

Scale Shifting and Compositionality

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1. Introduction

In this paper we extend the model developed for path and manner-of-motion constructions proposed in [15] to predicates denoting the creation of an object, whether syntactically realized or not. This model, Dynamic Interval Temporal Logic (DITL), exploits the formal distinctions available in the “events as programs” metaphor, to differentiate both lexical and compositional properties of telicity involved in scalar predication. Specifically, we distinguish between lexical and phrasal constructions which denote *tests* over their successful dynamic execution (test predicates), from expressions which denote the inherent *assignment* and re-assignment of a value to an attribute (assignment predicates). Tests denote telic, while iterated assignments correspond to atelic constructions. Following [15], and related to [9]’s analysis, we use this distinction to characterize different subclasses of creation verbs, where the created objects play different roles in the calculation of telicity.

2. Creation Verbs

Creation verbs have long posed a problem for verbal aspectual classification (cf. [11]). Traditionally viewed as accomplishments, the standard analysis, at least since [2] and [18], is that they differ from regular accomplishments in that they take a participant that measures out the event, i.e., an incremental theme argument. Recent work on scalar change offers a new way to look at the inherent temporal properties of these verbs, but also makes conflicting statements regarding the kind of change entailed, particularly with regard to the *locus* of the scale. [4] claim that creation and consumption incremental theme verbs (ITVs) lexicalize an *extent scale*, while [17] and [6] argue that the scale for an ITV is not encoded in the verb, but is rather introduced compositionally by the referent of the direct object. [17] analyzes ITVs as activities, and in support of this view, [9] claim that ITVs lack argument realization properties which other scalar predicates share, such as resistance to object deletion.

None of these analyses, however, can account for the long recognized distinction ([1]) between transitive creation verbs which may exhibit an object-drop alternation (e.g., *draw*, *write*, *dig*, *knit*, *paint*) and those which typically do not exhibit this alternation (e.g., *build*, *construct*, *create*, *make*, *produce*). This distinction is illustrated below.

- (1) a. John quickly drew a map (of the route).
b. Children were drawing on pieces of paper on the floor.
- (2) a. John wrote a new book.
b. Sophie has been writing for hours.

- (3) a. John built a wooden bookcase.
 b. *John has been building for weeks.

Within the dynamic framework mentioned above, we analyze both these verb types as *assignment predicates*, changing the value of an attribute against a scale. While both verb classes involve variable assignments over an *ordinal scale*, the *build*-class also introduces a predicate against which the ordinal scalar change is tested. Hence they are test predicates as well. This test, we suggest, makes reference to a *nominal scale*.¹

In our use of the notions of scales we depart from the linguistic terminology, according to which a scale is usually understood as an ordinal scale (either two-point or multi-point, cf. [17]), and make reference to measurement theory, where a principled distinction is drawn between different types of scales (e.g. *nominal*, *ordinal*, *interval*, *ratio*, cf. [7]). This allows us to conceptualize the very point of the paper; viz., that different scalar theories can be referenced in a compositional process, and that shifting operations may be at play in the examples discussed.

3. Dynamic Interval Temporal Logic

We assume an event structure based on linear temporal logic (LTL), with standard operators, \circ , \square , \diamond , and \mathcal{U} (cf. [3,8,12]). A *state* is a single frame structure, wherein a proposition is interpreted at temporal index i , $\boxed{\phi}_i$; concatenation can apply to two or more indexes, denoted by the interval $[i, j]$, $\boxed{\phi}_i \boxed{\phi}_j = \boxed{\phi}_{\langle i, j \rangle}$. We define a *transition* as a sequence containing a propositional opposition over adjacent states. From a 2-state transition, $\boxed{\phi} \boxed{\neg\phi}_{\langle i, i+1 \rangle}$, we can compose *extended transitions*, $\boxed{\phi}_{\langle i, j \rangle} \boxed{\neg\phi}_{j+1} = \boxed{\phi} \boxed{\neg\phi}_{\langle [i, j], j+1 \rangle}$.

As with transitions and extended states, we interpret *processes* dynamically as programs. To understand this, we turn directly to the semantics of incremental theme verbs. We assume that ITVs operate over a scale. For now, we ignore interval properties and focus on the simpler order-preserving transformation defining an ordinal scale. An *ordinal scale* consists of a set of elements, \mathcal{D} , exhibiting the attribute to be measured, along with an ordering of \mathcal{D} over this attribute, \preceq , where, if $a, b, c \in \mathcal{D}$, then if $a \preceq b$ and $b \preceq c$, then $a \preceq c$.

We will assume that a process has characteristics of both states and transitions. For any process, there must exist at least one attribute of an object, whose value is changing over the trace of the state transitions. Adopting the analysis from [14], we refer to this as an *iterated dynamic assignment*. Hence, the object remains persistent otherwise, while varying in the value assigned to this one attribute. For the present discussion, somewhat informally, let $\mathcal{A}(x) = y$ refer to the proposition ‘‘attribute \mathcal{A} holds of x with value y ’’. We define an *attribute assignment* as a 2-frame structure where the second frame indicates the changing binding associated with the attribute statement, with $y \neq z$. We define the iteration of an assignment (marked with $^+$) as a *process*. If there exists at least an ordinal scalar constraint, e.g., \preceq , that holds over each iteration, then we call the process *directed*. These are:

$$\boxed{\mathcal{A}(x) = y} \boxed{\mathcal{A}(x) = z}_{\langle i, i+1 \rangle}, \boxed{\mathcal{A}(x) = y} \boxed{\mathcal{A}(x) = z}^+_{\langle i, j \rangle}, \text{ and } \boxed{\mathcal{A}(x) = y} \boxed{\mathcal{A}(x) = z, y \preceq z}^+_{\langle i, j \rangle}.$$

¹ For reasons of space, we concentrate on *build*- and *write*-verbs and do not examine other creation classes such as those encoding only a test component (*invent*-verbs) and those alternating with a change-of state reading (*bake*-verbs) (for a recent overview of creation subclasses, see [5]; for an account within DITL, cf. [14]) and [16]).

4. The Analysis

Adopting the analysis of manner-of-motion predicates like *walk* and *run* from [15], we say that a process “leaves a trail” as it is executed. For motion, this trail is the created object of the path which the mover traveled on. For ITVs, this trail is the created object brought about by order-preserving transformations as executed in the directed process above. Hence, a verb such as *write* is an assignment predicate, denoting a directed process, which leaves a trail of the process, namely the material written. This argument is unexpressed in the syntax but present in the inspection of any state or the overall trace of the process. Following [14], we call this a program variable, \vec{y} , to the verb *write*, as in: $\lambda\vec{y}\lambda x[write(x, \vec{y})]$.

Now consider *build*. Unlike the verb *write*, it denotes a directed process which is measured against a defined *test*, introduced explicitly by the direct object argument, In other words, during the dynamic execution of a build-event, the test component constantly checks whether the current stage of creation of the object is identical to the distinguished end point identified by the semantics of the direct object, and stops when this point is reached. The test component of *build* references a *Nominal scale*, in that it introduces a nominal dichotomy that did not exist before (cf. [7]). Thus, a verb such as *build* also leaves a trail, but while testing the value of this trail against the semantics of the distinguished value denoted by the direct object. Therefore, it has both an incrementally created (trail) argument, denoted by a program variable, as well as the argument identified with the test: $\lambda\vec{z}\lambda y\lambda x[build(x, \vec{z}, y)]$. This is represented schematically in the event structure below, ignoring the agent, x :

$$(4) \begin{array}{|c|c|} \hline \mathcal{A}(x) = y & \mathcal{A}(x) = z, y \preceq z \\ \hline \neg bookcase(z) & bookcase(z) \\ \hline \end{array}^{+}_{(i,j)}$$

Returning to the expressed object examples with *write* and *draw* verbs, it is now clear what is being computed. The direct object introduces a test which determines when the ITV directed process should terminate. This shifts the scale of interpretation for these predicates from ordinal to nominal, something we refer to as *scale shifting*.

Regarding the compositional distinction between *build a house* and *write a letter*, the following is the case. Telicity is defined by reference to a test, and any test will do. Lexically, *build*-verbs encode the test as part of their semantics, and the nominal test is selected for as an argument. This makes them inherently test predicates. Verbs such as *write*, however, do not encode a test, but are assignment predicates. There are at least two options for how to treat *write*-verbs (for a detailed discussion, cf. [16]).

- (5) a. Optional argument solution ([13]): $\lambda^*z\lambda\vec{y}\lambda x[write(x, \vec{y}, z)]$
- b. Cocompositional solution: argument introduction licensed by special constraints.

We focus here on the latter, which introduces a compositional strategy that perform this testing. Such strategies would be limited by the grammar and would also be cocompositional:

- (6) a. ARGUMENT INTRODUCTION; creates a test by reference to a new nominal scale;
write a letter, draw a circle, run a mile, knit a sweater
- b. ADJUNCT INTRODUCTION; creates a test with a measure phrase relevant to the trail created by assignment; *write/draw for an hour, walk to the store, knit until noon.*

Under this analysis, *write a letter* would involve a cocomposition resulting in a VP expression equivalent to $\lambda z\lambda\vec{y}\lambda x[write(x, \vec{y}, z)]$.

$$\begin{array}{|c|c|} \hline \mathcal{A}(x) = y & \mathcal{A}(x) = z, y \preceq z \\ \hline \neg letter(z) & letter(z) \\ \hline \end{array}^{+}_{(i,j)}$$

As pointed out above, durative adverbials are a potential test expression in composition with assignment predicates, such as *write* and *draw*. Hence, instead of argument introduction (option a above), adjunction is possible, as in *write for an hour* and *walk for a mile*. Both innovations create tests over the assignment predication, as shown below for *write*, where τ traces the interval length of the event, e .

$\mathcal{A}(e, x) = y$	$\mathcal{A}(e, x) = z, y \preceq z$ ⁺
$\tau(e) \neq (\text{hour}, 1)$	$\tau(e) = (\text{hour}, 1)$

_(i,j)

Notice how *walk for a mile* can now be “clocked” with a frame adverbial, as in *walk for a mile in 10 minutes*. Hence, while frame adverbials are actually clocking an activity to completion, and *require* that a test is already present, durative adverbials introduce a test that measures the activity without clocking it.

References

- [1] Dowty David R. 1979. *Word meaning and Montague Grammar*. Dordrecht: Reidel.
- [2] Dowty David R. 1991. Thematic proto-roles and argument selection. In *Language* 67: 574-619.
- [3] Fernando, T. 2004. A Finite-state Approach to Events in NL Semantics. *JLC*:14(1): 79-92.
- [4] Hay Jennifer, Chris Kennedy and Beth Levin. 1999. Scalar Structure underlies Telicity in Degree Achievements. In *The Proceedings of SALT IX*. Matthews and Strolovitch (eds). 127-144. Ithaca: CLC.
- [5] Jezek Elisabetta. 2010. *Classes of creation verbs*, ms., Università di Pavia (submitted).
- [6] Kennedy Chris 2009. Aspectual Composition and Scalar Change. Oral Presentation at *Workshop on Scalarity and Event Structure at Chronos 9*. Paris Diderot, U of Chicago Center, Paris, Sept. 2-4, 2009.
- [7] Krantz, David and Patrick Suppes. 1971. *Foundations of measurement*, Academic Press, New York.
- [8] Kröger, Fred and Stephan Merz. 2008. *Temporal Logic and State Systems*, Springer Verlag.
- [9] Levin Beth and Malka Rappaport Hovav. 2010. Lexicalized Scales and Verbs of Scalar Change. Oral Presentation at *46th Annual Meeting of the CLS*, University of Chicago, Chicago, IL, April 8-10, 2010.
- [10] Naumann, Ralf. :2001. Aspects of changes: a dynamic event semantics, *Journal of Semantics*: 18:27-81.
- [11] Piñón Christopher 2008. Verbs of creation. In Dölling J., T. Heyde-Zybatow and M. Schäfer (eds) *Event Structures in Linguistic Form and Interpretation*. Walter de Gruyter. 493-521.
- [12] Pnueli, A 1977. The Temporal Logic of Programs, *19th Symp. on Foundations of Computer Science*.
- [13] Pustejovsky, J. 2000. “Lexical Shadowing and Argument Closure”, in Y. Ravin and C. Leacock (eds.), *Polysemy and Lexical Semantics*, Oxford University Press.
- [14] Pustejovsky, James 2011. “Dynamic Selection and the Semantics of Change”, to appear in *Atti del XLII Congresso della Società di Linguistica Italiana (SLI)*, Pisa, 25-27 Sept. 2008.
- [15] Pustejovsky, James and Jessica Moszkowicz 2011. “The Qualitative Spatial Dynamics of Motion in Language”, *Spatial Cognition and Computation*, 11:132, 2011.
- [16] Pustejovsky, James and Elisabetta Jezek 2011. “Scale-shifting and event composition”, ms., Brandeis University and Università di Pavia.
- [17] Rappaport Hovav, Malka. 2008. Lexicalized meaning and the internal temporal structure of events. In Rothstein (ed). *Crosslinguistic and Theoretical Approaches to the Semantics of Aspect*. Benjamins. 13-42.
- [18] Tenny Carol. 1994. *Aspectual Roles and the Syntax-Semantic Interface*. Dordrecht, Kluwer.