes to affixation patterns with elements like *un-* and *re-*. In this approach, there is nothing in this semantics that "prevents" irreversible change; it is completely left up to context whether irreversible change happens or not. As we have argued, *un-* requires that the result of the base verb action not render the object such that reversal to the prior state of existence becomes impossible. So *un-* requires more specificity than what (83) is offering us. Concretely, *un-* is sensitive to the internal structure of the possibilities in the space of outcomes. This is because *un-* needs to check that there are member outcomes in the set of outcomes that are compatible with *un-*'s combined presupposition and assertion of reversability (a fragment: $...\tau(e') \ll \tau(e) \wedge \texttt{res}(e')(x) = \texttt{pre}(e)....\wedge \texttt{res}(e)(x) = \texttt{pre}(e')(x)$).

(84) Set of Outcomes ($fold(e)$) =

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

Maybe only the first three result states are compatible with *un-*'s presupposition? So *un-* will only be able to attach to a verb like ⟦ *fold* ⟧ when the object is in one of the three compatible states after the result of the verb. So the object receives force, and can 'change', only up to a certain point, i.e. it should not reaching a point that would prevent $\texttt{res}(e)(x) = \texttt{pre}(e')(x)$ from happening. This kind of check would be unavailable in a simple existential relation specified as in (83). The same issue would arise with *re-* trying to attach to PFC verbs.

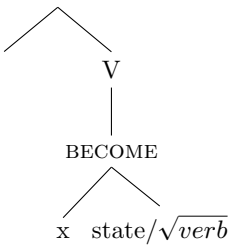
6.2 Some previous syntactic approaches to affix distribution

The set of previous syntactic explanations for *re-* is a large set, as we discussed in Section 3. Some of this previous work use existing syntactic frameworks to explain *re-*'s distribution. We describe the two major approaches we mentioned – the decompositional approach and the first phase syntax approach – and highlight a few issues with each of them in accounting for *un-* and *re-*'s behavior accurately.

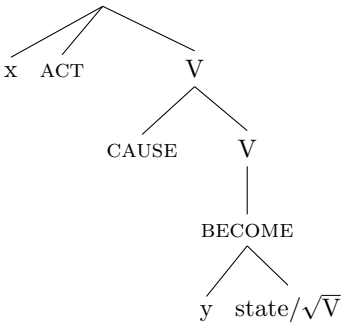
6.2.1 Pure decomposition

As we saw briefly above, the tradition of McCawley (1968), McCawley (1972), Dowty (1979), Levin (1999), a.o. ties Vendlerian aspectual distinctions (Vendler 1967) to differential decompositional spines in the syntax:

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

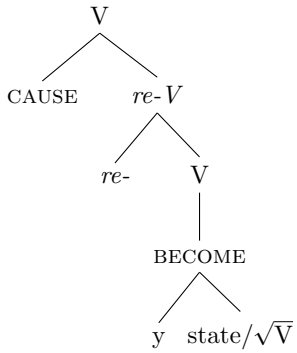


(86) accomplishment verbs: *clean, draw, fill*



Activity predicates have only the ACT layer, while states have only have the content of the state. Differentially articulated functional sequences like these have provided the foundation of distinguishing argument structure in affixation as well. Delving into the big question of what morphosyntactic properties does *re-* have that allows it only a restitutive meaning, there has been a 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.):

(87)

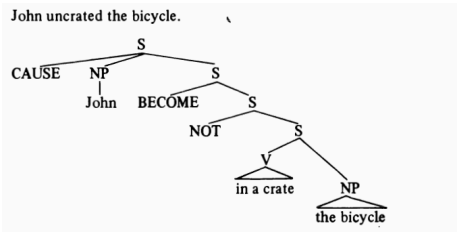


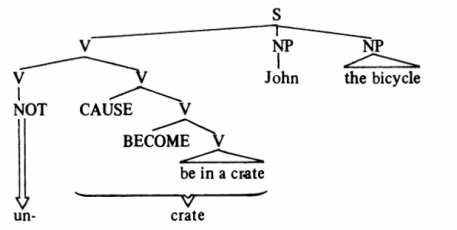
This analysis aims to capture the condition on *re*-affixation – (50) above. The *re*-verb signifies an action that causes the BASE verb's result state to hold again, and does not signify a repeat of the BASE verb's action. This analysis, however, in this form, gives rise to a concrete prediction:

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

Our argument is that 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. We have shown in Section 3.2 that firstly, COS is not a homogeneous categorization, and secondly, that *re-* does not play nice with many subclasses of COS. The decompositional approach, in its current form, predicts compatibility with *all* COS verbs just as long they have a result state.

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

(89) 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 (49). As we discussed, *un-* needs access to four total states: `res` and `pre` of the BASE verb, and `res` and `pre` of the affixed verb. The decomposition provides access to the 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. So a decompositional approach is insufficient on a few different fronts to accurately capture the domains of affixation of *un-* and *re-*.

6.2.2 First phase syntax approach

Ramchand (2008) has posited a decomposition of the VP layer into initiationP, processP, resultP with argument relations like INITIATOR, UNDERGOER, RESULTEE. In Ramchand (2008), p.38, she notes '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.

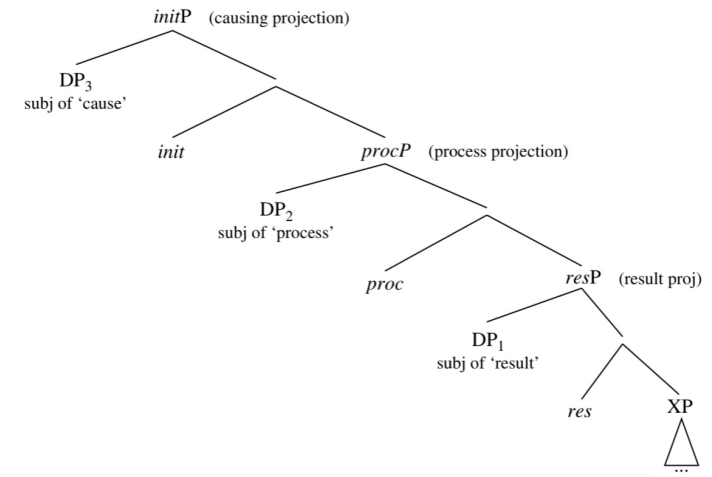
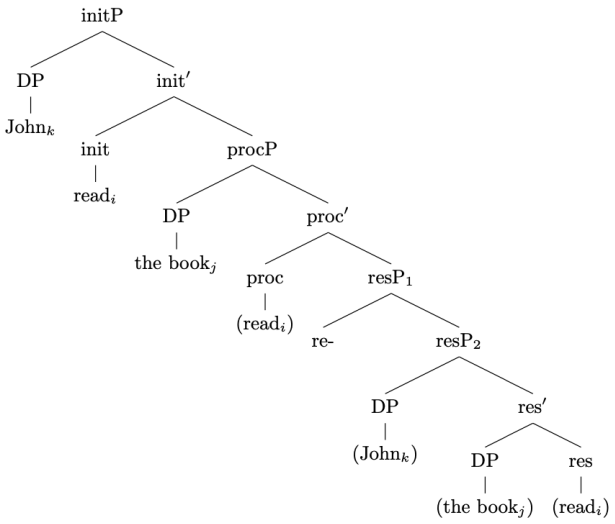


Fig. 8: Ramchand (2008): 3(1)

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



This kind of approach takes the Res projection to be the locus of attachment for *re-*. The problems with this approach, however, are the same ones we pointed out with the decomposition approaches in the previous section – the presence of a *res* layer does not guarantee that the result can be restored. A whole host of diverse predicates meet the criterion of having a *res* layer, but many of them do not allow *re-*prefixation. Conversely, *re-* works systematically with a class of verbs that lack the Res projection.

Nevertheless, it is useful to see how our approach would fit in with a first phase syntax approach. In this work, we have proposed the VRO model whereby affixes are sensitive to the internal structure of verb roots – 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-*. This analysis then raises the question: since the shared goal is a transparent representation of event structure decomposition, can the `res` and `pre` operators we have formulated be directly assimilated into Ramchand's framework – into the *init* and *res* heads?

Attempting to do so leads to some complications, conceptual and technical. Ramchand's *res* (Ramchand 2008, 3(10)) is a predicate that holds of an individual (the RESULTEE):

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

From 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: (i) a Ramchandian 'process' is 'an eventuality that contains internal change' (p. 44) – this leaves open how processes without integral change can be represented; (ii) the same conception issue arises with PFC verbs with no entailed result; (iii) *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. Thus, overall, we stick to the strict compositionality approach we have laid out so far, which has yielded an accurate set of predictions and captured the core facts. Also, it could be helpful to note that with regard to first phase syntax (and possibly also pure decomposition), our compositional VRO framework is more general. Since our proposals about the lexical semantics of verbs and affixes holds no matter the syntactic implementation, these syntactic frameworks could adapt our proposals to their frameworks with relative ease.

7 Conclusion

We set out to answer a set of research questions, as laid out in Section 1. The questions, with their empirical focus on the semantics of the morphemes *un-* and *re-*, were about (i) argument structure of affixes and how they choose stems for attachment; (ii) division of labor between the morpho-syntax and semantics; (iii) analytical tools that can provide a unified analysis of the distribution of *un-* and *re-*.

We have now proposed some answers to these questions, and formulated a lexical semantics for verb meaning and morphosemantic computation. 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. This approach we called the Verb-Root-Outcomes framework, or VRO. We argued for a flexible approach to verb meaning whereby the kind of force the action designates has crucial consequences for semantics. Specifically, when affixation happens with morphemes like *un-* and *re-*, it is not the simple addition of an affix, but a deep-level computation of compatibility between the verb's treatment of the object and the affixes' requirements about the state of the object. The lifespans of objects are now formalized into a set of discrete lifespan points (different types of lifespan intervals) that allows access to many different properties of the object at these given points. The actions designated by change-inducing verbs affect these properties, and having access to lifespan points allows us to model exactly what changed. Thus, we can achieve a nuanced level of detail in verb meaning via the VRO model. This kind of approach also allowed a concrete semantics of what the notion of 'potential' change could mean for verb meaning and object states. The simple idea that multiple outcomes are possible with potential-for-change verbs as opposed to single outcomes for more deterministically forceful verb actions allowed us to capture crucial differences that the affixes then interact with. We proposed lexical entries for a wide array of verbs following the VRO approach of encoding the consequences of the action on the lifespan of the object, leading to a hierarchy of outcome sets depending on verb classes. Without having an enriched verb root semantics like we have proposed here, there is no other straightforward compositional way to capture the fact that force and its result on an object plays a big role in such derivation at the level of affixation.

Thus, verbal affixes have argument structure that goes far beyond category information, aspectual labels, or even simple event decomposition information. We have argued that affixes like *un-* and *re-* are sensitive to the affectedness of the direct object and this information is built into their semantics. When there is a morphological composition between *un-* and *re-* and a verb, several checks and balances play a role in bringing forth felicitous meaning, which we argued plays out in the different compositional stages – at the word-level (`[Level 1]`) and the minimal VP level (`[Level 2]`). We proposed that *un-* and *re-* are result state modifiers, which means that what state the object is in after the action of the verb stem has applied on it is crucial information to these affixes, i.e. whether or not the consequence and quality of affectedness prevents reversability (*un-*) and restitution (*re-*). This approach geared towards looking at composition at the sub-lexical level has potential implications for morphosemantic theories in general. We hope to apply this approach to a wider array of morphological computations in future work.

The framework of analysis here provided opportunities for compositionally formalizing the notions of equivalence between states/events. Previously used diagnostics of neat lexical aspect classes, telicity, pure decomposition or first phase syntax, 'change-of-state' diagnosis – were all argued to be single-handedly insufficient in accurately mapping the full picture of what these affixes are compatible with or not. We showed that reversative *un-* requires that the object be left in a state that allows reversal to a prior state, and we formalized this notion of reversal with `res` and `pre` operators that yield the state of an object with the salient lifespan property at the boundaries of events. These are not temporal operators but operators that yield lifespan points of an object given a temporal point. The affix *re-*, on the other hand, requires that the object be left in a state that allows the action of the verb to be employed on it again, to restore the previous result state again. Reversability is thus equivalence between pre-states and result states of prior and later events applied to the same object, while restitution is equivalence between result states of prior and later events applied to the same object. We argued that *re-* attaches to more diverse categories of verbs than *un-* overall because equivalence of lifespan properties across result states is allowed by many categories of verbs, while equivalence of lifespan properties across result states and pre-states is allowed mostly by PFC verbs. Thus, reversal and restitution is directly analyzed and compared with the same formal notions and tools.

Overall, we hoped to have shown that in *un-* and *re-*'s behavior we see morphology interacting with semantics in the true compositional sense and this can be captured within a framework such as the VRO, which equips verb roots with core information. We have to look deep inside the semantics of verbs, understand their impact on their objects, and inside the semantics of the affixes as well, and see how compatibility and the lack thereof arises due to compositional, pragmatic, and sentential factors.

Compliance with ethical standards

The authors have no conflict of interests to report. This research did not involve human subjects or animals, and thus informed consent did not apply.

References

Alexiadou A, Anagnostopoulou E, Lechner W (2014a) Variation in repetitive morphemes: some implications for the clausal architecture. In: Workshop on the State of the Art in Comparative Syntax, University of York, vol 25, p 2014

Alexiadou A, Borer H, Schäfer F (2014b) The syntax of roots and the roots of syntax, vol 51. Oxford University Press

Andrews E (1986) A synchronic semantic analysis of de-and un-in american english. American Speech 61(3):221–232

Beavers J (2011) On affectedness. Natural language & linguistic theory 29(2):335–370

Beavers J, Everdell M, Jerro K, Kauhanen H, Koontz-Garboden A, LeBovidge E, Nichols S (2021) States and changes-of-state: A crosslinguistic study of the roots of verbal meaning. Language

Beck S (2005) There and back again: A semantic analysis. Journal of semantics 22(1):3–51

Beck S, Berezovskaya P, Pflugfelder K (2009) The use of again in 19th-century english versus present-day english. Syntax 12(3):193–214

Blackham JH (2017) There and back again: An adverb's tale. Master's thesis, The University of Utah

Carlson G, Roeper T (1980) Morphology and subcategorization: Case and the unmarked complex verb. Lexical grammar pp 123–164

Clark EV, Carpenter KL, Deutsch W (2008) Reference states and reversals: Undoing actions with verbs. Journal of Child Language 22(3):633–662

Copley B, Harley H (2011) Force dynamics for event semantics: Reifying causation in event structure. ms, CNRS/Paris 8

Covington MA (1981) Evidence for lexicalism: A critical review.

Croft W (1991) Syntactic categories and grammatical relations: The cognitive organization of information. University of Chicago Press

Croft WA (1990) Possible verbs and the structure of events. meanings and prototypes: Studies in linguistic categorization, ed. by savas l. tsohatzidis, 48–73

Cruse DA (1973) Some thoughts on agentivity1. Journal of linguistics 9(1):11–23

Csirmaz A, Slade B (2016) Result states and repetitive adverbs. Acta Linguistica Hungarica 63(4):443–455

De Clercq K, Vanden Wyngaerd G (2017) Why affixal negation is syntactic. In: 34th West Coast Conference on Formal Linguistics, Cascadilla Proceedings Project, pp 151–159

Dowty D (1991) Thematic proto-roles and argument selection. language 67(3):547–619
Dowty DR (1979) Word meaning and montague grammar (synthese language library 7). dordrecht: D
Fabricius-Hansen C (2001) Wi (e) der and again (st). Audiatur Vox Sapientiae A Festschrift for Arnim von Stechow 52:101–130
Filip H (1999) Aspect, eventuality types, and nominal reference. Psychology Press
Fillmore C (1970) The grammar of hitting and breaking. R Jacobs, & P Rosenbaum, Readings in English transformational grammar Waltham: Ginn
Gaeta L (2015) Restrictions in word-formation. In: Word-formation. An international handbook of the languages of Europe, vol 40, Mouton de Gruyter, pp 858–874
Gergel R, Beck S (2015) Early modern english again: A corpus study and semantic analysis. English Language & Linguistics 19(1):27–47
Hale K, Keyser SJ (1997) On the complex nature of simple predicators. Complex predicates 64:29–65
Horn L (1988) Morphology, pragmatics, and the un-verb. In: Proceedings of the Fifth Eastern State Conference on Linguistics. Columbus, Ohio: Ohio State University
Horn L (2005) An un-paper for the unsyntactician. Polymorphous linguistics: Jim McCawley's legacy pp 329–365
Horn L (2016) What's in an un-word: Lexical semantics vs. lexical pragmatics. Talk given at the ECOM Workshop at UConn: *What's in a Word?* University of Connecticut
Horn LR (1980) Affixation and the unaccusative hypothesis. In: Papers from the... Regional Meeting. Chicago Ling. Soc. Chicago, Ill, 16, pp 134–146
Horn LR (2002) Uncovering the un-word: A study in lexical pragmatics. Sophia linguistica 49:1–64
Jackendoff R (1996) The proper treatment of measuring out, telicity, and perhaps even quantification in english. Natural Language & Linguistic Theory 14(2):305–354
Jackendoff RS (1990) Semantic structures, vol 18. MIT press
Jäger G, Blutner R (2000) Against lexical decomposition in syntax. In: Proceedings of IATL, University of Haifa Haifa, vol 15, pp 113–137
Jespersen O (1917) Negation in English and other languages, vol 1. AF Høst
Joshi S (2012) Affixal negation–direct, indirect and their subtypes. Syntaxe et semantique (1):49–63
Kac MB (1976) On composite predication in english. In: The Grammar of Causative Constructions, Brill, pp 229–258
Kearns K (2003) Durative achievements and individual-level predicates on events. Linguistics and Philosophy 26:595–635
Kelly B, Wigglesworth G, Nordlinger R, Blythe J (2014) The acquisition of polysynthetic languages. Language and Linguistics Compass 8(2):51–64
Kennedy C, Levin B (2008) Measure of change: The adjectival core of degree achievements.
Kennedy C, McNally L (1999) From event structure to scale structure: Degree modification in deverbal adjectives. In: Semantics and linguistic theory, vol 9, pp 163–180
Kenny A (2003) Action, emotion and will. Routledge
Keyser SJ, Roeper T (1992) Re: The abstract clitic hypothesis. Linguistic Inquiry 23(1):89–125
Kratzer A (2000) Building statives. In: Annual Meeting of the Berkeley Linguistics Society, vol 26, pp 385–399
Kratzer A (2007) On the plurality of verbs. Event structures in linguistic form and interpretation 269:300
Krifka M (1998) The origins of telicity. In: Events and grammar, Springer, pp 197–235
Lakoff G (1976) Toward generative semantics. In: Notes from the linguistic underground, Brill, pp 43–61
Lasersohn P (2013) Plurality, conjunction and events, vol 55. Springer Science & Business Media
Lemmon EJ (1967) Comments on d. davidson's "the logical form of action sentences"'. The logic of decision and action pp 96–103
Levin B (1999) Objecthood: An event structure perspective. Proceedings of CLS 35(1):223–247
Levin B, Rapoport TR (1988) Lexical subordination. In: CLS. Papers from the General Session at the... Regional Meeting, 24-1, pp 275–289
Lieber R (2004) Morphology and lexical semantics, vol 104. Cambridge University Press
Maienborn C (2011) Event semantics. Edited by Claudia Maienborn Klaus von Heusinger p 232
Marantz A (2007) Restitutive re-and the first phase syntax/semantics of the vp. Talk given at the University of Maryland
Marchand H (1960) The categories and types of present-day English word-formation: A synchronic-diachronic approach. Beck
Marín R, McNally L (2011) Inchoativity, change of state, and telicity: Evidence from spanish reflexive psychological verbs. Natural Language & Linguistic Theory 29:467–502
Maynor N (1979) The morpheme un. American Speech 54(4):310–311

McCawley J (1968) The role of semantics in a grammar. In: Bach E, Harms R (eds) Universals in Linguistic Theory, Holt, Rinehart, and Winston, pp 125–170
McCawley JD (1972) Syntactic and Logical Arguments for Semantic Structures. Indiana Univ. Linguistics Club
Mittwoch A (1991) In defence of vendler's achievements. Belgian Journal of Linguistics 6(1):71–85
Parsons T (1990) Events in the Semantics of English. MIT press Cambridge, MA
Pinker S (1994) How could a child use verb syntax to learn verb semantics? Lingua 92:377–410
Piñón C (1997) Achievements in an event semantics. In: Semantics and Linguistic Theory, vol 7, pp 276–293
Pullum GK (1999) Why you can't unhear this talk. Lingua Franca
Pustejovsky J (1991) The syntax of event structure. cognition 41(1-3):47–81
Pylkkänen L, Oliveri B, Smart AJ (2009) Semantics vs. world knowledge in prefrontal cortex. Language and Cognitive Processes 24(9):1313–1334
Ramchand G (2008) Verb meaning and the lexicon: A first-phase syntax, vol 116. Cambridge University Press Cambridge
Rappaport Hovav M (2008) Lexicalized meaning and the internal structure of events. Theoretical and crosslinguistic approaches to the semantics of aspect 110:13
Rappaport Hovav M, Levin B (2001) An event structure account of english resultatives. Language pp 766–797
Rappaport Hovav M, Levin B (2002) Change of state verbs: implications for theories of argument projection. In: Annual Meeting of the Berkeley Linguistics Society, vol 28, pp 269–280
Schein B (1993) Plurals and events, vol 23. Mit Press
Smith C (1997) The Parameter of Aspect (2nd edition). Dordrecht: Kluwer Academic Publishers
Smith CS (2013) The parameter of aspect. Springer Science & Business Media
Stechow Av (1996) The different readings of wieder 'again': A structural account. Journal of semantics 13(2):87–138
Stockall L, Manouilidou C, Gwilliams L, Neophytou K, Marantz A (2019) Prefix stripping re-re-revisited: Meg investigations of morphological decomposition and recomposition. Frontiers in psychology p 1964
Talmy L (1976) Semantic causative types. In: The grammar of causative constructions, Brill, pp 41–116
Talmy L (1985) Lexicalization patterns: Semantic structure in lexical forms. Language typology and syntactic description 3(99):36–149
Talmy L (1988) Force dynamics in language and thought. Cognitive science 12
Tenny C (1992) The aspectual interface hypothesis. Lexical matters 24:1–27
Thomas M (1983) Interchangeable pairs in un-, in-, en-, etc. American Speech 58(1):78–80
Vendler Z (1967) Linguistics in philosophy. Cornell University Press
Vendler Z (2019) 4. Verbs and Times. Cornell University Press
Wechsler S (1989) Accomplishments and the prefix re. In: Proceedings of the North Eastern Linguistics Society, vol 19, pp 419–434
Whorf BL (1956) A linguistic consideration of thinking in primitive communities. Language, thought, and reality: Selected writings of Benjamin Lee Whorf 65:86
Williams E (2006) Telic too late. Harvard University talk handout