Telicity and iconic scales in ASL

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October 27, 2015

Abstract

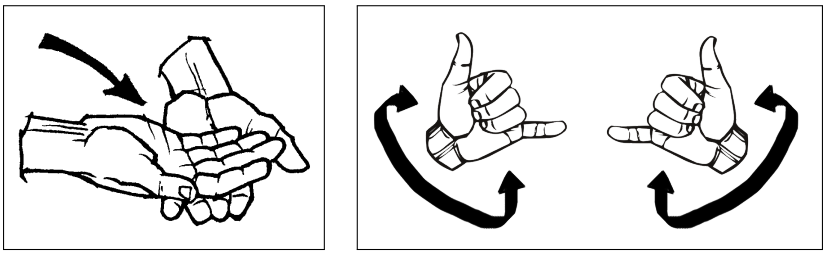
In a series of papers (Wilbur 2003, *i.a.*), Ronnie Wilbur shows that a number of sign languages display a non-arbitrary form-to-meaning correspondence in the verbal lexicon: telic verbs end with sharp deceleration ('end-marking'); atelic verbs do not. In ASL, Wilbur also shows that the phonetic form of a verb may be manipulated with semantic effect. In this paper, I provide an analysis of these facts in terms of structural iconicity, where the interpretation of a sign preserves abstract structure of the form of the sign. I follow Kennedy and Levin 2008 in assuming that the meanings of change-of-state verbs are derived from scales; I argue that verbs in ASL iconically represent these scales, and that end-marking on telic verbs is the iconic representation of the maximum of a closed scale.

1 Overview

In a series of papers (Wilbur 2003, 2008, 2009; Malaia and Wilbur 2012), Wilbur shows that there is a non-arbitrary form-to-meaning correspondence in the verbal lexicon of several unrelated sign languages (American Sign Language (ASL), Croatian Sign Language (HZJ), and Austrian Sign Language (ÖGS)). Specifically, in these sign languages, she observes that the phonetic form of **telic** verbs systematically differs from that of **atelic** verbs: the former show abrupt deceleration to a stop; the latter do not.

The basic pattern can be illustrated with the signs ARRIVE and PLAY in ASL. The verb *arrive* is telic in ASL and English, as evidenced in English by its incompatibility with *for*-adverbials (as in (1)a); the verb *play* is atelic in ASL and English, as evidenced in English by its grammaticality in the same environment. (Analogous tests hold for ASL, as well.) In ASL, these verbs differ in an important phonetic way as well. The telic verb ARRIVE ends with sharp deceleration ('slamming on the brakes'), as the dominant hand makes contact with the non-dominant hand (see Figure 1a)). In contrast, the atelic verb PLAY has no sharp stop, being signed with a back-and-forth twisting motion of the two hands that can be extended to an arbitrary length (see Figure 1b))[1].

(1) a. * John arrived for twenty minutes. → telic
b. John played for twenty minutes. → atelic



ARRIVE PLAY

Figure 1: Images of ARRIVE and PLAY in ASL

This phonetic generalization holds across a wide range of lexical predicates, including psychological and social verbs like PONDER vs. DECIDE and NEGOTIATE vs. BUY.

This phenomenon has been argued to be grounded in a more general cognitive representation of event structure. Malaia 2014 draws connections to psychological work (Zacks et al. 2007) which shows that the same visual cues (e.g. rate of deceleration) are employed in event segmentation in completely non-linguistic tasks. In a forced-choice meaning-guessing task, Strickland et al. 2015 show that naive non-signers are sensitive to the connection between telicity and the phonetic form of a sign. These findings illustrate a surprising, robust connection between the visual system and abstract, conceptual space.

In sign language, this connection plays an active part in the grammar: Wilbur (2003, 2009) shows that in ASL, the phonetic form can be manipulated in the synchronic grammar with syntactic and semantic effects. These manipulations include stopping the motion of a telic verb before completion, slowing the motion of a verb, and reduplicating a verb in various ways. For example, the verb SIT-DOWN in ASL ends with contact between the signer's two hands; if the sign is produced without this contact at the end, the verb is interpreted roughly as 'almost sat down.'

How are these phonetic effects encoded into the grammar? While acknowledging the iconic origin of these effects, Wilbur (2003, 2009) takes this connection to be purely historical. As far as the synchronic grammar is concerned, Wilbur proposes that phonetic features are discretely codified in the grammar as a finite set of combinatorial morphemes; she argues that the productive patterns emerge from the combination of these sub-lexical morphemes. She takes the sign language data as new evidence in favor of theories of argument structure that posit sub-lexical verbal decomposition (e.g. Ramchand 2008).

In this paper, I have two goals. First, contra Wilbur, I argue that the iconic mapping from a verb form to its meaning remains active in the grammar (as opposed to just a grounding for a set of morphemes). As evidence, I present examples with gradient interpretive effects that cannot be generated by a discrete combinatorial system alone. I discuss the properties of this

[1]Sources of images: The images of ARRIVE, CLOSE, and FILL in Figures 1 and 2 appear courtesy of Bill Vicars and http://www.lifeprint.com/. The diagrams in Figure 9 and 10 also include an image from http://www.lifeprint.com/. The image of PLAY in Figure 1 was drawn using images from Gallaudet-TT font by David Rakowski. All images are used with permission.

iconic mapping.

Second, assuming the new iconic analysis, I turn to the places where phonetic manipulations have categorical, syntactic effects: namely, the telicity divide observed by Wilbur and new data involving *again*-ambiguities. Special consideration will be given to degree achievements (like *rise* and *grow*), which have been shown to have interesting properties with respect to telicity.

I will argue that the data provide new evidence in favor of recent theories in which verbal meanings derive from **scales** (Kennedy and Levin 2008, Pedersen 2014). These theories maintain a decompositional view of verbs (like Ramchand, etc.), but allow some of the sub-verbal arguments to be selected through pragmatic competition. I argue that the phonetic form of verbs in sign language iconically represents these scales, and that categorical effects arise from the way they interact in the pragmatic system.[2]

2 Background

2.1 Telicity many ways

Natural language is known to grammatically categorize verbs based on their abstract temporal properties. The relevant property—telicity—can be observed in a variety of syntactic and semantic phenomena. Most famous in English is the choice of temporal adverbials: atelic predicates are compatible with *for*-adverbials but not with *in*-adverbials; the opposite holds for telic predicates.

(2) Atelic predicates
  a. John {played/pondered the question/negotiated} for 20 minutes.
  b. * John {played/pondered the question/negotiated} in 20 minutes.

(3) Telic predicates
  a. * John {arrived/decided what to do/bought the car} for 20 minutes.
  b. John {arrived/decided what to do/bought the car} in 20 minutes.

Semantically, the division between telic and atelic predicates can be characterized by a property of divisibility: if an atelic predicate holds of an event e, then it also holds of temporally short sub-parts of e. We can formalize this property with Champollion 2010's definition of Stratified Reference, given in (4). Atelic predicates have this property; telic predicates do not. (Here, * returns the algebraic closure of a predicate under sum-formation; τ returns the runtime of an event; ε is a contextually-determined small number.)

[2]Methodology: New data that is presented in this paper was gathered through fieldwork with a native signer of ASL. Judgments were gathered following the 'playback method' (Schlenker 2011). The signer was asked to sign a paradigm of sentences for a video recording. The resulting video was then played back for the same signer, who gave grammaticality judgments using a 7-point scale (7 = best) and answers to any interpretation questions. Judgments could then be repeated on separate days. Generalizations in the present paper are based on at least three ratings of a construction; all sentences reported as grammatical had average ratings of 6/7 or greater.

(4) Definition: Stratified Reference (SR: adapted from Champollion 2010)
$\text{SR}_{\varepsilon}(P) := \forall e[P(e) \rightarrow e \in {}^{*}\lambda e'(P(e') \ \wedge \ \tau(e') \leq \varepsilon)]$
'A predicate P has Stratified Reference if any event e in P can be divided exhaustively into temporally small sub-events that are also in P.'

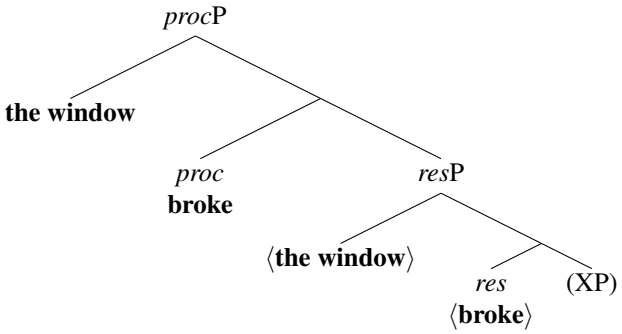
For example, if John slept for several hours, then the event can be divided into 10-minute sub-events, each of which is also a sleeping event. But, if John painted a picture in several hours, it is not possible to divide up the event into short 'painted-picture' events because most sub-events will not include a completed painting. *Slept* satisfies (4) so is atelic; *paint a picture* does not so is telic.

Ultimately, the source of this difference—the reason why telic verbs do not have divisibility/Stratified Reference—is the presence of a **result state** in the meaning of telic verbs. The insight (dating back to Aristotle's *Metaphysics*) is that telic verbs denote events that are more than the sum of their parts. For example, the process of pondering and and the process of deciding are exactly the same; the difference is that the latter results in something new—the decision. The fact that this new state of affairs results from the process as a whole is what prevents divisibility or Stratified Reference from holding of small subevents. (This result state is Aristotle's *telos*, or 'purpose,' from which telicity gets its name.)

A host of syntactic and semantics properties conspire to determine the telicity of a predicate. For example, for some predicates (those with an 'incremental theme'), the telicity of the predicate is determined by the semantic properties of its nominal arguments: '*eat an apple*' (with a count noun) is telic, but '*eat rice*' (with a mass noun) is atelic. For other predicates, the telicity seems to come built-in; for example, '*look at an apple*' and '*look at rice*' are both atelic, regardless of the semantic properties of the noun. (For more discussion of incremental themes, see Krifka 1989, among others.)

Ramchand 2008 argues that verbs are structurally complex, and that the telicity of predicates is in part determined by the sub-lexical decomposition of the verb. Most notably, she argues that a certain class of telic verbs (roughly, those that fall into the Vendler (1957) class of Achievements)), derive their telicity from the presence of a syntactic head *res* that introduces a result state into the lexical meaning. For example, the structure in (5) provides Ramchand's lexical decomposition of the verb *break*, applied to the argument *the window*. Of relevance, the fact that this structure comes with a built-in *res*P means that the verb is necessarily telic.

(5)



Another class of verbs which may be telic are degree achievements that denote progression along some closed scale—e.g., *dry*, *cool*, *straighten* (for more discussion of scales, see §4). These verbs have the unique property that they are systematically ambiguous between a telic and atelic meaning, evidenced by their compatibility with both *in-* and *for*-adverbials (as seen in (6)); under the telic reading with *in*-adverbials, they receive the meaning that a change in measure (e.g. dryness) reached its maximal degree.

(6) a. The towel dried in an hour.
b. The towel dried for an hour.

Since these verbs may receive an atelic interpretation, they cannot come with a built-in *res* feature; the telic interpretation must therefore come from somewhere else. Ramchand proposes that, like incremental theme verbs such as *eat*, degree achievements also inherit their telicity from an argument, but that in the case of degree achievements, it is an implicit, scalar argument.

Finally, Ramchand 2008 proposes that a *res* feature may be added to a verb of any class by the addition of a particle. Specifically, in particle-verb constructions like *eat up*, *break off*, and *throw out*, where a particle can be optionally separated from the verb, Ramchand proposes that the particle itself bears a *res* feature. The result is that particle-verb constructions necessarily yield a telic predicate. The example in (7) provides a minimal pair: while the former predicate may be used in an atelic frame, the latter predicate, with a particle, is necessarily telic.

(7) a. I ate the leftover turkey for two weeks.
b. * I ate up the leftover turkey for two weeks.

Thus, the particle in a particle-verb construction is essentially an overt reflection of the *res* feature in English.

To sum up, telic predicates do not get their telicity from a homogenous mechanism. Specifically, we have seen at least four kinds of telic predicates, which pattern in empirically different ways. (I will ultimately be moving away from a theory with a *res* feature, but for discussion of Wilbur's hypothesis, the categories below are described in terms of Ramchand's analysis.) The categories are:

1. Inherently telic verbs, which get their telicity from a *res* feature on the verb. English verbs in this category include: *break*, *throw*, *find*, *explode*, *enter*, *arrive*, *disappear*.

2. Incremental theme verbs, which inherit their telicity from the semantic properties of their complement. English verbs in this category include: *eat* (*an apple*), *paint* (*a picture*), *read* (*an article*).

3. Degree achievement verbs, which inherit their telicity from an implicit scalar complement. English verbs in this category include: *dry*, *cool*, *straighten*, *close*, *fill*.

4. Particle-verb constructions, productively derived by the addition of a particle bearing a *res* feature to a verb of any other class. English predicates in this category include: *break off*, *eat up*, *cool down*.

2.2 Visible telicity

Wilbur 2003 observes that lexical predicates in ASL can be classified as telic or atelic based on their phonetic movement. Roughly speaking, telic verbs end with a sharp stop (and often contact with another part of the body); atelic verbs have no such phonetic end-marking. Malaia and Wilbur (2012) provide tentative experimental support for this generalization based on quantitative measurements of lexical predicates in two unrelated sign languages, American Sign Language (ASL) and Croatian Sign Language (Hrvatski Znakovi Jezik, or HZJ). Using 3D motion-capture recordings, they report that both languages show a significant correlation of telicity with several phonetic features (including maximum peak velocity and rate of deceleration following peak velocity). These phonetic effects are dissociable from other properties affecting signing rate like phrase-final lengthening.[3]

However, in light of the many factors that conspire to generate a telic predicate (as discussed in the previous section), the interpretation of Wilbur's generalization is not entirely straightforward. In particular, does the presence of phonetic end-marking correspond to a semantic property of the output form (e.g. lack of Stratified Reference), an abstract morpheme in the syntax (e.g. *res*), or something else?

Wilbur (2008, 2009) takes an explicit stand on this question. Under the 'Event Visibility Hypothesis,' Wilbur proposes that the phonetic end-marking of telic events in sign language is a reflection of an abstract result state in the sub-lexical decomposition; in Ramchand 2008's terms, it is an overt manifestation of the *res* feature. Essentially, then, the sharp stop of ARRIVE is a reflection of the same abstract morpheme instantiated by the *up* of *eat up*. On Wilbur's analysis, the sign language data thus provides another kind of evidence for the sub-lexical decomposition of verbs.[4]

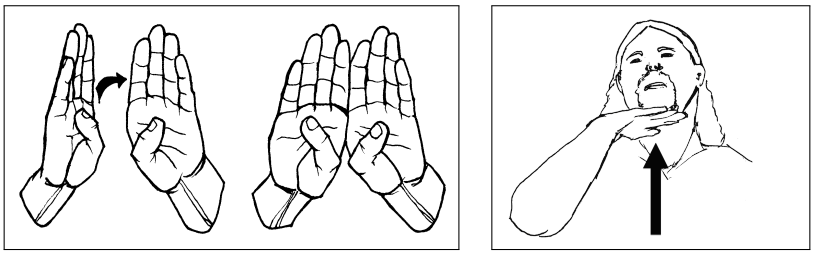
Wilbur 2008 provides evidence for the claim that phonetic end-marking in ASL has a syntactic status by showing that it can be manipulated with semantic effect. For example, the sign for ARRIVE is made by moving the dominant hand to make contact with the non-dominant hand, as shown in Figure 1a; if the sign is produced without this end-marking, the sign is interpreted roughly as 'almost arrived' (Liddell 1984). Wilbur 2008 argues that this meaning results from an 'incompletive' morpheme (similar to English *almost*) that modifies the result state instantiated by contact between the hands.

When we consider Wilbur's theory in the more precise terms discussed above, however, the generalization becomes somewhat more shaky. In particular, we face seeming counterexamples when we consider telic degree achievements like *close* and *fill*. In ASL, the sign CLOSE (a door)

[3]For statistical reasons, some caution should be taken when interpreting these results. The results show that *some* phonetic marker relating to velocity and deceleration is correlated with telicity, but the five kinematic variables are highly correlated and were each tested individually, which makes it impossible to conclude anything substantive about specific phonetic cues. There are also some questions regarding stimuli selection; notably, the verbs translated as *send* and *interrupt* were puzzlingly categorized as atelic in ASL. (Regardless of translation issues, in other work, Wilbur 2009 categorizes SEND as telic in ASL.)

[4]Other theoretical commitments of Wilbur are less clear: does end-marking instantiate *res* only when it is part of a lexical specification, or can end-marking act like English particles, productively attaching to verbs to make them telic?

is made by moving the dominant hand to make contact with the non-dominant hand, as seen in Figure 2a. The verb *fill* is signed in several ways in ASL; Figure 2b shows the sign GET-FULL (as in, 'I got full from eating so many cookies'), where the hand makes contact with the chin.



a. CLOSE b. GET-FULL

Figure 2: Images of CLOSE and GET-FULL in ASL.

These two verbs show end-marking and are telic; thus, at a first pass, they may seem to support Wilbur's hypothesis. But although the verbs are telic, we saw evidence from English that they do not bear a *res* feature; instead, they inherit their telicity from an implicit scalar complement. These verbs thus provide a counterexample to the claim that end-marking is the overt spell-out of *res*.

Naturally, we can't conclude anything about ASL signs just by looking at their closest English translation; these arguments must be made based on ASL-internal data. Nevertheless, the examples with CLOSE and FILL are suggestive that Wilbur's generalization about the distribution of end-marking (namely, as the spell-out of *res*) is not quite the correct natural class.

In what follows, I will argue that, in general, Wilbur's theory is not able to capture the full range of data; in particular, I will show that there are more manipulations that can be done to verbs in ASL than can be described by manipulating *res* and other discrete morphemes. I will argue that these data must be described through an iconic mapping.

Like Wilbur (and Ramchand, etc.), I will adopt a theory with sub-verbal decomposition. Departing from these theories, however, I will follow Kennedy and Levin 2008 in the proposal that all verbs (not just degree achievements) are decomposed into a logical form with a scale (e.g. for *widen*, the scale is the totally-ordered set of possible widths). I will propose that verbs in ASL display an iconic mapping that represents change along this scale. End-marking is the iconic representation of the closed end of a scale.

This analysis will yield a natural class that cleanly encompasses both 'inherently telic' verbs like ARRIVE and telic degree achievements like CLOSE: both are built from scales with a closed end-point. The difference between the two is that verbs like ARRIVE are built from degenerate scales that only have two points: 0 and 1 (although a richer scale can often be coerced by iconic manipulations). Adopting Kennedy and Levin 2008's scale-based theory of telicity will allow us to derive the fact that end-marking generates telic predicates.

3 Iconic manipulations

Here, I will argue that manipulations of the phonetic form of verbs are interpreted iconically in ASL. As background, I will start with the manipulations described by Wilbur, along with her analysis. I will then show that the phenomenon is more general than Wilbur's analysis allows, and that the manipulations Wilbur describes arise as a special case of this more general mapping.

3.1 Wilbur's observations

Wilbur (2003, 2008, 2009) shows that the phonetic form of a sign can be manipulated with semantic effects. She discusses several classes of examples, including extended path movement, incompletive marking, and reduplication. Wilbur analyzes these as arising from the combination of discrete morphemes.

First, Wilbur 2008 observes that the motion of a sign may be elongated to indicate an elongated event. Specifically, when a sign includes a 'path motion'—i.e. movement from one position to another—the duration of the motion can be extended from the default speed, often by adding an arc movement. The resulting semantic inference is that the event occurred slowly. For example, when ARRIVE is signed slowly in (8), the interpretation is that the arrival happened slowly.

(8) FINISH-LINE I SEE, ARRIVE-slow.
'I saw the finish line, then arrived at it slowly.'

Wilbur analyzes this elongation of the sign as a morpheme [extra] with an adverbial meaning (something like 'over an extended time'). This analysis makes the prediction that there are only two possible forms of a verb with respect to this manipulation: either the verb has [extra] or it doesn't.

Second, as mentioned above, a path movement can be halted before completion of the sign to produce an incompletive meaning for a telic verb (as mentioned above for ARRIVE). Wilbur 2008 reports, following Smith 2007, that there are in fact two forms of the incompletive. If the sign is halted immediately after it begins, then it is interpreted as meaning that the event barely even started to happen.

(9) I SIT-DOWN-unrealized-inceptive.
'I almost started to sit down.' (from Wilbur 2008)

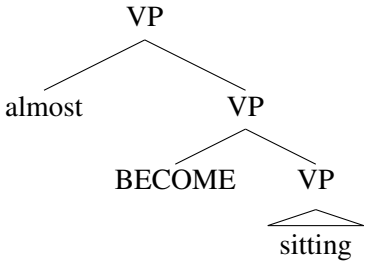
If the sign is halted immediately before it would otherwise be completed, then it is interpreted as meaning that the event started to happen but didn't quite finish.

(10) I SIT-DOWN-incomplete.
'I almost sat down (but stopped myself before contacting the seat).'
(from Wilbur 2008)

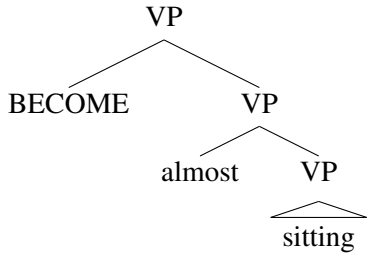
Wilbur proposes that both of these forms are the spell-out of an incompletive morpheme that has a meaning similar to English *almost*. In particular, she notes that English *almost* is known to be ambiguous with telic events in English, producing meanings similar to the ones described for (9) and (10) above. This ambiguity has been argued to result from an attachment ambiguity (e.g., Dowty 1979, Pustejovsky 1991).

(11) I almost sat down. (English)

(12) a.



b.



Wilbur argues, following Smith 2007, that the two forms in (9) and (10) correspond to the attachment of the incompletive morpheme at different heights. Though Wilbur is not explicit about this point, we are led to understand that the morpheme is spelled out by deleting the phonological realization of its complement.[5] The result is that the two structures are disambiguated, depending how much phonological material is deleted.

This analysis makes explicit predictions: namely, there can be only as many incompletive forms as there are syntactic levels where the incompletive morpheme can attach. If there are two levels (as suggested by the two readings English *almost*), then there should be exactly two distinct incompletive forms in ASL.

Finally, Wilbur 2009 discusses cases of reduplication in ASL, which give a predicate a pluractional meaning. Myriad reduplicative verbal forms have been described in ASL, including ones labeled 'durative,' 'iterative,' 'continuative,' 'incessant,' and 'habitual' (Klima and Bellugi 1979). Wilbur argues that a wide typology of these forms can be generated based on what subtree of the verbal decomposition is targeted by the reduplicative morpheme, and whether the morpheme [extra] appears on these subtrees. Because the issues introduced by plurality are quite complicated, I will not discuss reduplication in depth here; however, see Kuhn and Aristodemo (ms.) for a discussion of pluractional inflection in French Sign Language (LSF) and American Sign Language, where it is argued that these constructions also display an iconic mapping.

[5]Note that Wilbur is forced to say that the incompletive construction is formed by the *addition* of an incompletive morpheme (instantiated by removing segments from the phonological form) as opposed to the *removal* of the result state in the syntax. This is necessary because the events denoted by incompletive verbs are still telic events (as seen in (13)); literally removing the result state would incorrectly make the predicate atelic.

(13) ?? ME SIT-incomplete (FOR) ONE MINUTE.

3.2 The iconic mapping

Following Schlenker, Lamberton, and Santoro 2013, I take 'iconicity' to refer to a mapping that preserves abstract structure from the form of a sign to its meaning. In the case at hand, I will argue that an iconic mapping preserves gradient temporal information contained in the phonetic form of a verb. Specifically, when a verb has a phonological path motion (i.e. when it moves without regression from one position in space to another), I will argue that this path is iconically mapped to the temporal progression of the event the verb denotes.

Intuitively, the effect of this mapping should feel very similar to the patterns described by Wilbur: for example, an extended phonetic path is interpreted as a temporally extended event; an incomplete motion is interpreted as an incomplete event. The difference, though, is that an iconic mapping is more general and more powerful, allowing manipulations that cannot be captured by discrete morphemes alone. In particular, I will argue that the iconic mapping preserves **geometric structure**, yielding gradient interpretation of gradient phonetic manipulations. Following Emmorey and Herzig 2003, I will use gradient interpretation as a diagnostic for iconicity.

If indeed there is a measurement-preserving iconic mapping, then why does Wilbur not find any gradient effects? The explanation arises from the fact that the mapping preserves only *relative* measurement, not *absolute* measurement. For example, the form for the verb DIE may be completed in a matter of seconds, yet still denote an event which takes months to elapse. Nevertheless, if two forms of DIE signed at different speeds are brought into comparison, then the slower sign must denote the slower event. What this example illustrates is that, when an event preserves only *relative* information, it is impossible to make any iconic inferences without a standard for comparison.

When a sign is produced in isolation, the only standard for comparison is the default form of the sign (relative to the rate of signing). If a sign is produced in an unexpected way—for example, at a speed that is markedly slower than the overall rate of sign—then it is interpreted in a meaningful way. However, since the default form and canonical meaning are determined by context, the result is an inherently vague interpretation. The situation is familiar from the case of vague adjectives, discussed by Kennedy 2007. In isolation, the adjective *tall* is vague, since the standard for comparison—i.e., what counts as 'tall'—must be inferred from context. In contrast, the sentence '*Ivan is taller than Dmitri*' yields crisp judgments: nothing needs to be taken from context, so half a centimeter difference in height is enough to verify or falsify the sentence.

Wilbur's examples, which look at signs in isolation, can only communicate information about marked or unmarked speed, so are inherently vague. In order to get crisp judgments on gradient forms, it is necessary to provide an overt comparative form.

3.3 Gradient iconic manipulations

First, we turn to cases of extended path movement, focusing on paradigms where instances of the same verb are produced at a variety of different speeds.

As it turns out, verbal reduplication provides a conveniently minimal example where many forms of a verb can be put into comparison at once. In ASL (like many other sign languages), a verb can be reduplicated multiple times to express that an event happened again and again. Critically for us, pronunciation of each repetition can vary in speed. When repetitions of the verb are produced at different speeds, the interpretation reflects the difference.

Figure 3 presents one attested example, where the sign for GIVE accelerates from a length of 0.27 seconds down to a length of 0.07 seconds. (In the graph, black bars represent the forward motion of the sign.) The resulting interpretation is that the event occurred at a speed that increased over time. Critically, the interpretation of acceleration is only possible with more than two levels of speed represented. Wilbur's analysis, with a single [extra] feature, undergenerates.

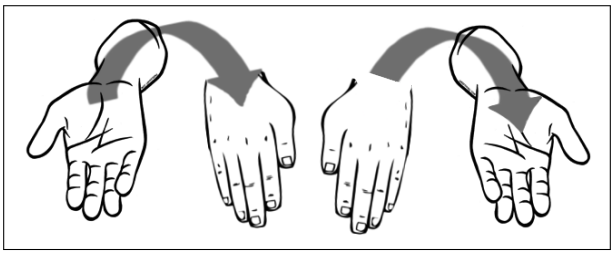
Figure 3: Image of accelerating GIVE-rep

Thus, we conclude that the iconic mapping keeps track of gradient information regarding the relative speed of events. The binary examples reported by Wilbur are the special case that emerge when the only comparison class comes from context.

Next, we turn to rapid deceleration to a stop, as it appears at the end of telic verbs and on incompletive forms. Unlike the speed manipulations above, we observe that rapid deceleration is *not* directly interpreted by the iconic mapping. For example, when the sign ARRIVE is signed slowly, as in (8), it may nevertheless speed up then decelerate immediately before contact. This does not generate the inference that the individual changed their speed right before arrival—it just emphasizes that the individual finally arrived. I thus adopt the insight from Malaia and Wilbur 2012 and Malaia 2014 that rapid deceleration is a cognitively domain-general mechanism for identifying distinguished points of events. I take this to be a separate system that feeds into the iconic mapping described here.

I depart from Wilbur by proposing that these boundary markers can be placed anywhere in the course of the sign and that the iconic mapping is gradiently sensitive to the extent of motion that has transpired by the point of the marker. Final end-marking, then, is just a special case when this marker happens to line up with the end of the path motion. The cases of incompletive forms discussed by Wilbur already suggest that something like this may be the case: stopping the motion of SIT-DOWN at the beginning of the sign produces a different interpretation than stopping the motion at the end of the sign (see above, in (9) and (10)).

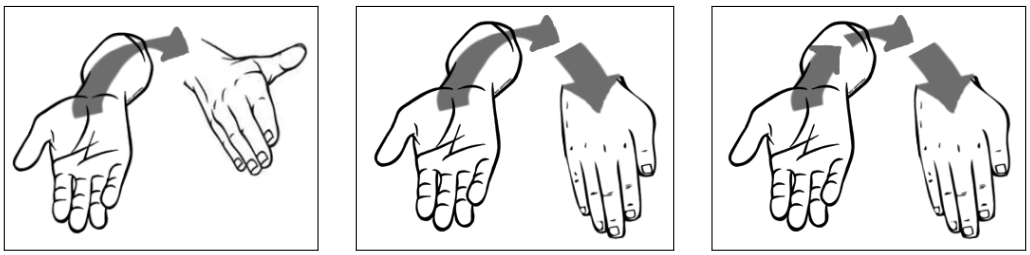
To test the availability of further levels, we turn to examples where motion of the sign stops multiple times during production, generating a 'bit by bit' interpretation. I will construct the argument with the verb DIE in ASL, shown in Figure 4: one hand turns palm-up to palm-down as the other turns the opposite direction.



DIE

Figure 4: Image of DIE in ASL

As we have seen for SIT-DOWN and ARRIVE, DIE allows motion to be stopped before completion, as in Figure 5a, resulting in the interpretation that the subject almost died.[6] However, the motion need not stop completely after this intermediate pause; it may continue to its normal end point, as shown in Figure 5b. The resulting inference of this second form is that the subject died, but that the death was interrupted by a period with no decline of health. Finally, the sign DIE can be interrupted by arbitrarily many such pauses, as in Figure 5c; the resulting inference of this 'bit-by-bit' inflection is that the subject died gradually, reaching successive states of decreased health until death.



a. 'almost died' b. 'died after a struggle' c. 'gradual death'

Figure 5: Iconic modifications of DIE in ASL

What is of note about this final form is that arbitrarily many stops can be included, distributed throughout the production of the sign. In order to get the attested meaning, it must be possible to track different extents of completion of the event. Notably, Figure 5c has a distinct meaning from simply reduplicating the incompletive form in 5a: a reduplicated 5a can mean that health increased in between the points; 5c means that the health did not.

Moreover, these intermediate markers are sensitive to fine-grained temporal and spatial modifications. For example, if there are an increased number of pauses as the motion of the sign nears its end point, this is interpreted as meaning that the subject's health declined more and more slowly until the moment of death. In order to capture this meaning, the interpretive system must be able to preserve information from at least two different dimensions: the time elapsed and the distance that the hand has traveled.

[6]For space reasons, the images in Figure 5 depict only the motion of the right hand, but the motion of the left hand is parallel.

Recall that Wilbur's theory predicted that interruptions to a sign should generate only two possible interpretations, depending on location of the attachment ambiguity. What we see here is far more general: there may be arbitrarily many interruptions in a sign; the interpretation of the form is gradiently sensitive to the extent of motion that has transpired at a given point. As before, the examples described by Wilbur are the special cases that emerge when the only standard for comparison comes from context.

3.4 Summary: iconicity

We have seen that Wilbur's discrete, morphological analysis fails to generate the full range of manipulations that are available in ASL. As an alternative, I have proposed that verbal manipulations are subject to an iconic mapping that preserves information about the form of the sign. This iconic mapping is sensitive to at least two dimensions—namely, the amount of time elapsed at a given point and the distance that the hand has traveled at that point. I have suggested that rapid deceleration is used as a marker to highlight distinguished points in the progression of the event that are sensitive to this mapping.

In the next section, I develop an analysis of change-of-state verbs based on scales that allows us to formalize the iconic mapping. I then turn to telicity, showing how a gradient iconic mapping is able to yield categorical effects.

4 Revised view: scales, not states

In §2.1, I introduced the fact that a result-state analysis is not viable for degree achievements like *dry* and *close*, based in particular on their variable telicity. I proposed, following Ramchand, that these verbs instead inherit their telicity through properties of an implicit scalar complement.

A recent body of work on the scalar properties of adjectives and verbs flips the perspective (see, e.g., Kennedy and McNally 2005, Kennedy 2007, Kennedy and Levin 2008, Pedersen 2014). Specifically, Kennedy and Levin 2008 propose an analysis in which degree achievements are treated as instantiating the *general case* of verbal telicity. As in Ramchand 2008 (and related theories), verbs are structurally complex; however, for Kennedy and Levin 2008, telic verbs and degree achievements are built from a scale, not from a result state. Telicity arises from the properties of these scales. In particular, inherently telic predicates like *arrive* arise from degenerate scales with only two points.

Scales are defined to be a set of totally-ordered degrees along some dimension (width, dryness, etc.). Together with the lexical meaning of the verb, we are able to associate this set of degrees with a set of states (e.g. the state where x has degree d). In this respect, the scalar analysis is strictly richer than the result-state based analysis; information about a result state is fully recoverable from the scalar component. I will argue that this degree of richness gives us the necessary power to describe the iconic mapping that we have observed in ASL. The iconic representation of closed scales will derive Wilbur's generalization about end-marking and telicity.

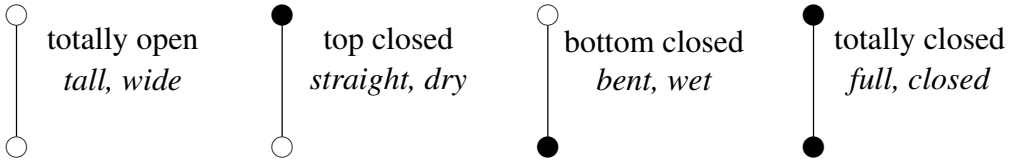
4.1 Scales in adjectives

Kennedy and McNally 2005 observe that many adjectives come associated with scales. These scales allow adjectives to show gradability with degree modifiers like *very* (e.g. *very tall*, *very wet*). Constructions like *how*-questions also provide direct reflection of these scales, as their meaning must be stated in terms of an ordered set of points.

(14) a. How large is the box?
b. How wet is the towel?
c. How straight is the path?

A scale, as a totally ordered set, can be characterized by certain mathematical properties. Kennedy and McNally 2005 show that adjectives can be classified by whether their associated scale contains a maximal and/or minimal element (in set terms, a supremum and/or infimum).

(15) Possible structures of gradable adjectives:



Kennedy and McNally 2005 demonstrate that natural language reflects this classification in a variety of ways. For example, some degree-modifiers are only available for scales with certain properties: *slightly* can only modify scales that are closed on bottom (e.g. *slightly wet* vs. **slightly* {*tall*, *dry*}); *completely* can only modify scales that are closed on top (e.g. *completely straight* vs. **completely* {*tall*, *bent*}); *half* can only modify scales that are closed on top and bottom (e.g. *half full* vs. **half* {*tall*, *straight*, *wet*}).

Kennedy 2007 shows that totally open scales display context-sensitivity that is not found for scales that are closed (on either end). The positive form of an adjective based on an open scale receives a relative interpretation; it must be evaluated with respect to a standard of comparison taken from context. For example, something is 'tall' if it has a greater degree of height than some contextually salient standard. In contrast, the positive form of an adjective based on a closed scale receives an absolute interpretation; something is 'wet' if it has greater than zero degree of wetness. Empirically, the relative/absolute distinction can be observed in paradigms with antonyms: if A is not dry, then it is wet, but if B is not wide, it is not necessarily narrow.

Kennedy 2007 proposes that the absolute interpretation of adjectives based on closed scales can be explained through sublexical decomposition and a principle of 'Interpretive Economy.' The essential insights presented below derive from Kennedy 2007, Kennedy and Levin 2008, and Pedersen 2014. However, a number of definitions have been changed from those papers to make synthesis easier and exposition (hopefully) clearer.

We define a measure function to be an additive function that takes an individual x and time t and returns a degree—the measure of x at t. The underlying type of an adjective is a measure

function. Thus, the range of the measure function for a given adjective is the scale associated with the adjective—for *wide*, the set of possible widths.

The positive form of an adjective is derived by the application of a function $\textbf{pos}_A$ to the measure function denoted by the adjective. For a given measure function m, $\textbf{pos}_A(m)$ checks whether the measure of a particular individual at a particular time is larger than some standard of comparison. This standard of comparison is given by the function **stnd**, which delivers a delineation of a given set with respect to the ordering relation $>$. Specifically, for a given measure function m, the function **stnd** returns a subset of the range of m, delineating the set of degrees into two parts: everything on one side of the delineation is in $\textbf{stnd}(m)$, and everything on the other side of it is not. For adjectives, it provides the set of degrees greater than whatever serves as the cut-off for tallness, wetness, straightness, etc.

(16) $\textbf{pos}_A(m) := \lambda xt.m(x)(t) \in \textbf{stnd}(m)$
'Given an individual x and a time t, return true if $m(x)(t)$ is in the set of degrees given by the standard of comparison $\textbf{stnd}(m)$.'

Given this definition of $\textbf{pos}_A$, the principle of Interpretive Economy states that, in the determination of **stnd**, context can only be used as a last resort. In the case of relative adjectives, the scale provides no intrinsic points of delineation, so a cut-off must be be taken from context. In the case of absolute adjectives, on the other hand, a closed endpoint of the scale can serve as a point of delineation; because this point is available, Interpretive Economy says that context *cannot* be used. We thus derive the non-context-sensitivity of absolute adjectives.

Figure 6 provides an example with *wide* and *dry*. *Wide* has an open scale, so $\textbf{stnd}(\textit{width})$ must come from context. In contrast, *dry* has a top-closed scale, so $\textbf{stnd}(\textit{dryness})$ consists of this maximal degree of dryness.

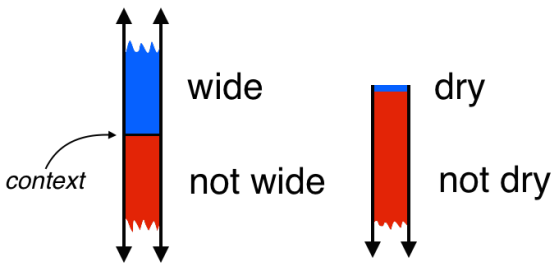


Figure 6: Delineation via **stnd** for wide and dry (adjectives).

4.2 Scales in verbs

Kennedy and Levin 2008 and Pedersen 2014 argue that a similar decomposition holds for verbs. Motivation for a parallel analysis comes from the observation that verbs are sensitive to the same categories as adjectives. The clearest examples are adjective/verb pairs with an overt morphological connection, like *wide*/*widen*, *straight*/*straighten*, *open*/*open*.

Empirically, a few properties are notable. First, in default contexts, verbs that have an underlying absolute scale generate the inference that the positive form of the adjective comes to hold. Verbs that have an underlying relative scale generate no such inference. This is demonstrated in (17).

(17) a. The towel dried. $\rightarrow$ The towel is now dry.
b. The gap widened. $\not\rightarrow$ The gap is now wide.

Second, the two categories pattern differently with respect to telicity. As we have seen, verbs based on closed scales have a telic and an atelic reading, as in (18). In contrast, verbs based on open scales are always atelic, as seen in (19).

(18) a. The towel dried for an hour.
b. The towel dried in an hour.

(19) a. The gap between the boats widened for a few minutes.
b. ?? The gap between the boats widened in a few minutes.

Kennedy and Levin 2008 and Pedersen 2014 argue that the same basic analysis for adjectives can be extended to verbs with a few modifications. As with adjectives, verb forms are decomposed; however, since verbs denote a change of state, the underlying measure function must be a *pair* of measures: the measure at the beginning of an event and the measure at the end of the event. Thus, for any measure function m, we define the m_{Δ} as the function that takes an individual and an event, and returns this pair of measures. In the definition below, **start**(e) returns the start time of e; **end**(e) returns the end time of e.

(20) For any measure function m,
$m_{\Delta} := \lambda ex.\langle \quad m(x)(\textbf{start}(e)) \ , \ m(x)(\textbf{end}(e)) \quad \rangle$

Pedersen 2014 proposes that positive verbal forms can be derived in a way completely analogous to the positive adjectival forms, by checking whether the change of degree of an individual x over an event e is in the relevant standard-of-comparison set. A definition of $\textbf{pos}_V$ is provided in (21).

(21) $\textbf{pos}_V(m_{\Delta}) := \lambda xe.m_{\Delta}(x)(e) \in \textbf{stnd}(m_{\Delta})$
'Given an individual x and an event e, return true if $m_{\Delta}(x)(e)$ is in the set of degrees given by the standard of comparison **stnd**(m_{Δ}).'

Pedersen 2014 observes that something interesting happens with respect to the delineation function **stnd** when it applies to verbs based on open scales. In the case of adjectives, we saw that open-scales provided no intrinsic point of delineation, so a relative adjective was forced to use a cut-off point from context. In the case of verbs, however, **stnd** takes as its input a set of *pairs* of degrees. Since **stnd** is sensitive to the ordering relation $>$, this means that the ordering relation *itself* can serve as the point of delineation across this two-dimensional set: the

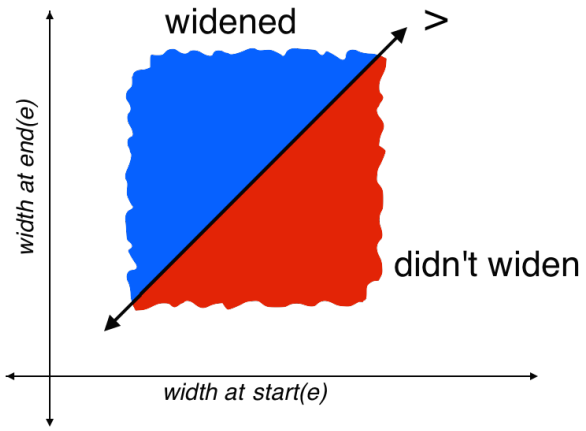


Figure 7: Delineation via **stnd** for widen (verb).

standard-of-comparison set includes any event with positive change along the scale. Figure 7 provides an example with the verb *widen*.

Because an intrinsic delineation can be found for verbs based on relative scales, Interpretive Economy says that context cannot be used. There is thus no inference that the positive form of the adjective holds, deriving the observation in (17b).

In fact, this delineation is available to any verb of change, including verbs derived from closed scales. In the case of verbs derived from closed scales, however, the closed endpoint of the scale can can also serve as a point of delineation with no cost from Interpretive Economy. The result is that two delineations are possible, and the verbs are ambiguous between two logical forms.

The two delineations for the verb *dry* are shown in Figure 8. The resulting readings are given in (22).

(22) a. There exists degrees d_1 and d_2 such that there is monotonic change in dryness from d_1 to d_2 and $d_2 > d_1$.

b. There exists degrees d_1 and d_2 such that there is monotonic change in dryness from d_1 to d_2 and $d_2 > d_1$ and $d_2 = \max(dry)$.

At this point, Kennedy and Levin 2008 propose that standard pragmatic reasoning kicks in: the two forms in (22) are in competition, so the more informative form is chosen. The form in (22b), which includes the condition that the maximum standard was reached, is strictly stronger. Thus, in standard cases, a sentence with a closed scale will generate the inference that the positive form of the adjective holds, deriving the observation in (17a).

But, since this is an ordinary implicature, it can disappear or be canceled; for example, it is the interpretation in (22a) that appears in *for*-adverbials (as in 18a), where there is no inference that a maximal degree was reached.

Finally, we can explain the facts about telicity by observing that the two meanings in (22) differ with respect to Stratified Reference. Specifically, if there is an event of monotonic change

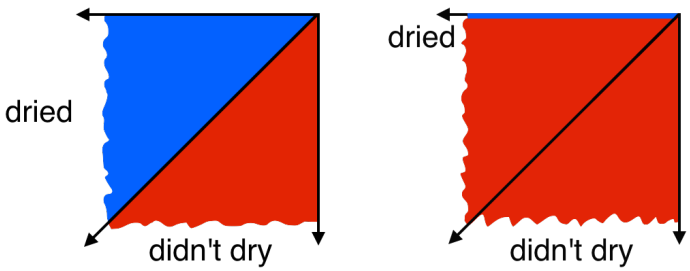


Figure 8: Ambiguous delineation via **stnd** for dry (verbs).

between some two points, then any subevent will also be an instance of monotonic change between two points. Thus, the meaning in (22a) has Stratified Reference. This is the only reading available for verbs with open scales, so these verbs are necessarily atelic, deriving the observation in (19).

On the other hand, if the value of one of these two points is specified, as in (22b), this will not be the case: no subevent that doesn't include that point will be able to satisfy the predicate. Thus, the meaning in (22a) does not have Stratified Reference. Both readings in (22) are available to verbs based on closed scales, so these verbs may be either telic or atelic, deriving the observation in (18).

4.3 Degenerate scales

The analysis of verbs as being associated with scales works very well for scalar verbs like *open*, *widen*, and *dry*, but doesn't immediately seem to carry over to predicates that seem to denote binary changes like *die*, *enter*, and *awaken*.

Rappaport Hovav 2008, and Kennedy and Levin 2008 show that there is in fact no fundamental problem for these cases; verbs of binary change are simply represented as a degenerate scale consisting of two points—for example, the verb *appear* consists of the two points 'not there' and 'there.' With only two points, these scales are necessarily top- and bottom-closed, so yield telic events.

In §5.2, I return to the case of degenerate scales in ASL. I show that many degenerate scales can be coerced into full scales by iconic modifications, providing motivation for this unified analysis.

5 Iconic scales

I propose that phonological path movement iconically represents the scale associated with a change-of-state verb in ASL.[7]

[7]It may turn out that verbs iconically represent even *more* information than just the scale associated with a verb. For example, Philippe Schlenker (p.c.) reports gradient judgments for paradigms involving the sign HIT-MISS 'tried to hit but missed,' where the distance by which the hit was missed is gradiently interpreted depending on the

The claim that scales can be iconically represented in sign language has been argued independently by Aristodemo and Geraci 2015 for adjectives in Italian Sign Language (LIS). They show that when the phonological form of an adjective includes a path motion, a comparative form can be constructed by signing the adjective at two different positions along the path motion. For example, in both LIS and ASL, the adjective TALL is signed with a bent flat hand held at some height in front of the speaker. The same sign can then be repeated at a higher height to indicate that a second individual is taller than the first. The distance between the two phonological forms is interpreted to indicate the relative degree of difference in the two heights. Aristodemo and Geraci 2015 demonstrate that an analogous pattern holds across a wide range of gradable adjectives, including ones involving abstract scales like CULTIVATED.[8]

(23) **Italian Sign Language** (from Aristodemo and Geraci 2015)
MARIA TALL-x GIANNI TALL-scale-more-y.
'Gianni is taller than Maria.'

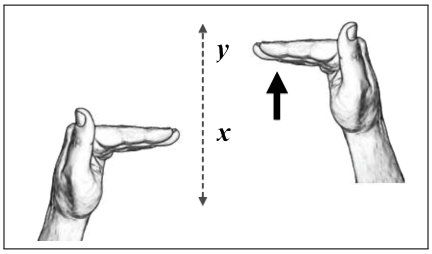


Figure 9: Images of 'TALL-x' and 'TALL-scale-more-y' in a comparative construction in LIS. The vertical dimension iconically represents the height scale.

As discussed in §4, scales may be open or closed at either end; Aristodemo and Geraci show that closed scales may be iconically represented in LIS and LSF by phonetic motions that are bounded on one end by contact of the dominant hand with another part of the body. For example, the adjective FULL in LIS is signed by making contact between the two hands; the result is that the adjective lacks the imprecision that generally characterizes gradable adjectives. Like the closed scale it represents, the hand literally can't move any further along the phonological path movement.

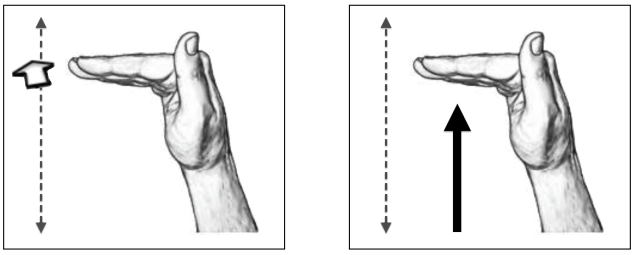
5.1 Iconic scales on verbs

I propose that the same scales that are iconically represented in adjectives are also iconically represented in change-of-state verbs in ASL. As discussed in §4, the same scale may form the

distance between the two hands. What is necessary for the current analysis is that the iconically represented scale that I describe here is *available*, either as a primitive in itself or as derived from a more general iconic mapping.

[8]Note that these scales need not always be iconically instantiated; for example, the scale associated with *smart* is no more abstract than the scale associated with *cultivated*, but SMART in LIS does not have the necessary phonological form to represent a scale.

semantic core of both an adjectival form and a verbal form, generating pairs like *wide* and *widen* in English. In ASL, similar pairs can be found, differing only in their phonological movement. For example, TALL in ASL is signed with bent hand and a small forward movement; the sign for GROW-UP in ASL is identical, except that the hand moves in a straight, upwards movement.



TALL GROW-UP

Figure 10: Images of TALL and GROW-UP in ASL.

Notably, the scale that forms the basis of both the adjective and verb is iconically represented in both phonological forms. In the case of the verb, movement along this scale is represented as movement along the phonological path. An analogous pattern can be seen with the adjective BIG, and the verbs GET-BIGGER (with a movement outwards) and SHRINK (with a movement inwards).

If scales are iconically represented in verbal forms, then the gradient manipulations described in §3.3 can be explained as an iconic mapping that preserves both scale structure of the event (as represented by distance along the phonological path movement) and time-course of the event (as represented by the time-course of the phonetic motion). End-marking on telic verbs is the iconic representation of the end of a closed scale.

More precisely, for each point in the production of a verb, we say that (a) the time that has elapsed after the onset of the sign is proportional to the time that has elapsed after the start of event, and that (b) the distance that has been traversed from the beginning of the phonetic motion is proportional to the degree that the measure has changed from the initiation of the event.

We state these two conditions formally in what follows. Given a verb V, let Φ be a phonetic form of V, and let e be an event in its denotation.

First, we define a relation **sync** that corresponds the time-course of Φ with the time-course of e. For any time t_Φ in the pronunciation of the verb and any time t_e in the runtime in of an event, we say that **sync**(t_Φ, t_e) (read: 't_Φ is synced with t_e') iff the same percentage of time has elapsed in the runtime of the event at t_e as has elapsed in the runtime of the pronunciation at t_Φ.

In the definition below, **start**(e) returns the start time of e; **end**(e) returns the end time of e. In the phonetic domain, **onset**(Φ) returns the start time of Φ; **coda**(Φ) returns the end time of Φ. I use different function names to stress that the former two deal with conceptual space and the latter two are measurements of the phonetic form.

(24) **Definition:**

$$\textbf{sync}(t_\Phi, t_e) \quad \Leftrightarrow \quad \frac{t_e - \textbf{start}(e)}{\textbf{end}(e) - \textbf{start}(e)} = \frac{t_\Phi - \textbf{onset}(\Phi)}{\textbf{coda}(\Phi) - \textbf{onset}(\Phi)}$$

Second, we posit an iconic condition that corresponds the distance that the phonetic form has traveled at time t_Φ with the degree that the measure has changed in the event at a synced time t_e. Namely, if t_Φ is synced with t_e, then the percentage of measurement that has changed at point t_e (relative to a complete event) is equal to the percentage of distance that has been crossed at point t_Φ (relative to a complete sign).

In the definition below, $m(x)(t)$ returns the measurement of x at time t; $d(t)$ returns the distance that the hand has traveled at time t. The event e_0 is a canonical event of V in which x_0 is the participant that changes in measure; Φ_0 is a default pronunciation of V.

(25) **Iconic condition on scalar change:**
$\forall t_\Phi, t_e.\textbf{sync}(t_\Phi, t_e) \rightarrow$
$$\frac{m(x)(t_e) - m(x_0)(\textbf{start}(e_0))}{m(x_0)(\textbf{end}(e_0)) - m(x_0)(\textbf{start}(e_0))} = \frac{d(t_\Phi) - d(\textbf{onset}(\Phi_0))}{d(\textbf{coda}(\Phi_0)) - d(\textbf{onset}(\Phi_0))}$$

Comparison to a default, canonical phonological form allows us a way to formulate what's going on in incompletive constructions: in order to know that a phonetic form is incomplete, we must know what the particular phonetic form was, but also *how it is normally signed*.

Finally, to formally represent the fact that end-marking on verbs is the end of a closed scale, we state the condition that if a phonological motion at t_Φ reaches the maximal distance it can travel (perhaps due to contact with another part of the body), then the measure of an individual at t_e synced with t_Φ is the maximal measure on a scale.

(26) **Iconic condition on scalar endpoints:**
$\forall t_\Phi, t_e.\textbf{sync}(t_\Phi, t_e) \quad \rightarrow \quad [d(t_\Phi) = \max(d) \rightarrow m(x)(t_e) = \max(m)]$

Essentially, what the conditions above say is that the graph of relative measure-over-time for the event e matches the graph of relative distance-over-time for the phonetic form Φ. For example, Figure 11 shows a possible graph of a phonetic form that starts out fast then decelerates, and never is completed (it never reaches 100% distance of the canonical form.) The same graph shows the event progression of the event denoted by the verb form.

One final revision is needed of this iconic mapping; namely, as we saw earlier, sharp decelerations may be used to segment distinguished points of an event without being interpreted literally as decelerations in the speed at which the event happens. To capture this observation, we will weaken the iconic condition in (25): instead of quantifying over all t_Φ, t_e, we quantify only over distinguished points of the phonetic form. One way of distinguishing points is to use sharp decelerations.

5.2 Degenerate scales in ASL

In §4.3, I suggested, following Rappaport Hovav 2008 and Kennedy and Levin 2008, that inherently telic predicates arise from degenerate, two-point scales, as opposed to arising from an

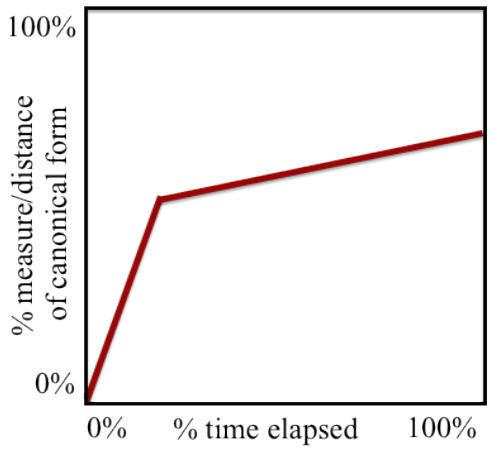


Figure 11: Event progression/phonetic form of a decelerating incompletive form.

unrelated mechanism (such as a *res* morpheme).

The ASL data seems to support the analysis that unites verbs of binary change with scalar verbs. In particular, iconic manipulations can easily coerce a scale that is otherwise binary into a more fine-grained scale. For example, the scale underlying *die* contains only two points, 'dead' and 'not dead.' As we have seen, though, on the iconic manipulations of DIE in Figure 5, the binary predicate is coerced into one denoting change along a scale.

As is perhaps expected, the ease with which this coercion can happen depends on how easy it is to accommodate a gradient scale for a particular verb meaning. For example, the verb *die* can easily be associated with a scale measuring health that is closed at the bottom by death (a state of zero health); in contrast, it is not as clear what non-binary scale can be associated with the verb *notice*.

These differences are reflected in grammaticality judgments of iconic manipulations of different verbs. For example, DIE-bit-by-bit (as shown in Figure 5c) is perfectly acceptable; similarly, the verbs CHANGE (as in 'a friend's face changed') and ARRIVE are perfectly acceptable with 'bit-by-bit' inflection, which entails the existence of successive intermediate stages of the event. In contrast, the verbs NOTICE and BUY receive degraded judgments with 'bit-by-bit' inflection.

In the cases where a gradient scale cannot be coerced, many iconic manipulations become unavailable. The result is that the manipulations that remain possible in many cases approximate the typologies discussed by Wilbur. However, this correspondence is not exact; for example, both NOTICE and BUY also receive a degraded judgment when signed with a slow, extended path movement. Wilbur has no explanation why [extra] couldn't apply here. In contrast, the iconic analysis makes the correct prediction that extended path motion should be available to an extent closely correlated with the availability of 'bit-by-bit' inflection, determined by the ease of coercing the relevant scale.

5.3 Deriving telicity in ASL

At this point, deriving the telicity of end-marked predicates in ASL is completely straightforward: when a verbal form travels the maximal distance that the phonological motion can travel, the iconic condition on endpoints in (26) entails that a scalar change reaches a maximal degree in every event in the denotation of the verb (in the terms above, that $m(x)(\textbf{end}(e)) = \textbf{max}(m)$).

This in turn means that the predicate is telic. The reasoning is exactly as we saw before: given an event e in the denotation of the predicate, any sub-event over an interval that doesn't include $\textbf{end}(e)$ will not include the maximal degree, so will not be in the denotation of the predicate. Thus, the predicate cannot be exhaustively divided into temporally small events of which the predicate holds. The predicate does not have Stratified Reference, so is telic.

The connection to the telicity of predicates in English is slightly more indirect. The key observation is that the iconic condition on endpoints is only defined if $\textbf{max}(m)$ exists—that is, if the meaning of the verb is based on a closed scale. As we saw in §4.2, verbs based on closed scales are exactly those verbs which default to telic meanings, though pragmatic reasoning governing the choice of **stnd**. Thus, the endpoint of a verb may only be iconically marked in ASL if it corresponds to a verb meaning that would be interpreted as telic in English as well.

6 Conclusions and extensions

6.1 Extension: *again*-ambiguities

One further extension should be flagged as an area for further research. In English, the adverb *again* has been shown to be ambiguous between a repetitive reading and a restitutive reading. For example, the sentence in (27) has two possible interpretations (neither of which entails the other), differing in their presuppositions: the first presupposes that a certain event previously occurred; the second presupposes a certain state previously held.

(27) The river widened again.
   a. It widened twice (perhaps incrementally).
   b. It widened to a former size.

Traditional analyses of *again*-ambiguities (e.g. von Stechow 1996) have captured them via an attachment ambiguity on a verbal decomposition containing a result state, parallel to what we saw for *almost*, as in (12). Pedersen 2014 argues, based largely on facts regarding degree achievements like the example in (27), that a more unified picture of *again*-ambiguities emerges if we posit a verbal decomposition containing a scale, as discussed in §4.2.

It turns out that ASL brings interesting data to the table in this domain as well. ASL, like English (and various other languages), shows ambiguities with AGAIN; the examples in (28) can each be shown to have two readings, analogous to the readings of the English glosses that I have given.

(28) a. ME DOOR AGAIN CLOSE.
'I closed the door again.'

b. YESTERDAY JOHN SELF CHANGE WOLF AGAIN
'Yesterday, John changed into a wolf again.'

c. THIS YEAR, GROUP AGAIN GREW.
'This year, my group grew again.'

d. THIS WEEK, TEMPERATURE INCREASE AGAIN.
'This week, the temperature increased again.'

In ASL, however, an interesting situation emerges when AGAIN is used with iconically incompletive verbs. Specifically, preliminary results suggest that when AGAIN modifies an incompletive form like CLOSE-incomplete, two readings are still available. On the repetitive reading, the sentence presupposes that the speaker incompletely closed the door previously. Interestingly, a restitutive reading also exists, and presupposes that the door was previously in a state *of being incompletely closed*. Note that this is not a possible reading of the English sentence '*I almost closed the door again*' (which nevertheless has about five other readings).

(29) I DOOR AGAIN CLOSE-incomplete.

(30) Possible presuppositions:

a. **Repetitive:** I incompletely closed the door before.

b. **Restitutive:** The door was incompletely closed before.

The availability of the restitutive reading in (30b) shows that the state of incomplete closure must be retrievable from the meaning of the modified verb so that it can be targeted by *again*. On a state-based decompositional analysis, no such state exists, since the only sub-tree available is the result state denoting full closure. In contrast, a scale-based decompositional analysis provides access to the full set of closures. The state of incomplete closure can be made available, provided that it is made sufficiently salient, like, for example, through by the sharp stop associated with the incompletive form.

I leave further empirical and theoretical investigation for future research.

6.2 Conclusions

In this paper, I addressed two observations from Wilbur 2003, 2008, and 2009: first, that certain properties of a verb's phonetic form are correlated with the telicity of the verb; second, that phonetic manipulations of a verb may be semantically interpreted. I argued that the purely morphological system proposed by Wilbur is not sufficient to capture the full range of manipulations that are possible in ASL. As an alternative, I advocated a theory in which an iconic mapping preserves information about timing and event progression. I showed that this iconic mapping could be formalized if we adopted recent theories (Kennedy and Levin 2008, Pedersen 2014) in which verbal telicity arises from the properties of associated scales.

I argued that the phonetic marking of telicity in ASL arises from the iconic marking of the maximum degree on a closed scale. This analysis presented a clear natural class of phonetically end-marked telic verbs in ASL, including both telic degree achievements like CLOSE and verbs based on degenerate scales like ARRIVE. A unified analysis of the two was also supported by the ability to iconically coerce some verbs of the latter category into forms with richer scale structures.

It should be noted that the analysis that I have advocated shares certain important features of Wilbur's analysis. First, I have posited that verbs are structurally complex, and that various syntactic and semantic properties of a verb emerge from properties of its sub-lexical decomposition. Second, I maintain the insight from Malaia and Wilbur 2012 and Malaia 2014 that rapid deceleration is a general cognitive mechanism for event segmentation.

The analysis presented here, however, puts iconicity front and center, not only as a grounding for discrete morphemes, but as active component of a synchronic form.

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