Modeling progress: causal models, event types, and the imperfective paradox

Elitzur Bar-Asher Siegal
Hebrew University of Jerusalem

Prerna Nadathur
Universität Konstanz

Linguistics Fall Seminar
Department of Linguistics
Hebrew University of Jerusalem

November 30, 2021

The lexical puzzle of telic predicates

Durative telic predicates (*accomplishments*) describe eventualities which **move towards a natural culmination or endpoint:**

- **relevant endpoints:** coming into being/destruction of an object (e.g., *write a play, eat a cookie*), terminus of a path (*run a marathon, walk to the store*), transition to a result state (*open the door*)
- **culmination conditions** (cf. Kratzer 2004) are reflected in the surface structure of telic predicates: products of culmination (states and/or associated objects) are referenced by main verb + modifiers

The **representation** of a telic predicate invokes more than culmination, however:

- modification by *almost* indicates sensitivity to a point of initiation

(1) Benny almost ran a marathon . . .

a. . . . but the race was cancelled. *diverted aim*

b. . . . but he collapsed in mile 25. *failed attempt*

The lexical puzzle of telic predicates

In addition to initiation and culmination points, accomplishments must **carry rich information about the intervening process(es)**:

- these processes can be relatively homogeneous (*run a marathon*) or complex, involving many different steps (*bake a cake*)
- progress from initiation towards culmination can sometimes (but not always) be measured by a property or extent of a(n incremental) theme argument

Natural languages supply a variety of ways to **refer to exclusively non-culminated stages of telic eventualities:**

(2) a. Henny began to write a symphony (but gave up right away).
b. Henny continued to write a symphony (but never completed it).
c. Henny stopped writing a symphony (and never began again).

- intuitively, the truth of (2)a-c depends on whether or not reference-time occurrences properly constitute *part of the process* which leads from initiation to culmination of a symphony-writing

The lexical puzzle of telic predicates

Upshot: although the surface structure of telic predicates apparently specifies only a culmination condition, their semantic representations must contain (or otherwise invoke) information which:

- specifies the conditions under which a culmination process counts as having been initiated
- subsumes the full arc of development from initiation to culmination
- is rich enough to detail the process or 'set of steps' along the way

The lexical puzzle:

- how is this rich procedural information mediated through the specification of an endpoint, goal, or culmination condition?
- how are stages (non-culminated portions) of telic eventualities related to what a predicate invokes?
- *relatedly:* what criteria are used to determine the truth (and/or felicity) of (non-)culminating uses of telic predicates?

Roadmap: causal models and the imperfective paradox

The puzzle has primarily been viewed through the lens of the **imperfective paradox** (Dowty 1979):

- progressives of accomplishments can be felicitous in contexts where successful culmination is precluded

(3) Henny was writing a symphony when she died.
$\not\rightarrow$ *The symphony was eventually completed.*

Roadmap:

1. Overview of the imperfective paradox and analytical challenges
2. Combining intensional and partitive perspectives: causal models for telic predicates
3. Imperfective paradox data in a causal perspective
4. Comparison with Landman (1992); benefits of the causal approach
5. Conclusions and outlook: causal models and event types

Background: the imperfective paradox

The relationship between accomplishments and their endpoints often manifests as a **culmination entailment** (e.g., English simple pasts):

(4) Maya wrote a book. → *A complete book came into being.*

Culmination entailments are typically explained as follows:

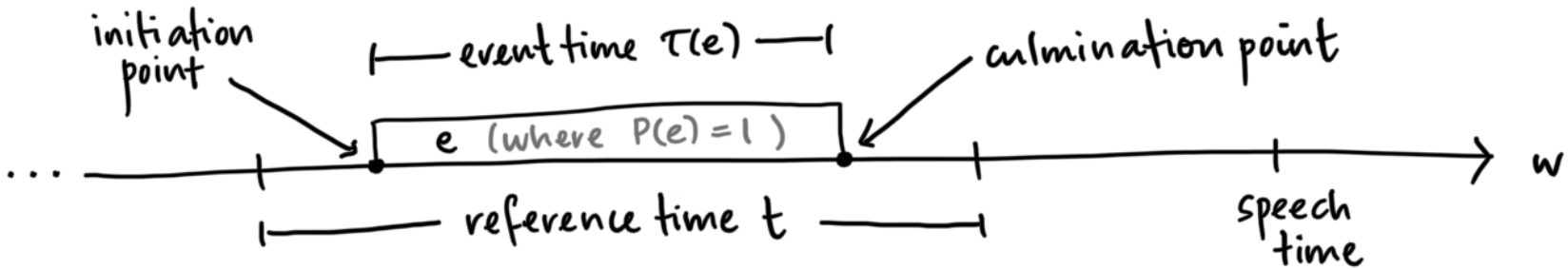
(i) an eventuality in the denotation of (uninflected) accomplishment predicate P **includes the culmination** as well as the process

(ii) viewpoint aspect instantiates a P-eventuality w.r.t. reference time; English PST is analyzed as an 'included' **perfective** (cf. Klein 1994)

(5) $[\![\text{PFV}]\!] := \lambda w \lambda t \lambda P\,.\,\exists e[\tau(e) \subseteq t \wedge P(e)(w)]$

(Kratzer 1998, Bhatt & Pancheva 2005, a.o.)

Consequently: since instantiating $e \in [\![P]\!]$ also realizes a P-culmination in w, $\text{PFV}(P)$ is predicted to give rise to a culmination entailment



Background: the imperfective paradox

These assumptions lead to the **imperfective paradox:**

(Dowty 1979; partitive puzzle, Bach 1986)

- **progressives** of accomplishments **lack culmination entailments**

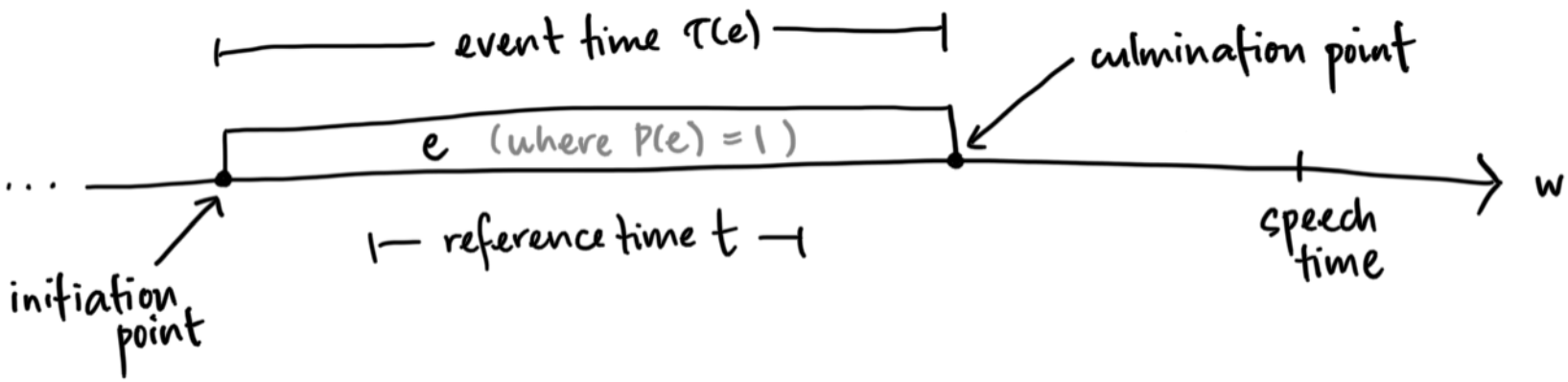
(6) Henrietta was crossing the street (when she was hit by a truck).
$\not\rightarrow$ *Henrietta reached the opposite side.*

However:

- an 'including' PROG instantiates a P-eventuality as ongoing at reference time

(7) $[\![\text{PROG}]\!] := \lambda w \lambda t \lambda P\,.\,\exists e[\tau(e) \supseteq t \wedge P(e)(w)]$

- **but:** if $e \in [\![P]\!]$ necessarily culminates, instantiation in w via PROG still gives rise to a culmination entailment



The imperfective paradox: two approaches

What makes PROG(P) apply to **partially-realized P-eventualities**?

(A) **Intensional** PROG

(Dowty 1979, Landman 1992, Asher 1992, Bonomi 1997, a.o.)

- **assumption:** $[\![P]\!]$ contains only culminated eventualities
- **result:** PROG has to allow 'partial' realizations, usually by shifting instantiation of a 'qualifying' (culminated) P-eventuality to a modal alternative to the evaluation world
- **analytical challenge:** constraining the modal relationship so that some **initial stage of a P-eventuality** occurs in the evaluation world

(B) **Extensional** PROG (e.g., Parsons 1990, Szabó 2008)

- **assumption:** PROG (like PFV) is extensional
- **result:** $[\![P]\!]$ must contain partial (process) eventualities as well
- **analytical challenge:** establishing what properties **qualify a partial ('process') eventuality as making progress** towards the culmination associated with P

(cf. Bach's 1986 'partitive puzzle')

Progress towards culmination

Our starting point: both approaches require an account of when an actual event counts as a P-eventuality:

- a possible-worlds approach must be supplemented by a framework for **part-whole event relationships** (cf. Landman 1992, Bonomi 1997)
- simultaneously, *partial realization* needs an intensional view, establishing whether or not an event can *make progress towards* culmination
- **so:** the mereological structure of telic predicates is already intensional

Main idea: accomplishment predicates invoke world knowledge about what is necessary and sufficient for initiating, developing, and completing a process for the realization of the specified culmination condition (C)

- this knowledge is captured by a **type-level causal model** for C
- the model provides a 'recipe' (strategy, roadmap) for the realization of C, together with the relevant (pre)conditions (properties, facts, events) and their interrelationships
- the model induces a **(causal) mereological structure,** mediated through the causal relationship between process and endpoint

Progress towards culmination

Given a **type-level** model for predicate P with culmination condition C:

- whether or not an actual eventuality counts as a *partial realization* of P (i.e., *makes progress towards* C) depends on how it compares to a causal pathway for C in the model
- a process for C (a partial realization of P) is part of a pathway which produces C in ideal (teleologically optimal) circumstances
- actual events are compared to the development of idealized (type-determined) pathways

Progressives of accomplishments are true just in case:

- the referenced eventuality e has developed in a way which makes progress (as defined by the type model) towards C
- nothing settled thus far by e (the token) precludes C's realization
- **crucially:** distinctions between model idealizations and actuality allow for 'paradox' effects
  - an in-progress P-eventuality e matches some normative process for C
  - **NB:** this is *not the same* as saying that e causes C (or produces C as a normal causal consequence) w.r.t. reference time circumstances

Overview: structural equation models

Causal information about a system can be represented by a **directed acyclic graph** D over a finite set Σ of vertices: (Pearl 2000, Schulz 2011)

- **vertices** represent **salient variables** (facts, properties, events), which can be valued as true (1), false (0), or *undetermined* (u)
- **edges** represent an atomic relation of **causal relevance**, with the arrow indicating causal direction ($P \to Q$ if P causally influences Q)
- plus a set of **structural equations** (represented by a function Θ_D) which specify how the value of a vertex is determined by the values of its immediate ancestors
  - to each $X \in \Sigma$, Θ_D assigns a pair $\langle Z_X, \theta_X \rangle$ where Z_X is the set of variables with edges that end at X, and $\theta_X : \{0,1\}^{|Z_X|} \to \{0,1\}$
- given a *situation* s (partial 0-1 valuation of Σ), D and Θ_D can be used to calculate the **causal consequences** of s

In the linguistic context, **causal information can be explicit or implicit:**

- (interventionist) causal models can be used to explicate counterfactual reasoning
- lexical representations refer to (predicate or presuppose) particular structural configurations as different causal dependency types

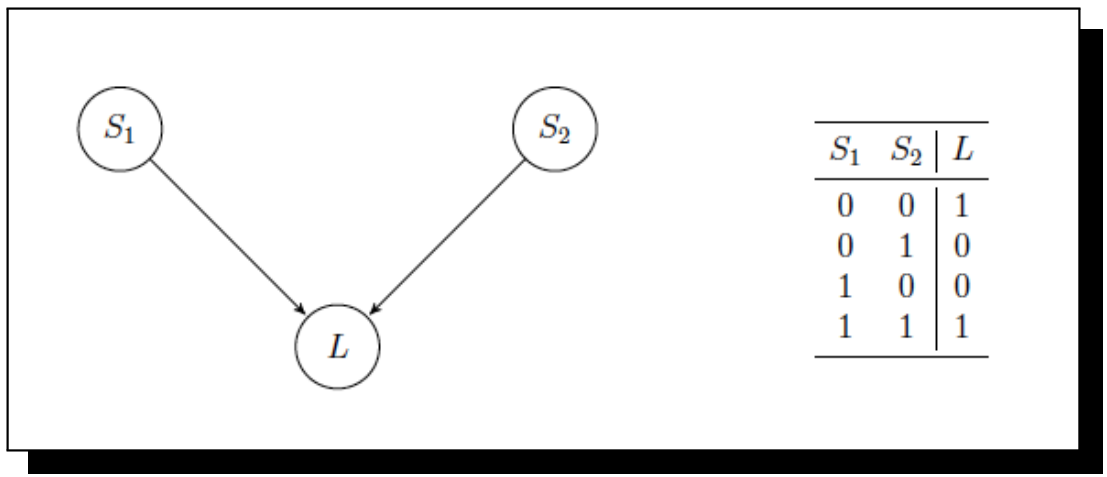
(cf. Nadathur & Lauer 2020, Baglini & Bar-Asher Siegal 2021)

Illustration: the Lifschitz circuit

(8) **The circuit example:** (Lifschitz 1990)

a. Suppose there is a circuit with two switches and one light, such that the light is on (L) exactly when both switches are in the same position (up or not up).

b. At the moment switch 1 is down, and switch 2 is up.



S_1	S_2	L
0	0	1
0	1	0
1	0	0
1	1	1

- (a) states the causal laws
- (b) gives us an initial setting (background situation)
- given (b), we expect the **causal consequences** to include that the light is off ($L = 0$)

Causal relationships in a model

The structure of a model allows us to define different causal relations: (Nadathur & Lauer 2020, Baglini & Bar-Asher Siegal 2021)

- **background assumption:** causation is a property of sets; effects are realized as the result of collections of conditions acting together
- **but:** overt causatives (esp. periphrastics) appear to predicate binary relations (statements of singular causation)
- **rapprochement:** causatives select causes with particular relationships to an effect **within a set of causes acting together**

Relations of interest (informally):

- **causal necessity:** s fact C is causally necessary for another fact E iff changing the truth value of C has causal consequences for (i.e., changes) the truth value of E
- **causal sufficiency:** an effect E occurs when a sufficient set of conditions has been realized; sufficient sets are made up of causes which are individually necessary for E (Baglini & Bar-Asher Siegal)
- **compare Mackie (1965):** individual causes can be viewed as INUS conditions, conditions which are individually **I**nsufficient but **N**ecessary parts of a **U**nnecessary but **S**ufficient collection

Causal necessity and causal sufficiency

Let $M = \{D, \Theta_D\}$ be a causal model on a set Σ of propositional variables. Let s be a situation: then s is a partial determination of Σ, or a set of pairs $\langle A, a \rangle$ so that $A \in \Sigma$ and $a \in \{0, 1\}$.

(9) a. **Causal ancestors:** For $X \in \Sigma$, the set A_X of **causal ancestors** of X is given by $A_X = \{Y \in \Sigma | R^T_{\Theta_D}(X, Y)\}$ (where $R^T_{\Theta_D}$ is the transitive closure of immediate ancestry)

b. **Domain of a situation:** For s a situation, let $\text{DOM}(s) = \{X \in \Sigma | \langle X, 1 \rangle \in s \vee \langle X, 0 \rangle \in s\}$

(10) **Causal necessity.**
A fact $\langle X, x \rangle \in s$ is **causally necessary** for fact $\langle Y, y \rangle \in s$ iff:

a. $X \in A_Y$

b. for any situation s' such that $\text{DOM}(s) = \text{DOM}(s'), s(X) \neq s'(X) \rightarrow s - s' = \{\langle X, x' \rangle, \langle Y, y' \rangle\}$, where $x \neq x', y \neq y'$

(11) **Causal sufficiency (of sets).**
A situation s is a **sufficient set** for a fact $\langle Y, y \rangle \in s$ iff:
$\forall X \in \{Z | Z \in A_Y \wedge Z \in \text{DOM}(s))\}, \langle X, s(X) \rangle$ is causally necessary for $\langle Y, y \rangle$

Definitions (10)-(11) adapted from Baglini & Bar-Asher Siegal

Causal models: from the specific to the general

Overtly causal language make reference to specific causal networks; a **statement of singular causation** can be:

- licensed by a salient model of local causal relationships (e.g., lexical causatives; Bar-Asher Siegal & Boneh 2020)
- used to describe a particular causal configuration within a network (as it is cognitively represented by the speaker; e.g., periphrastic causatives, Nadathur & Lauer 2020)

Language also makes reference to more **generalized representations of (courses of) events:**

- causal models can capture idealized representations of functional world knowledge: *how things work* and/or *how to do things*
- these models underlie the use of complex eventuality descriptions
- they can be built from experience and observation (by making generalizations over instances of singular causation as well as by extrapolating from these instances)
- type-level models can be faulty (when based on false beliefs) or 'gappy', leading to contrasts with token instances

Token- vs. type-causal statement

A causal model provides the set of causal relations between **variables**

- thus corresponding to type-level statements about causal relationships between properties
- **statements of general instances of causation** state general causal regularity or law
- general statements of causation support particular expectations in token instances, but are not falsified by token instances of failure

A statement of a singular instance of causation is a claim about an **actual causal relation**, which obtains between particular events

- such statements are about actual cause and effect at a reference time, not about those properties or types in virtue of which actual and possible instances are causally related
- the truth of token instances of causation rely (from the perspective of the model) on variables having or changing specific values at particular places and times

(Hausman 1998, 2005; Woodward 2003)

Type-level causal models in language

Abilities: (cf. Nadathur 2019)

- *x can*$_{ab}$ *A* isn't a pure-possibility claim, but instead indicates that *x* has a way of (deliberately) bringing $A(x)$ about
- use of *can/be able* indicates speaker belief in a type-level model for $A(x)$, where $A(x)$ is causally dependent on prior choices for *x*
- the ability claim can still be true even if *x* sometimes fails to bring about $A(x)$ (despite pursuing the *A*-strategy)

Accomplishments (durative telic predicates): **today**

- *bake a cake* $\sim$ perform a series of actions which collectively bring about the existence of a cake (among other consequences)
- accomplishment predicates, like lexical causatives, presuppose a causal model, but in this case a type; truth judgements depend on a match between model and actuality
- the type/token distinction makes it possible to actually engage in (part of) the process *without realizing the type-level result*
- this explains **imperfective paradox** effects from progressives of accomplishments

Imperfective paradox: the view from causal models

Causal models provide a framework for what counts as progress towards culmination that can capture both intensional and mereological elements of imperfective paradox effects

Two claims:

1. PROG combines felicitously with a predicate P iff there is a contextually-available model of the P **eventuality type**
   - an **eventuality type** is a (idealized) model for the causal relationships between different components of P
   - availability is influenced by facts about the world, *modulo* a speaker's information state (cf. *perspectives*; Asher 1992)
2. A progressive is true of a specific **token eventuality** e iff e follows a (culmination) pathway in the eventuality type
   - e cannot be a(n in-progress) P-eventuality if it lacks the preconditions for P
   - e ceases to be an in-progress P-eventuality when it validates a sufficient set of conditions for non-realization of P's culmination

Accomplishment event types

An accomplishment **event type** is a causal model for **how to do** P (how to realize P's culmination):

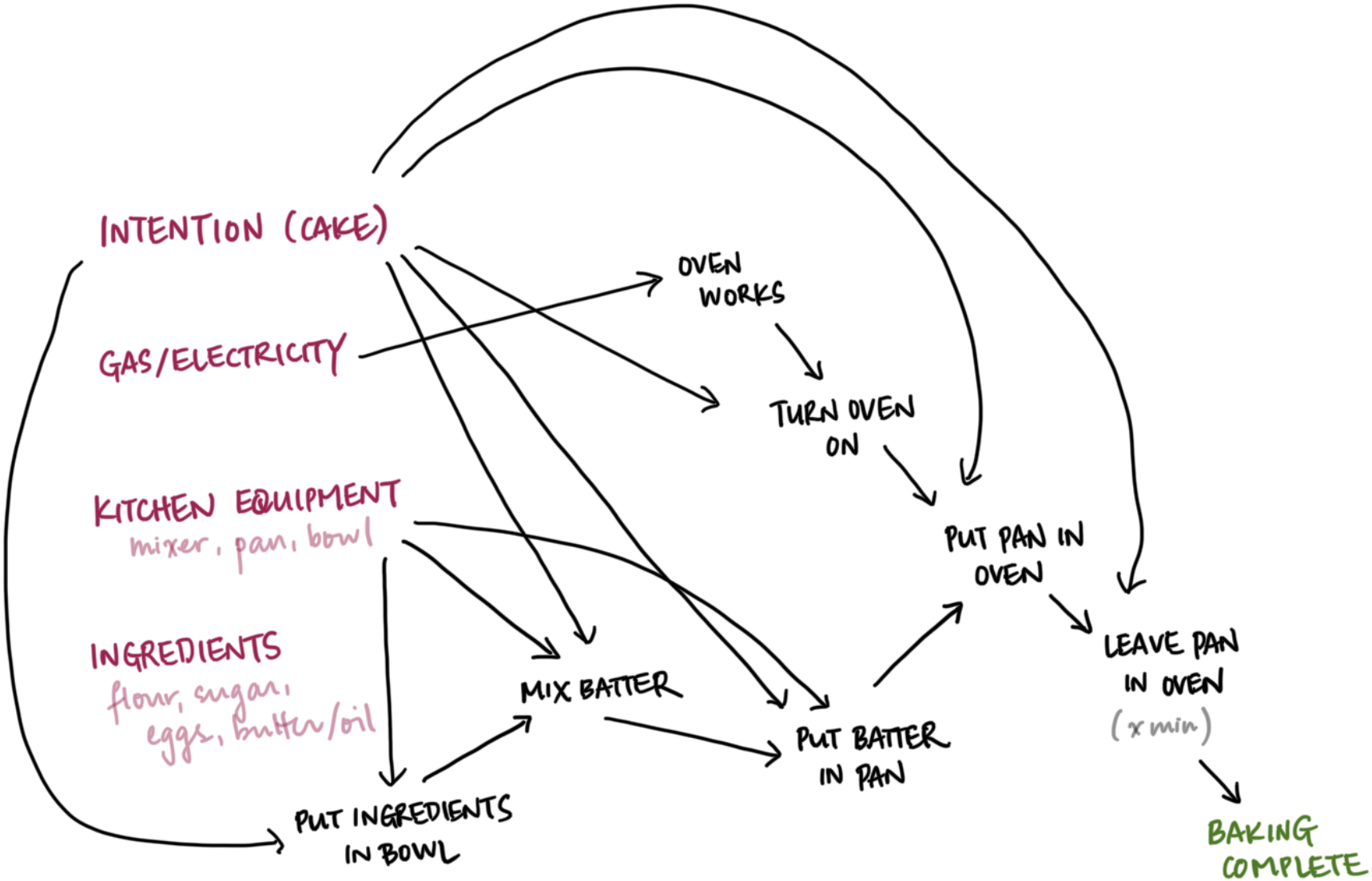
- use of P presupposes existence of a model: i.e., that, as far as the speaker knows, **there is a way to complete** P
- the model links certain conditions/steps to one another and to the realization of P's culmination, C
- a **process** for P (a **causal pathway** S for C) is a set of jointly sufficient conditions for C $(\text{SUFF}^M(S, C))$
- the model also specifies sufficient sets for **non-culmination**

Truth conditions for PROGs of accomplishments

For telic P with culmination condition C, $\text{PROG}(P)$ is true at time t iff:

1. some condition Q which is part of a sufficient set S for C holds at t (but no sufficient set is completed)
   $\exists s[\tau(s) \circ t \wedge (\exists Q \exists S : Q \in \text{SUFF}^M(S, C) \wedge Q(s)) \wedge$
   $(\forall S' : \text{SUFF}^M(S', C)$ s.t. $\exists Q' \in S'$ w/ $Q'(s), \exists Q'' \in S'$ s.t. $\neg Q''(s))]$
2. no sufficient set of conditions Ω for $\neg C$ is completed at t
   $\forall \Omega : \text{SUFF}^M(\Omega, \neg C), \exists \sigma \in \Omega$ s.t. $\neg \sigma(s)$

A model for cake-baking



Paradox data in the intensional view

Intuition underlying intensional PROG accounts of the paradox:

- PROG(P)'s truth depends on the possibility/likelihood of completion
- completion occurs in **all normal historical alternatives** to the evaluation world ('inertia' futures; Dowty 1979)
- i.e., if ongoing processes continue 'as they are'/uninterrupted (Landman 1992)
- P-events **typically** culminate once initiated (defaults; Asher 1992)

The empirical 'juggling act' of culmination potentials: (cf. Landman)

- **impossible events** (IEs; *swim across the Atlantic*) cannot culminate, by definition ✗IE progressives
- attempts at **unlikely events** (UEs; *cross a minefield*) rarely culminate successfully ✓UE progressives
- **out of reach contexts** (OORs; *I swim the Channel*) for telic predicates preclude culmination locally ✓OOR progressives

Impossible tasks and intensional PROG

Impossible tasks:

(12) a. ??Mary is/was swimming across the Atlantic.
b. ??The children are/were digging a hole to China.

Intensional PROG:

- PROG(P) is true at w, t if all normal modal alternatives are completion alternatives
- normal alternatives are projected from a circumscribed situation (or *perspective*; Asher) (a global view would include potential interruptors)
- expectations involve processes that are already going on (Vlach 1981), "what is internal" to the event (Landman; p.25)

Prediction from intensional PROG:
PROGs of impossible tasks are **false**, since they are not completed in any normal worlds

Unlikely events and intensional PROG

Problem: the same prediction (automatic falsity) is made for progressives of **unlikely events**:

(13) Henrietta was crossing a minefield.

(14) **The sailing competition** (cf. Bonomi 1997)
An international association organizes a sailing competition to circumnavigate the globe. After a selection process, 100 boats are admitted, and they all set sail from the same point. A few days later, a spokesman says:

a. 100 boats are circumnavigating the globe. Most of them will fail.

- intensional PROG requires that all normal continuations of reference-time events lead to culmination
- **but:** a 'typical' attempt to cross a minefield or circumnavigate the globe does not end in successful culmination → predicted false
- **empirically:** (13) and (14a) are **acceptable** even in contexts which make the unlikeliness of success salient

Out of reach contexts and intensional PROG

Potential solution: capture the empirical contrast between IE and UE progressives by weakening intensional PROG to have existential force*

- **problem:** culmination in some but not all normal alternatives is still too strong for **out of reach** progressives

(15) **The un(der)trained runner** (cf. Szabó 2008)

Amateur runner Benny signs up for an ultramarathon. As he is well aware, he cannot complete it, because he has not trained enough to build up the necessary stamina. Nevertheless, he starts with the other runners. The first few miles go well, but at the halfway point he collapses from exhaustion.

a. ✓Benny was running an ultramarathon (when he collapsed).

- no situation containing Benny (+ task-relevant properties) has normal alternatives in which he completes the race

→ predicted false

- **but:** (15a) is **acceptable** and **true**, despite context

*see Dowty 1979 (cf. Thomason) for further objections to existential PROG.

Generalizing over the data: models for progress

Observation: what matters for the OOR is not a local culmination possibility, but instead that Benny is *doing what he needs to do* to run an ultramarathon (cf. Varasdi 2014)

- attempted *minefield crossings, circumnavigations* are assessed similarly
- **for UEs and OORs:** what matters is that reference-time events follow an established or recognized path for culmination
- **this contrasts with impossible events:** there is no roadmap for succeeding at impossible tasks, so reference-time activities cannot match a culmination pathway/process

The view from causal models:

- intuitions about culmination possibilities are actually intuitions about the structure of the model, not what happens in a specific instance (type vs. token)
- the relevant notion of normality is evaluated w.r.t. culmination, not the other way around: what normally happens *en route* to culmination (not what normally follows from process activities)

Event types and (im)possibility

Intensional PROG cannot differentiate between **IEs, UEs**, and progressives in **OOR** contexts, but the causal approach does:

1. PROGs of **globally-impossible tasks** are **infelicitous** (not false) because they lack a model
   - e.g., no set of conditions collectively sufficient for a human to swim across the Atlantic

2. because they have a (context-independent) model, **UE** and **OOR** progressives can be **true or false**, depending on actual occurrences
   - in order to complete an ultramarathon, one must show up at the start, take steps along the path, . . .
   - even though Benny's in-context properties ensure that failure conditions are realized (i.e., depleted stamina) prior to the finish line . . .
   - . . . the progressive is true because—up to collapse—his actions match a culmination pathway
   - **upshot:** it's predictable that his endurance fails, but Benny can *and crucially did* make progress in the race until his collapse

Licensing and culmination on the causal approach

- the intuitions that intensional PROG analyses cash out via culmination accessibility are actually **type-level intuitions**
- intuitions are not about possibility/likelihood w.r.t. real-world events, but instead *what should happen if culmination is to occur*
- event type causal models capture the closed world reasoning relevant for progressive judgements
- but allow us to separate this from local (token-specific) culmination possibilities

Upshot:

- progressives can be true even if there never was an actual culmination possibility
- . . . *as long as* the set of conditions which ensure **non-culmination** is not completed prior to the realization of at least one condition in a completion pathway

More generally: the type/token relationship allows us to explain otherwise confusing data about when/where the evalution-world completion possibilities matter

Event types and normality

On the causal approach, **UE** and **OOR** progressives pattern together:

- it's enough that the task has (world-)historical completions: this supplies the event type model (to some degree of specification)
  (**NB:** also explains why unexpected success licenses past-tense PROG)
- any particular attempt may be doomed to failure, but the progressive can be true up to the point where a sufficient set of conditions for failure is satisfied (equipment failures, loss of interest, wind changes, fatal accidents, . . .)
- **corollary:** judgements for less-understood tasks are less robust

In general: a process leading to failure can be ongoing at the same time as a process leading to success, without falsifying the progressive

(16) a. Benny is running a race which he will not/cannot complete.
b. As he lay dying, Mahler was writing his tenth symphony.

- mutually exclusive progressives can hold simultaneously

(17) a. Henrietta was crossing the street.
b. Henrietta was walking to her death (as it turned out).

Making sufficient progress

Where PROG(P) is licensed, its truth or falsity is determined by a match between actual events and completion pathways in the licensing model

(a) at least one condition in a sufficient set for P's culmination has been satisfied (∼ at least one step has been taken in a P-process)

(b) no sufficient set of conditions for P's failure is complete (∼ there is a possible next step to take in a P-process)

The event type specifies when progress starts (as well as when it stops):

- condition (a) fleshes out a partitive notion of what's enough to count as progress (e.g., Bach 1986, ter Meulen 1987, Link 1987)

  (18) **The part-of proposal** (mod. from Landman, p.13)
  PROG(P) is true iff some actual event e realizes **sufficiently much** of the type of events of P

- in the cake-baking example:
  - baking cannot begin without (some of) the ingredients present
  - the model backgrounds acquisition activities (preconditions for process steps); cake-baking begins when a process step is taken

(NB: futurate uses of PROG might have weaker prerequisites)

Comparison with Landman (1992)

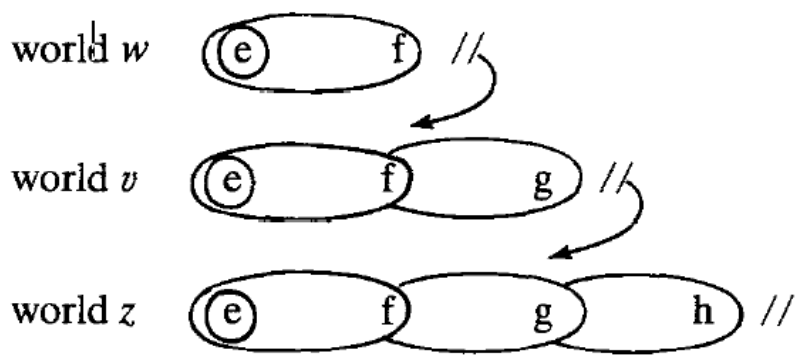
The causal approach has some commonalities with **Landman (1992)**:

- check for culmination in the *continuation branch* of a reference-time eventuality (rather than across a set of normal worlds)

(19) $[\![\text{PROG}(e, P)]\!]^{w,g} = 1$ iff $\exists f \exists v : \langle f, v \rangle \in \text{CON}(g(e), w)$ and $[\![P]\!]^{v,g}(f) = 1$

- **assume:** if e stops (pre-culmination) in w, there is a closest world where it continues
- **assume:** any event e in w is associated with a set of worlds $R(e, w)$, which are the **reasonable options** for e in w; $v \in R(e, w)$ if there is a reasonable chance on the basis of *what is internal to e in w* that e continues in w as far as it does in v

Build a continuation branch:
follow the development of e as far as it goes in w, then (iteratively) move to the closest world where it continues, as long as this world is in $R(e, w)$ ∃ PROG; cf. Varasdi



Comparison with Landman (1992)

Landman (1992, p.26): the *continuation branch* for e in w is the smallest set of pairs of events and worlds $C(e, w)$ such that

a. for every event f in w such that e is a **stage** of f, $\langle f, w\rangle \in C(e, w)$; the continuation stretch of e in w

b. if the continuation stretch of e in w stops in w, it has a maximal element f and f stops in w. Consider the closest world v where f does not stop:

   i. if $v \notin R(e, w)$, the continuation branch stops

   ii. if $v \in R(e, w)$, then $\langle f, v\rangle \in C(e, w)$. In this case, we repeat the construction.

- if $[\![\text{PROG}(e, P)]\!]^{w,g} = 1$, $g(e)$ is necessarily a stage of an event of type P (in the continuation branch); it is a P-in-progress event
- **required primitives:** *stage-of* and *part-of* relations with respect to event (types), what counts as *internal to an event* (for similarity calculation)
- **similarity to the causal approach:** centering the (immediate) possibility of continuation, rather than culmination itself

Comparison with Landman (1992)

Although Landman's approach ultimately requires at least one 'reasonable' culmination world, it differentiates between IEs and UEs:

- UEs are unlikely because of the high probability of disruption; building a continuation branch allows each potential interruption to be considered independently

  The continuation branch seeks the middle ground between removing only the actual interruptor and removing all danger of interruption: we remove potential interruptors one at a time. If we can do that and still end up in a world which is a reasonable option and where the relevant event gets realized, the progressive is true. (Landman, p.30)

- removing a series of obstacles is *not enough* to build a culminating continuation branch for IEs, given the constraint of *reasonability*
- **however,** if an IE gets realized against expectation (e.g., through divine intervention), the continuation branch is fully contained in the evaluation world, and past-tense progressives are true

  (20) I would never have believed it at the time, but the children were digging a hole to China

Comparison with Landman (1992)

Some important distinctions:

- ultimately, Landman's PROG is at least existential (relies on accessibility of culmination)
- consequently, it cannot distinguish between IE progressives and acceptable OOR progressives
- there is *no reasonable chance* that Benny will complete his race; no sequence of avoided interruptions leads to culmination within the continuation branch

The causal approach gives content to Landman's primitives:

- the notion of developmental stages (and how they are related to one another) is provided in terms of (sub)sets of causal pathways for culmination in the causal approach
- **upshot:** the causal approach not only eschews the accessibility of culmination, but provides a richer basis for the mereological structure of telic eventualities
- this allows us to go beyond Landman in explaining cases of **indeterminacy**, where multiple outcomes are (salient and) compatible with reference-time occurrences (Bonomi 1997)

Telic progressives and underdetermination

Event stages:

- the same actual event can be a *stage* of different developments
- **in the causal approach:** this allows us to compare reference-time events to different event types, as long as certain conditions are met
- **for Landman:** because the notion of *stage* is not mediated through event type, problems with underdetermined data (Bonomi 1997)

(21) **The multicity problem**

Maya was driving north from Monterey. Her intention was to go to either San Francisco or Oakland. Approaching San Jose, she has not yet decided which, when she gets into a trip-ending accident.

a. Maya is driving to a Bay Area city/to SF or Oakland. ✓

b. Maya is driving to SF. ✗

c. Maya is driving to Oakland. ✗

- for Landman: truth of (21a) requires the continuation branch of Maya's ref-time activities to include arrival in one of the two cities
- but this requires that one of (21b-c) is true (cf. Szabó 2004)

(problem: culmination accessibility again)

Telic progressives and underdetermination

On the causal approach:

- Maya's actions are compared to causal pathways for *driving to a Bay area city*, *driving to SF, driving to Oakland*
- intention to go to X is a precondition for *driving to* X: w.r.t. the model, you cannot begin an event of this type *sans* intention
  - (21a) is true because Maya has taken steps on the route to a Bay Area city, and intends to go to one
  - (21b-c) could become true once she made up her mind, but her driving in right direction is by itself insufficient
- **thus:** neither (21b) nor (21c) is true (*contra* Landman, it's not just that we don't know which)
- (**NB:** for non-agentive accomplishments: a parallel to intention comes from momentum/forces)

Adding this to the semantics (first pass):

- conditions of this sort have a special status: they are 'globally' necessary, or members of all sufficient sets for C

$$\forall Q : (\forall S \text{ s.t. } \textsc{suff}^M(S, C), Q \in S), Q(s)$$

(see also Varasdi 2014 on 'sustaining' conditions for telic predicates)

Summary and outlook

Imperfective paradox effects require both an intensional and a mereological perspective:

- an account that relies on local accessibility of culmination is too strong; this is converted on the causal approach to the requirement of a possible next step
- the model provides a structure against which to measure *partial realization*: both what counts for 'getting started' and when an event ceases to make progress towards culmination
- intuitions about what is *normal* are real, but are assessed from the **type** not **token** perspective (what is normal, given culmination)

Progressives of accomplishments require causal knowledge but are **not themselves causal statements** (they do not predicate causation):

- we need a (plausible) causal model to license $\textsc{prog}(P)$
- use of $\textsc{prog}(P)$ indirectly (via presupposition) conveys a speaker's belief in a causal model for P's culmination (a belief that there is a way to do P)
- **but:** asserted content only reports a match between actual events and the structure of the type-level model

Outlook, questions

The debate has centered on **whether (uninflected) telic predicates or progressive operators** are responsible for imperfective paradox (non-culmination) effects: (Zucchi 1999, a.o.)

- the notion of event type most naturally rests in the predicate's semantics (see also Nadathur & Filip 2021 on telicity)
- how does this extend to models for other aspectual classes?
- can we extend this to explain futurate uses of PROG?
- or to other non-culmination phenomena? (see, e.g., Martin 2020)

Causality and modal theories:

- intensional PROG approaches generally assign PROG universal force
- since progressives can be true when culmination is neither normal nor expected, $\forall$ is too strong
- viewed intensionally, our proposal is closer to an existential analysis (once true, a progressive is true until all ways to take a step forward are blocked)
- but the approach is stronger than a pure existential: a completion pathway in the type model represents a class or bundle of worlds (or, a generalization over token instances)

Acknowledgements

Elitzur Bar-Asher Siegal:
This paper is part of the project "Talking about causation: linguistic and psychological perspectives" funded by the Niedersachsen-Israel Grant [Elitzur Bar-Asher Siegal and Nora Boneh (HUJI) and York Hagmayer (University of Göttingen)]

Prerna Nadathur:
Prerna Nadathur's research is part of the project "Linguistic inference and the representation of causation", funded by a two-year postdoctoral fellowship at the Zukunftskolleg at the University of Konstanz

Zukunftskolleg