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Fine-Grained Event Structure Representations for Language: Aspect, Force Dynamics, Mental Spaces

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Introduction

This presentation reviews current work in a project to develop event structure representations for all of the verb classes in VerbNet (`verbs.colorado.edu/verbnet`) based on the "three-dimensional" representations introduced in Croft (2009a, 2012, 2015). The three dimensions include continuous dimensions of time (t) and (change in) qualitative state (q) for aspect, and a third "dimension" representing a causal chain of force dynamic interactions between participants. The event expressed by a verb is decomposed into a separate subevent for each participant; each participant has an aspectual contour representing what it does/what happens to it over time, and each participant's subevent is in a force dynamic relationship with the other participants' subevents, forming the causal chain. An example is given in Figure 1.
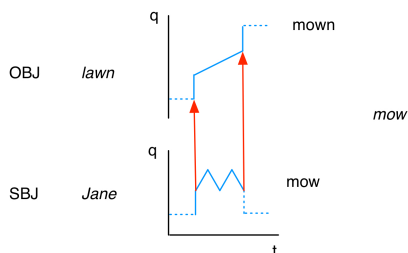

Figure 1: A representation of an aspectual and causal event decomposition for *Jane mowed the lawn* (Croft, 2012).

Aspect

Aspect—how events unfold over time–is analyzed using a phasal model including the following phases: states (single point on q, but may be of different extents on t); transitions (changes on q construed as instantaneous on t); incremental change (monotonic on q), and nonincremental change (nonmonotonic on q). This analysis allows for the representation of the aspectual types of verbs in simple tense-aspect constructions found in the semantics literature (Croft, 2012).

We have revised the analysis in order to include a fifth Venderlian aspect type, *endeavors*: events that terminate without completion (unlike accomplshments). Certain Russian perfective prefixes express undirected endeavors (terminated nonincremental changes), as in *On po-spal posle obeda* 'He had a sleep after dinner', and directed endeavors (terminated incremental changes), as in *On pri-otkryl dver'* 'He opened the door a little' (Croft, Pešková, & Regan, 2017). Semelfactives, as in *The mouse squeaked*, were analyzed in Croft (2012) as cyclic achievements—transitions ending in a point state. However, semelfactives may be better analyzed as punctual endeavors—transitions that terminate immediately.

Force Dynamics and Incremental Theme Types

By far the most important development in the project is the enrichment of the force dynamic analysis presented in Croft (2012). That work is based on Talmy (1976, 1988) and my earlier publications (Croft, 1991, 1993, 1998a, 1998b, 2009a, 2009b; Croft, Taoka, & Wood, 2001). However, this work is unable to capture the common categories of event types found in the recent verbal semantics literature, such as directed motion, placing/application, removal, creation, change of state, transfer of possession and so on. These categories are more specific than the more general force dynamic relations described in Talmy's and my earlier work.

The additional semantic information that yields the generally recognized categories of event types is the type of incremental theme change that the theme participant undergoes in the event (Dowty, 1991; Hay, Kennedy, & Levin, 1999; Croft, Pešková, & Regan, 2016). For example, the difference between spraying paint on the wall (application) and pushing the table against the wall (caused motion) is in what changes incrementally in the process. The incremental change described by spraying is that the theme, the paint, ends up on the wall drop by drop (mereologically). In contrast, the incremental change described by pushing is movement of the table incrementally on a path towards the wall. The incremental change is a feature of the qualitative dimension (the types of intermediate states in the process).

We have identified five distinct types of changes that the theme participant may undergo. A mereological change refers to part-by-part change. A property change refers to change in degree of a property of the entity as a whole. A design change refers to a change in the identity of the object. A path change refers to change along a spatial path of the object. Finally, an internal change refers to a dynamic change internal to the object (e.g. unfolding). These types of changes account for physical event types. Our current work on mental and social event types indicates that the same types of change are found in mental events, although in some cases it represents a metaphor (e.g. transfer of possession is construed as mereological, but involves ownership, not spatial co-location).

Our current work also indicates that mental and social

events involve a wider range of force dynamic relations than those proposed by Talmy (1976). In addition to Talmy's affective causation for mental events, there is also attending to a stimulus and an experiential stative relation (Croft, 1993). In addition to Talmy's asymmetric inducive causation relation between two agents carrying out an action, a more symmetric mutual relation between agents is also systematically distinguished grammatically (e.g. with a comitative adposition, or a sociative causative construction). There is also a transfer relation for at least possession and communication, expressed by a distinct double object construction in many languages.

The revised analysis of aspect, force dynamics and theme type has been formalized for commonsense reasoning in Croft et al. (2017), using temporal interval calculus (Allen, 1984) and a recent formalization of commonsense psychology (Gordon & Hobbs, 2017). An annotation scheme for computational linguistic applications is being developed.

Mental Spaces and Unrealized Subevents

Events denoted by the complement clauses of verbs such as *want* or modals such as *might* are unrealized. However, subevents of verbal events may also be unrealized: in *Keri baked Sandy a cake*, Keri intends Sandy to receive the cake but Sandy might not actually receive it (Goldberg, 1995; Croft, 2003); and in *He had risked two of his submarines by sending them to the edge of the American beaches*, the subevent of sending the submarines is actual but the harm to the submarines is only potential (Croft & Vigus, 2017). Hence a full event structure representation must allow for differing modal status of verbal subevents.

Unrealized subevents are being modeled in terms of mental spaces (Fauconnier, 1985). Each subevent is situated in a mental space. A mental space is linked to its parent space by a stance relation (full or partial positive, neutral or full or partial negative). Mental space types required include epistemic spaces (real and hypothetical), tense spaces, "future-oriented" spaces (including deontic), generic spaces (including dynamic) and fictional spaces.

Acknowledgments

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