Causation and telicity in a force-theoretic framework

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The short version

- There are two kinds of causation, due to two possible temporal relationships between a cause and its effect. This fact has not been represented in event semantics at the interface with syntax, though it has been in conceptual and cognitive linguistic force-dynamic approaches.

- Modeling both kinds of causation with a force-theoretic semantics while retaining advances of quantization and scales, gives us a better way to represent telicity and atelicity.

This talk reflects joint work with Heidi Harley, University of Arizona (Copley & Harley 2014, in prep).
Causation and telicity
Two kinds of causation

Causes can have either of two temporal relationships to their effects.

(1)  
   a. launch  

   [Diagram: ]

   b. entrainment  

   [Diagram: ]

Two kinds of causation

However, event semantics at the interface with syntax has not paid much explicit attention to entraining causation. There seems to be rather a focus on launching causation (and stative results).

(2) Pustejovsky 1995
Mary ran to the store: \([cause(\text{act}(m), \text{become}(\text{at}(m, \text{the-store}) \text{ BY run})]\]

(3) Higginbotham 2000
John saddled the horse: \(\exists e \exists e' \ [\text{agent}(John, e) \text{ saddled}(\text{the horse}, e') \ (e, e') \text{ is a telic pair}]\)

(4) Ramchand 2008
Mary opened the door: \(\text{Subject}(Mary, e_1) \&\)

\[\begin{align*}
\text{a. } & \quad [v] = \lambda P \lambda x \lambda e \exists e_1, e_2 \ [P(e_2) \& v(e_1) \& \text{State}(e_1) \& e = e_1 \rightarrow e_2 \& \text{Subject } (x, e_1)] \\
\text{b. } & \quad [V] = \lambda P \lambda x \lambda e \exists e_1, e_2 \ [P(e_2) \& V(e_1) \& \text{Process}(e_1) \& e = (e_1 \rightarrow e_2) \& \text{Subject } (x, e_1)]
\end{align*}\]
Understanding atelicity with entraining causation

- Krifka 1998 e.g.: Certain predicates involve a mapping from parts of the event to parts of object; quantized object $\Rightarrow$ telicity.
- Kennedy & Levin 2008, e.g.: Certain predicates involve a mapping from parts of the event to degrees on a scale; endpoint $\Rightarrow$ telicity.
- Filip & Rothstein 2005, Filip 2008: Both these mechanisms for telicity are subsumed under a $\text{MAX}_E$ function that picks out the maximal event in the case of telic predicates.

Proposal: The key intuitions above are retained but the mechanism is different. Telicity involves launching causation, while atelicity involves entraining causation.
Proposal

- Both telic and atelic predicates specify a result situation as well as a causing situation.
- The result situation need not be a state, though it can be.
- Given a causing and a result situation, world/lexical knowledge tells us whether it begins as the causing situation ends (launch), or begins as the causing situation begins, as a “cotemporal result” (entrainment).

(5)  
- a. Mary ate apples for/*in five minutes.  
- b. Mary ate an apple *for/in five minutes.

(6)  
- a. Mary pushed the cart for/(*)in five minutes.  
- b. Mary pushed the cart to the fence (*)for/in five minutes.

(7)  
- Mary heated the soup for/in five minutes.
Proposal

The goal now: to use both kinds of causation, along with quantization and scales, to represent telicity and atelicity, in a formal semantics.

We’ll do this by using the notion of force instead of event, so first we’ll look at two reasons why we need forces to represent causation in verbal predicates.
A force-theoretic framework
Firstly, event arguments work well for launching, but not for all cases of entrainment, because event individuation fails.

(8)  
   a. Mary ate an apple.  
   b. Mary heated the soup.

(9)  
   a. Mary ate apples.  
   b. Mary danced.

What we really need is the notion of an input of energy or force.
Why forces?

Secondly, without forces it’s hard to distinguish between, e.g. staying eventualities and being eventualities:

(10) a. John was in the room.
    b. John stayed in the room.

(11) a. #John is being in the room.
    b. John is staying in the room.

(12) a. stay: $e_1 \text{ CAUSE } e_2 \& \text{ BE}(e_2, p)$?
    b. stay: $e_1 \text{ CAUSE } e_2 \& \text{ BECOME}(e_2, p)$?

Instead: stay refers to a force with a cotemporal stative result.
Conceptual and cognitive linguists and psychologists have long explained verbal meanings by representations of configurations of forces.

- Talmy 1976, 1988, 2000 e.g.: especially cases of force-dynamic accord and opposition, e.g., cause, help, prevent
- Croft 1991, 2012 e.g.: argument structure is sensitive to force-dynamic considerations
- Gärdenfors 2000, 2014: all verb meanings are represented by configurations of forces
- Wolff 2007 e.g.: psychological verification of Talmian accord and opposition, force chaining
Forces in the literature

In more formal approaches, forces have been referred to for:

▶ argument structure, including internal causation and affectedness (Rappoport-Hovav & Levin 2002, Beavers 2011, e.g.)
▶ the progressive (offhand remarks in Portner 1998, Asher 1992)
▶ prepositions (Zwarts 2010 e.g.)
▶ a general formal framework including forces: van Lambalgen & Hamm 2005
Forces in the literature

Van Lambalgen & Hamm 2005

- There are forces (and events)
- Two kinds of causation
- But: basic typological difference is governed by duration

\[(13)\text{ An eventuality is a structure } (f_1, f_2, e, f_3), \text{ where}\]
\[\begin{align*}
  a. & \ f_1 \text{ is a fluent which represents an activity, something which exerts a force} \\
  b. & \ f_2 \text{ is a parametrized fluent, representing a parametrized object or state, which is driven by the force } f_1 \\
  c. & \ e \text{ is the culminating event, representing a canonical goal} \\
  d. & \ f_2 \text{ is a fluent which represents the state of having achieved the goal}
\end{align*}\]
The framework

Copley & Harley 2014, in prep

- Essential type difference is of dynamicity: forces and situations
- A force is represented in language by a function from an initial situation to a *ceteris paribus* final situation
- Double ontology: conceptual ontology ≠ linguistic ontology

<table>
<thead>
<tr>
<th>conceptual</th>
<th>linguistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>inputs of energy</td>
<td>force functions</td>
</tr>
<tr>
<td>states of affairs</td>
<td>situations</td>
</tr>
</tbody>
</table>

Force functions are type ⟨s,s⟩ (or type f for short).

The evaluation function is used, as usual, to mediate between the linguistic and conceptual level. So one may write \([f] = \varphi\), or \([s] = \sigma\), e.g.
\( \varphi \leftrightarrow f \)

arises from
(all) the individuals
and property
attributions in

\( \sigma \leftrightarrow S \)
We define two linked sequences, one of situations and one of force functions:

\[(14)\] 
\[
\ldots, s_{-2}, s_{-1}, s_0, s_1, s_2, \ldots
\]
\[
\ldots, f_{-2}, f_{-1}, f_0, f_1, f_2, \ldots
\]

\[(15)\]
\[
a. \text{ Let } f = \text{net}(s) \text{ iff } [f] \text{ is the net force of } [s]
\]
\[
b. \quad f_n = \text{net}(s_n)
\]
\[
c. \quad s_{n+1} = f(s_n)
\]

\[(16)\]
\[
a. \quad init(f_n) = s_n
\]
\[
b. \quad fin(f_n) = s_{n+1}
\]
Stative predicates: predicates of situations

- type: \( \langle s,t \rangle \)
- example: \([\text{be in the room}] (s), [\text{know French}] (s)\)

Dynamic predicates: predicates of forces

- type: \( \langle f,t \rangle \), aka \( \langle \langle s,s \rangle,t \rangle \)
- examples: \([\text{eat}] (f), [\text{stay}] (f)\)

Voice introduces source(f).
Telicity and atelicity

(17)  
a. Dowty's (1979) BECOME: \( \neg p(t_1) \land p(t_2) \)
b. Copley & Harley's (2014) \( v_{\text{become}} \):
\( \neg p(\text{init}(f)) \land p(\text{fin}(f)) \)
c. New \( v_{\text{change}} \): \( p(x)(\text{init}(f)) \mathcal{R} p(x)(\text{fin}(f)) \)
(cf. Koenig & Chief 2008)

\( \mathcal{R} \) can either be specified lexically, by context, or (perhaps) in flavors of little \( v \) that select verbs. When we define \( \mathcal{R} \), we'll call \( p(x)(\text{init}(f)) \) “\( d_0 \)" and \( p(x)(\text{fin}(f)) \) “\( d_1 \)."

(18)  
a. scalar adjectives behave as usual
b. New predicate “EXT” = existence or extent
quantized: existence is categorical: object either exists (\( d=1 \)) or it doesn't (\( d=0 \))
non-quantized: no endpoints but possible to compare degrees, i.e. amounts
Telicity

(19) Mary ate an apple.
   a. eat: predicate is EXT, d_0 > d_1
   b. quantized object: d=0 or d=1
   c. \( \lambda f . \text{EXT([an apple]) (init(f))} R \text{EXT([an apple])(fin(f))} \& \text{[eat](f)} \& \text{source(Mary, f)} \)
   d. \text{fin(f)} starts when current d = 1
      \Rightarrow \text{launching causation} \Rightarrow \text{telic}

(20) Mary heated the soup (sufficiently).
   a. there is a contextual endpoint of scale \( d_{max} \)
   b. heat: predicate is hot, d_0 < d_1
   c. \( \lambda f . \text{hot(x) (init(f))} R \text{hot(x)(fin(f))} \& \text{source(Mary, f)} \)
   d. \text{fin(f)} starts when current d = \( d_{max} \)
      \Rightarrow \text{launching causation} \Rightarrow \text{telic}
Atelicity

(21) Mary ate apples.
   a. eat: predicate is EXT, \( d_0 > d_1 \)
   b. non-quantized object: \( d \) can have any value
   c. \( \lambda f. \) EXT([an apple]) \((init(f)) R \) EXT([an apple])(\(fin(f)\)) & [eat](f) & source(Mary, f)
   d. \( fin(f) \) starts when current \( d < d_0 \) 
      \( \Rightarrow \) entrainment \( \Rightarrow \) atelic

(22) Mary heated the soup (some).
   a. there is no endpoint of scale \( d_{max} \)
   b. heat: predicate is hot, \( d_0 < d_1 \)
   c. \( \lambda f. \) hot(x) \((init(f)) R \) hot(x)(\(fin(f)\)) & source(Mary, f)
   d. \( fin(f) \) starts when current \( d < d_0 \) 
      \( \Rightarrow \) entrainment \( \Rightarrow \) atelic
Atelicity

(23) Mary danced.
    a. dance = create dance, predicate is EXT
    b. non-quantized object: d can have any value
    c. $\lambda f . \text{EXT}([\text{dance}]) \left( \text{init}(f) \right) \text{R} \text{EXT}([\text{dance}])(\text{fin}(f)) \&$
        source(Mary, f)
    d. fin(f) starts when current $d < d_0$
        $\Rightarrow$ entrainment $\Rightarrow$ atelic

(24) Mary stayed.
    a. contextually-provided LOC predicate
    b. stay: $d_1 = d_0$
    c. $\lambda f . \text{LOC}(\text{Mary}) \left( \text{init}(f) \right) \text{R} \text{LOC}(\text{Mary})(\text{fin}(f)) \&$
        source(Mary, f)
    d. fin(f) starts when current $d = d_0$
        $\Rightarrow$ entrainment $\Rightarrow$ atelic
There are two kinds of causation: launching corresponds to telicity and entrainment to atelicity; this can be modeled in a force-theoretic framework.

By incorporating scale degrees and quantization (the latter by using an EXT predicate) into the force-theoretic framework, we can model telicity and atelicity.

Davidson was right about reified arguments, but wrong about what they refer to.

There’s no need for time in the LFs of verb phrases.

The smallest telic and atelic predicates have the same syntactic/LF structure.

Kinematics AND dynamics!
Thank you!
Danke schön!