Causal dependence in ability and actuality*

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Prerna Nadathur

pnadathur@stanford.edu

1 Introduction: two ways of being able?

From Thalberg (1972):

> "Take as a premise this report of Brown's performance at the shooting gallery: 'He hit three bull's-eyes in a row.' [...] I admit that we are entitled to conclude, 'Brown *was able* to hit three bull's-eyes in a row.' I deny, however, that this conclusion is equivalent to asserting that Brown has a certain degree of ability at target practice.
>
> The non-equivalence becomes noticeable if we expand our account of Brown's display of marksmanship: 'Before he hit the three bull's-eyes, he fired 600 rounds, without coming close to the bull's-eye; and his subsequent tries were equally wild.' This amplified record of Brown's performance in no way compels us to retract our assertion that he *was able* to hit three bull's-eyes in a row. He was able to do it, but without any regularity. Therefore he does not have this sort of ability at target shooting.
>
> The story reveals the ambiguity of expressions from the 'being able' family. [...] 'Was able' sometimes means 'had the ability', and sometimes means 'did'."

In aspect-marking languages like French,[1] the 'ambiguity' extends to the ability modal:

(1) a. *Rebecca **pouvait** traverser le lac à la nage, mais elle ne l'a jamais traverse.*
'Rebecca could-IMPF swim across the lake, but she never crossed it.'

b. *Rebecca **a pu** traverser le lac à la nage, #mais elle ne l'a pas traverse.*
'Rebecca could-PFV swim across the lake, #but she didn't cross it.'

- in (1a), we get the 'ability' reading: the modal prejacent remains deniable
- (1b) has an uncancellable 'actuality' reading

Actuality entailments (Bhatt, 1999):
perfectively-marked ability modals entail the realization of their prejacents

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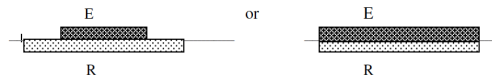
[1]The perfective, represented here by the French *passé composé*, typically indicates episodic or bounded eventualities, while the imperfective (French *imparfait*) can be used to make generalizations or describe ongoing situations.

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- actuality entailments are mysterious from a modal standpoint:
  - ability modals are (usually) treated as circumstantial possibility modals:

    (2) $S\ can_{\text{ability}}\ \phi := \Diamond_{\text{circ}}\phi(S)$

  - actuality entailments do not occur with other modal flavours (Hacquard, 2006, 2009):[2]

    (3)   Epistemic **_pouvoir_**:
          *Jean **a** (bien) **pu** partir, mais il est aussi possible qu'il soit resté.*
          'Jean might-PFV (well) have left, but it is also possible that he stayed.'

- there's no obvious reason why adding the perfective should force actualization:
  - the perfective aspect 'looks at events from the outside' (Bhatt and Pancheva, 2005): event time (E) is contained within reference time (R)

      or   (4) $[\![\text{PFV}]\!] := \lambda P \lambda t. \exists e[P(e)\ \&\ \tau(e) \subseteq t]$

  - but in other cases, the state simply gets contained with the reference time:

    (5)   *Marie a été belle.*   ↝ [Marie is no longer beautiful.]
          'Marie was-PFV (has been) beautiful.'

  - this is what happens with periphrastic ability constructions:

    (6)   *Jean **a eu la capacité** de soulever un frigo, mais il ne l'a pas soulevé.*
                                              ↝ [John no longer has the capacity.]
          'Jean had-PFV the ability to lift a fridge, but he didn't lift it.'

Upshot: either there is a missing ingredient, or one of our basic assumptions is wrong.
- **today's answer:**
  - ability modals are not straightforward circumstantial possibility modals
  - there is a missing component (in the concept of ability): **causal dependence**

Roadmap:
1. An alternative approach to ability modals
2. Actuality entailments as implicative behaviour
   - a causal-dependence view of implicative verbs (e.g., *manage*)
   - aspect and causality in optionally-implicative *enough*/*too* constructions
3. Extending the implicative account to ability modals
4. Questions and concerns

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[2]Hacquard (2006) argues that they do arise with deontic modals; work from Mari (2015) and others suggests the correct generalization may be that the uses which give rise to entailments are teleological.

2 Ability modals

From the philosophical literature: ability modals do not behave like standard possibility modals! (Austin, 1961; Thalberg, 1972; Kenny, 1976)

- if $S\ can_{\text{ability}}\ \phi := \Diamond_{\text{circ}}\phi(S)$, we expect: $\phi(S) \vdash S\ can_{\text{ability}}\ \phi$ $\qquad\qquad [T : p \to \Diamond p]$

    - compare: *Roses grow here* $\vdash$ *It's possible*$_{\text{epist}}$ *for roses to grow here.*
    - but: a single witness for the prejacent doesn't seem to justify abilitative *can*

        (7) Suppose Tara is a beginning golfer. She misses most of her shots. On this occasion, however, she strikes the ball from the tee and it happens to go into the hole, so on this occasion she makes a hole in one. (Maier, 2018)

        Claim: it's at least difficult to decide whether or not *Tara can make a hole in one* is true

- ability-*can* is stronger than circumstantial possibility: we want some consistency
- circumstantial necessity is too strong: we don't need Tara to hit a hole in one in every future[3]

An alternative: a complex view of abilitative (or agentive) modals:

> **Claim:** Ability modals are **hypothetical guarantees**
>
> - stronger than $\Diamond$, but weaker than $\Box$
> - $S\ can_{\text{ability}}\ \phi \sim$ 'It is possible for S to bring ϕ about.'

Seeing to it that (Belnap and Perloff, 1988; Belnap, 1991):[4]

- the *stit* operator is a 'canonical form' for agentive statements:

    - the difference between (8) and (9) is about agentivity

        (8) Ahab sailed in search of the white whale.
        $\equiv$ Ahab *stit:* Ahab sailed in search of the white whale

        (9) Ishmael sailed in search of the white whale.
        $\not\equiv$ Ishmael *stit*: Ishmael sailed in search of the white whale

- the *stit* operator is defined over a branching time framework (Thomason, 1984), augmented with a notion of agent choice (cf. von Neumann and Morgenstern, 1944):

    - intuitively: $S\ stit\ \phi$ at $\langle w^*, t^* \rangle$ if S made a prior choice which ensured $\phi(S)(w^*)(t^*)$
    - $S\ stit\ \phi$ at $\langle w^*, t^* \rangle$ just in case there is a branch-point at $t_0 \prec t^*$ such that w^* passes through t_0, and a choice A in the choice-set $\mathcal{C}_{\langle w^*, t_0 \rangle}(S)$ for S at t_0 such that:
      (i) for any world (history) $w_1 \in A$, $\phi(S)(w_1)(t_1) = 1$ for $t_1 \in w_1$, and $t_1 \sim t^*$
      (ii) there is some world w_2 through t_0 such that, for $t_2 \in w_2$, $t_2 \sim t^*$, $\phi(S)(w_2)(t_2) = 0$

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[3]Actually, we probably don't even need her to do it in every future in which she tries – only in those in which certain external conditions (wind-speed, visibility, etc) are met.

[4]Similar proposals (Louie, 2014; Mandelkern et al., 2017; Maier, 2018): S has some 'practically available action' such that if S tries to take this action, S performs ϕ.

- the **choice-set** $\mathcal{C}(S)(t)$ for S at t is a partition of all of the worlds (histories) through t such that if w_1, w_2 are collapsed at t, they belong to the same member of the partition
- **proposal:** ability modals embed a *stit* proposition

> (10) $S\ can_{\text{ability}}\ \phi := \Diamond_{\text{hist}}[S\ \text{stit}\ \phi(S)]$

Upshot:

- the golfing problem is solved: Tara's success is not really agentive (no *stit* form)
- we can explain the asymmetry in present vs. past uses of the ability modal
  - it's possible to describe Brown's single run of hits as (11), but we we cannot use (12) for his present or future performance:

    (11)   Brown was able to hit the bullseye three times in a row.

    (12)   Brown is able to hit the bullseye three times in a row.

  - **Why?** Looking at the past, we can see that some course of action that Brown took ensured that the future (from that past point) contained only 3-bullseye worlds[5]
- **question:** how is the agent's choice connected to the modal prejacent?

3   Implicative inferences

Two other constructions license 'actuality inferences':

(I) **implicative** verbs **entail** the realization of their complements (Karttunen, 1971)

  (13)   Solomon **managed** to build a temple. $\vdash$ *Solomon built a temple.*

(II) ***enough*** **and** ***too*** **constructions** (Karttunen, 1971; Meier, 2003; Hacquard, 2005)

- English E&T constructions **implicate** the realization of their complements

  (14)   Juno **was fast enough** to win the race. $\leadsto$ *Juno won the race.*

- perfectively-marked E&T constructions **entail** the realization of their complements:

  (15)   *Juno **a été assez rapide** pour gagner la course, #mais elle n'a pas gagné.*
  'Juno was-PFV fast enough to win the race, #but she did not win.'

Bhatt (1999) and **Hacquard (2005)** propose that E&T constructions and ability modals have the same (complement-entailing) lexical semantics as implicatives, but this won't work:

1. If all three constructions (implicatives, E&T, and ability modals) share a lexical semantics, why do the inference patterns only match under perfective aspect?

- imperfective E&T constructions, ability modals don't produce actuality entailments:

  (16)   *Juno **était assez rapide** pour gagner la course, mais elle n'a jamais gagné.*
  'Juno was-IMPF fast enough to win the race, but she never won.'

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[5]Ultimately, we want to be a bit more careful here – historical possibility collapses the past, but the notion of agent choice seems to hinge on the connection between the choice and a particular outcome.

- but implicative entailments are not affected by aspect:
    - (17) a. *Juno **réussissait** à gagner la course, #mais elle n'a jamais gagné.*
      'Juno manage-IMPF to win the race, #but she never won.'
    - b. *Juno **a réussi** à gagner la course, #mais elle n'a pas gagné.*
      'Juno manage-PFV to win the race, #but she did not win.'

	PFV	IMPF	English
implicatives	⊢	⊢	⊢
E&T	⊢	⤳	⤳
ability modals	⊢	⤳	⤳

Table 1: Actuality inference patterns by aspect

2. E&T entailments show **optionality** associated with the matrix adjective:

   - (18) *Juno **a été assez grande** pour boire de l'alcool, mais elle n'a l'a jamais bu.*
     'Juno was-PFV old enough to drink alcohol, but she never drank it.'

3.1 A causal semantics for implicative verbs

Karttunen (1971) characterizes implicatives by two-way complement entailment:

- (19) a. Solomon managed to build a temple. ⊢ *Solomon built a temple.*
   b. Solomon did not manage to build a temple. ⊢ *Solomon did not build a temple.*

- **logical problem:** what blocks the intuitively wrong conclusion that implicative assertions are equivalent to assertions of their complements?
- **answer:** presuppositional content associated with the implicative (e.g., difficulty)

Key points:

- Karttunen's presupposition/assertion 'division of labour':
    - (20) Schema: for an implicative I and a proposition P,
        - a. *presupposition:* $I(P)$ is a necessary and sufficient condition for P
        - b. *assertion:* $I(P)$
- Baglini and Francez (2016)'s insight: the relationship between an implicative's presupposition and its complement is about **causal dependence**[6]

Proposal: the semantics of implicatives (Nadathur, 2016)

- (21) Given an implicative I, and a proposition X, the utterance $I(X)$:
    - a. presupposes the existence of a causal condition A for X, where A is *causally necessary* and *causally sufficient* for X in the utterance context
    - b. asserts A

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[6]Baglini and Francez (2016) argue, cf. Coleman (1975), that the presupposition of *manage* must be less specific than either difficulty or presupposition, since it can be realized as either.

- implicatives may vary in their specificity about the nature of prerequisite (e.g. *dare* suggests that courage was required for the implicative complement)
- evidence for the causal component: legal/deontic prerequisites do not license implicatives

(22) a. *Context:* being 21 is legally necessary and sufficient for drinking (alcohol). Juno turned 21 yesterday.

   b. ?Juno managed to drink.

- causal dependencies are cashed out via Schulz (2011)'s **dynamics** for causal entailment[7]

Implicatives unpacked: 3 components for entailment

(i) coincidence of a necessary and sufficient condition for the complement

(ii) causal interpretation of necessity/sufficiency

(iii) assertion that the necessary/sufficient condition was satisfied

	presupp	*modality*	*assert*	pos-infer	neg-infer
implicatives	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	causal	A	$\vdash X$	$\vdash \neg X$

Table 2: Actuality inference patterns by semantic component

- **prediction:** E&T constructions (and ability modals) will entail their complements (prejacents) just in case these conditions are met

3.2 Optional implicativity in E&T constructions

3.2.1 Semantic background

E&T constructions are analyzed as modalized degree comparatives (von Stechow et al., 2004):

(23) Juno is fast enough to win the race.
   Juno is as fast as she must be to make winning the race possible.

- a real degree (Juno's speed in the actual world) is:
  - attributed to the sentential subject
  - compared to a modally-determined degree (the speed needed to win)
- components of the construction:
  (a) a gradable adjective (of variable type), relating individuals and (downward-closed) sets of degrees on a scale:

   - individual level: *tall*   - **actionable:** *fast*
   - stage-level: *hungry*   (24) $[\![\text{fast}]\!]^w := \lambda d \lambda x . \text{SPEED}(x)(w) \geq d$

  (b) complement proposition (for degree measurement/comparison)

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[7]See Baglini and Francez (2016); Nadathur (2016); Lauer and Nadathur (2018) for definitions of causal necessity and causal sufficiency within this framework.

(c) a comparative and modal operator: equative *enough* ($\sim$ *as* ADJ *as*; von Stechow et al.)

(25) $[\![\text{enough}]\!]^w :=$
$\lambda Q_{est} \lambda P_{dest} \lambda x_e . \{d : \forall w' \in \text{ACC}(w)[Q(x)(w') \to P(d)(x)(w')]\} \subseteq \{d : P(d)(x)(w)\}$

(26) a. Juno be fast enough to win the race
   b. $\{d : \forall w' \in \text{ACC}(w)[\text{win}(j)(w') \to \text{SPEED}(j)(w') \geq d]\} \subseteq \{d : \text{SPEED}(j)(w) \geq d\}$
   c. *Juno's maximal degree of speed is at least as great as the maximum degree of speed that she has in every world where she wins (i.e. the minimal speed such that there is a world in which she wins)*

- this leads to a **necessity presupposition:** there is a minimum degree d_{nec} which makes it possible for Juno to win:[8]

(27) $\exists d_{\text{nec}} : \forall w' \in \text{ACC}(w)[\text{ADJ}(x)(w') < d_{\text{nec}} \to \neg Q(x)(w')]$

Summary:

- like implicatives, E&T presuppose a **necessary condition** for their complements
- like implicatives, E&T assert that this **condition was satisfied**
- unlike implicatives, the modal flavour of an E&T construction is not pre-set:
  - it can be **deontic:**   - or **circumstantial:**
    (28) Juno was old enough to drink   (29) Juno was tall enough to reach the branch.
                                            (30) Juno was fast enough to win the race.
- unlike implicatives, **no sufficient condition** is presupposed (so far)

Current predictions:

	presupp	*modality*	*assert*	pos-infer	neg-infer
implicatives	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \to \neg X$	deontic	A	$\not\vdash X$	$\not\vdash \neg X$
E&T	nec: $\neg A \to \neg X$	circumst.	A	$\not\vdash X$	$\vdash \neg X$

Table 3: Predictions for E&T actuality inferences

- **deontic E&T constructions:** predictions upheld (no entailments)

(31) a. Juno was old enough to drink, but she was a teetotaler.
    b. Juno was not old enough to drink, but she drank anyway.

  – in the negative case (31b), a legally-necessary condition is not met, but the real world need not be one in which laws are obeyed

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[8](23) is infelicitous if there is no world in which Juno wins the race; we presuppose there is one: $\exists w' \in \text{ACC}(w) : Q(x)(w')$. It follows that the set of degrees of Juno's speed in every world where she wins is non-empty, and thus that there is a minimum degree d_{nec} which makes it possible for her to win.

- **circumstantial E&T constructions:** predictions are not sufficiently fine-grained!

  - when ADJ is a static property (e.g., *tall*), we only get a negative entailment, verifying the Table 3 predictions:

    (32) a. Juno was tall enough to reach the branch, but she didn't even try.

        b. Juno was not tall enough to reach the branch, ?#but she reached it.

  - when ADJ is an **actionable capacity** (e.g., *fast*), neither positive or negative (English) E&T statements entail:

    (33) a. Juno was fast enough to win the race, but she didn't participate.

        b. Juno was not (really) fast enough to win the race, but the leader tripped on the last lap, making Juno the unexpected winner.

Two questions:

- what is the (inference-relevant) difference between static properties and actionable capacities?
- how do we get rid of the unwanted negative entailment, but *only* for actionable-capacity E&T constructions?

3.2.2 Adding sufficiency

Recall: perfectively-marked E&T constructions **entail** their complements (Hacquard 2005)

(34) a. *Juno a été assez rapide pour gagner la course, #mais elle n'a pas gagné.*
      'Juno was-PFV fast enough to win the race, #but she did not win.'

    b. *Juno n'a été pas assez rapide pour gagner la course, #mais elle a gagné.*
      'Juno was-PFV not fast enough to win the race, #but she won.'

Contra Hacquard, we **do not want a sufficiency presupposition** across the board:

(35) **Sufficiency condition** (for E&T constructions):

$$\exists d_{\text{suff}} : \forall w' \in \text{ACC}(w)[(\text{ADJ}(x)(w') \geq d_{\text{suff}}) \to Q(x)(w')]$$

- setting $d_{\text{suff}} = d_{\text{nec}}$ to match the implicative presupposition, we get:

  (36) **'Implicative' presupposition** (for E&T constructions):

  $$\iota d_{\text{NS}} : \forall w' \in \text{ACC}(w)[Q(x)(w') \leftrightarrow (\text{ADJ}(x)(w') \geq d_{\text{NS}})]$$

  There is a unique degree d_{NS} of ADJ *such that x is d_{NS}-ADJ in a world w if and only if x realizes Q in w*

- the implicative-style presupposition (36) is too strong:
- for circumstantial E&T constructions with static properties, it predicts a positive entailment: this prediction is not upheld even in the perfective

  (37) *Juno a été assez grande pour toucher la branche, mais elle ne l'a pas touchée.*
      'Juno was-PFV tall enough to touch the branch, but she did not touch it.'

  - (this is a new qualification to Hacquard's generalization about perfective E&T)

- we get the right result (positive and negative entailments) for perfectively-marked E&T constructions with actionable capacities, but in an **intuitively wrong** way:

  (38) *Juno a été assez rapide pour gagner la course.* $\vdash$ Juno won the race.
  'Juno was-PFV fast enough to win the race.'

  paraphrase, given (36): *Juno's actual speed was at least as great as the speed that guarantees race-winning in all circumstantially-accessible worlds.*

  – since the real world is circumstantially accessible to itself, Juno's win is guaranteed by her speed in (38)

However ...

  – *being d-fast* involves having the capacity to do things at speed d, but does not require anything to actually be done!
  – the relationship between *being fast* and winning the race **is causal,** but only when the 'fastness' is **manifested in an action** (e.g., running)
  – the 'implicative' presupposition (36) does not capture this

Making sense of these facts:

- we differentiate static-property E&T constructions from actionable-capacity E&T constructions in terms of **causality**
  – static properties (e.g., *be tall*) can be circumstantially associated with an E&T complement (e.g., reaching a branch), but they *do not in themselves cause* the complement's realization
  – **actionable capacities** (e.g., *be fast*) **are causally associated with E&T complements** as follows: acting on the capacity causes complement realization
- consequently, **sufficiency conditions** for E&T complements only arise when the matrix adjective is an **actionable capacity:**
  – in that case, x performing ADJ at d_nec is *causally sufficient* ($\triangleright_\mathrm{caus}$) for realizing the E&T complement $Q(x)$:

  (39) **Actionable-capacity sufficiency condition:** DO-ADJ$(x)(d_\mathrm{nec}) \triangleright_\mathrm{caus} Q(x)$

Crucially, **E&T assertions differ from implicative assertions** when ADJ is an actionable capacity:

- implicatives assert that a necessary and sufficient condition for the complement is satisfied
- actionable-capacity E&T constructions instead assert the *possibility* of the necessary and sufficient condition being satisfied

  (40) ADJ$(x)(w) \geq d_\mathrm{nec} \sim \Diamond[\text{DO-ADJ}(x)(d_\mathrm{nec}) \triangleright_\mathrm{caus} Q(x)]$

Given the components of actionable-capacity E&T inferences, we predict actuality inferences/entailments just in case a manifestation of the actionable capacity is implied/entailed.

	presupp	*modality*	*assert*	pos-infer	neg-infer
implicatives	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \to \neg X$	deontic	A	$\not\vdash X$	$\not\vdash \neg X$
E&T, static	nec: $\neg A \to \neg X$	circumst., non-caus	A	$\not\vdash X$	$\vdash \neg X$
E&T, actionable	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	$\Diamond A$	?	?

Table 4: Predictions for E&T actuality inferences

3.2.3 Aspect to the rescue!

Proposal: the semantics of *enough* constructions: (Nadathur, 2017)

Let R be a proposition of the form $R = x$ be ADJ *enough to* Q, where x is an individual, ADJ a relation between individuals and degrees, and Q a property of individuals. Evaluated with respect to a world w:

(I) R presupposes a degree d_{nec} that is necessary for the possibility of $Q(x)$:

$$\exists d_{\text{nec}} : \forall w' \in \text{ACC}(w)[\neg(\text{ADJ}(x)(w') \geq d_{\text{nec}}) \to \neg Q(x)(w')]$$

(II) R asserts that x has least d_{nec} of ADJ in w:

$$[\![R]\!]^w = \text{ADJ}(x)(w) \geq d_{\text{nec}}$$

(III) When ADJ represents an actionable capacity, R backgrounds:

$$\forall w' \in \text{ACC}(w)[\text{DO-ADJ}(x)(d_{\text{nec}})(w') \triangleright_{\text{caus}} Q(x)(w')]$$

Actionable-capacity E&T constructions align almost exactly with implicatives:

- they presuppose the coincidence of a causally necessary and causally sufficient condition for the realization of their complements
- however, they at-base assert only the possibility that this condition will be satisfied:
  - if the assertion is interpreted eventively, as a manifestation, we fully align with implicatives, and actuality inferences are predicted
  - if the assertion is interpreted statively, as an attribution of a (latent) capacity, no actuality inferences are predicted

English E&T actuality inferences:

- English actionable-capacity attributions are **systematically ambiguous** between eventive and stative interpretations:

(41) Juno was loud.   *eventive:* Juno did (something) loud/loudly.
                                stative: Juno had the capacity to do (something) loud/loudly.

(42) Juno was fast enough to win the race.   *eventive:* Juno ran at a speed of at least d_{nec}
                                        stative: Juno can run at a speed of at least d_{nec}

- if the eventive reading is privileged, we get actuality inferences:

  (43) I didn't know Juno was a runner, but I saw her at the 5K yesterday! She was fast enough to win! $\rightsquigarrow$ *Juno won the race.*

- actuality inferences in English are defeasible because there is no reliable way to fix (entail) the eventive interpretation

French actuality entailments:

- in French, the aspectual marker forces a choice between eventive and stative readings
- perfective combines with statives via **aspectual coercion** (Moens and Steedman, 1988; de Swart, 1998)
  - *love*, in (44) is coerced into an **inchoative** reading, returning its onset point:

    (44) *Jupiter a aimé Europa.* $\rightarrow$ *Jupiter fell in love with Europa.*
           'Jupiter loved-PFV Europa.'

  - actionable capacities lend themselves to **'instantiative'** coercion (cf. Homer, 2011), returning an action characterized by the actionable adjective:[9]

    (45) *Juno a été rapide.* $\rightarrow$ *Juno did something quickly.*
           'Juno was-PFV fast.'

- **as a result**, perfectively-marked actionable-capacity E&T constructions turn the baseline E&T assertion into an implicative assertion:
  - perfective marking entails that the causally-sufficient condition for the E&T complement was satisfied

    (34) *Juno a été assez rapide pour gagner la course.* $\vdash$ *Juno won the race.*
           'Juno was-PFV fast enough to win the race.'
           a. *entails*: DO-SPEED$(j)(d_{\text{nec}})$ sufficient for win, by presupposition
           b. *interpretation:* Juno ran at a speed of at least d_{nec} (and that caused her to win the race).

- imperfective aspect, on the other hand, selects for the stative interpretation of an actionable-capacity attribution, and so we correctly predict no entailment

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[9]Homer (2011) wants to use *actualistic* coercion to derive ability modals' actuality entailments directly; I believe that it is more constrained in output than he suggests.

(1) $\llbracket \text{ACT} \rrbracket = \lambda P_{vt} \lambda Q_{vt} \lambda w_s \lambda e_v . Q(e) \wedge e \in w \wedge \forall e'_v[e' \sqsubset e \rightarrow \neg Q(e')] \wedge \exists e''_v[P(e'') \wedge \tau(e) = \tau(e'')]$
     Q is a bounded (pragmatically-determined) predicate of eventualities such that its runtime is simultaneous with the runtime of an eventuality in the denotation of the core stative predicate P.

(46)   *Juno était assez rapide pour gagner la course ...*
       'Juno was-IMPF fast enough to win the race, ...'

                                        ... but she did not participate.
                 ... but something unexpected always happened, and she never won.

Getting around necessity:
- due to the across-the-board necessity presupposition, we predict entailments in the negative direction for *all* circumstantial E&T constructions
- negated actionable-capacity E&T constructions **do not entail** under the imperfective:

  (47)   *Juno n'était pas assez rapide pour gagner la course, mais elle a gagné.*
         'Juno was-IMPF not fast enough to win the race, but she won.'

- following Bhatt (1999); Hacquard (2005): the imperfective is associated with a genericity operator, which quantifies only over *normal* worlds:
- for imperfective E&T constructions:

  (48)   a. $[\![\text{GEN}]\!]^w := \lambda Q_{st}[\forall w' \in \text{NORM}(w)[Q(w')]]$

         b. GEN(Juno not be fast enough to win the race)
              $\forall w \in \text{NORM}(w^*)[(\exists d_{\text{nec}} : \neg(\text{SPEED}(j)(w) \geq d_{\text{nec}}) \to \neg\text{win}(j)(w)]$
                   $[\text{SPEED}(j)(w) < d_{\text{nec}}]$
              In all normal worlds where there is a necessary speed for winning the race, Juno does not have this speed.

- the real world need not be normal:

  (49)   *Juno n'était pas assez rapide pour gagner la course, ...*
         'Juno was-IMPF not fast enough to win the race, ...'
                     ... but the leader tripped on the last lap, leaving Juno in first place.

---

	presupp	*modality*	*assert*	pos-infer	neg-infer
implicatives	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \to \neg X$	deontic	A	$\not\vdash X$	$\not\vdash \neg X$
E&T, static	nec: $\neg A \to \neg X$	circumst., non-caus	A	$\not\vdash X$	$\vdash \neg X$
E&T, actionable	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	PFV $\vdash A$ IMPF $\vdash \Diamond A$ Eng: $A, \Diamond A$	$\vdash X$ $\not\vdash X$ $\leadsto X$	$\vdash \neg X$ $\not\vdash \neg X$ $\leadsto \neg X$

Table 5: Actionable-capacity E&T inferences (summary)

3.3 Differences between implicatives and E&T inferences

Question: why do the entailments of implicatives and E&T constructions differ?
- implicative entailments are built into the lexical semantics
- E&T entailments arise compositionally, from the combination of aspect and adjective

- in general, E&T presuppose only a necessary condition for the realization of their consequent
- in the special case of actionable-capacity E&T, which involve causality, necessity, and sufficiency, implicatives and E&T constructions differ in asserted content:
  - implicatives always assert that their preconditions are satisfied (eventive)
  - E&T constructions in general only assert that it is possible for their precondition to be satisfied (at base stative)

The differences emerge under imperfective aspect (and in English):

- in the imperfective, a generic interpretation of an eventive implicative assertion yields regular instances of a particular event, repeated over a period of time:

  (50) *Juno réussissait à gagner la course.*
        'Juno managed-IMPF to win the race.'
        Over some past period of time, Juno regularly managed to win some (salient) race.

  - this requires actual events in which *managing* took place, therefore requiring actual events in which Juno won the relevant race.

    (17a) *Juno réussissait à gagner la course, #mais elle n'a jamais gagné.*
           'Juno managed-IMPF to win the race, #but she never won.'

- on the other hand, the generic interpretation of an actionable-capacity E&T construction is simply interpreted as the attribution of a latent capacity:

  (46) *Juno était assez rapide pour gagner la course, mais elle n'a jamais gagné.*
        'Juno was-IMPF fast enough to win the race, but she never won.'

- no event of being d_{nec}-*fast* (at race time) is entailed; her speed might have been measured or evidenced another way

	presupp	*modality*	*assert*	pos-infer	neg-infer
implicatives	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \to \neg X$	deontic	A	$\nvdash X$	$\nvdash \neg X$
E&T, static	nec: $\neg A \to \neg X$	circumst., non-caus	A	$\nvdash X$	$\vdash \neg X$
E&T, actionable	nec: $\neg A \to \neg X$ suff: $A \to X$	causal	PFV $\vdash A$ IMPF $\vdash \Diamond A$ Eng: $A, \Diamond A$	$\vdash X$ $\nvdash X$ $\leadsto X$	$\vdash \neg X$ $\nvdash \neg X$ $\leadsto \neg X$

Table 6: Implicative and E&T inference patterns

4 Ability modals and actuality entailments

Recall: ability modals pattern with actionable-capacity E&T constructions

(1) a. *Rebecca **pouvait** traverser le lac à la nage, mais elle ne l'a jamais traverse.*
     'Rebecca could-IMPF swim across the lake, but she never crossed it.'

   b. *Rebecca **a pu** traverser le lac à la nage, #mais elle ne l'a pas traverse.*
     'Rebecca could-PFV swim across the lake, #but she didn't cross it.'

- representing ability attributions in the same way as actionable-capacity E&T constructions:

Ability attributions:

Let $R = S\ can_{\text{ability}}\ \phi$, where S is an individual and ϕ a property of individuals. Evaluated with respect to a world w:

(I) R presupposes a **condition** A for S such that $A(S)$ is necessary for $\phi(S)$:

$$\exists A(S) : \forall w' \in \text{ACC}(w)[\neg A(S)(w') \to \neg \phi(S)(w')]$$

(II) R asserts that S has the option of A in w:

$$[\![R]\!] = \Diamond_{\text{ACC}} A(S)(w)$$

(III) R backgrounds the causal sufficiency of $A(S)$ for $\phi(S)$:

$$\forall w' \in \text{ACC}(w)[A(S)(w') \triangleright_{\text{caus}} \phi(S)(w')]$$

- this looks familiar:

Ability modals as hypothetical guarantees:

(10) $S\ can_{\text{ability}}\ \phi := \Diamond_{\text{hist}}[S\ \text{stit}\ \phi(S)]$

- putting things together:

  - the relevant accessibility relation, ACC, should be historical possibility
  - the condition A is a member of the choice-set $\mathcal{C}_{\langle w^*, t_0 \rangle}(S)$
  - refine the notion of a choice: A is an action (course of action, process) such that the worlds in which $A(S)$ is realized represent an equivalence class of the partition $\mathcal{C}_{\langle w^*, t_0 \rangle}(S)$
  - so, $A(S)$ is necessary and sufficient for $\phi(S)$ w.r.t. historical possibility
  - in order for $A(S)$ to ensure $\phi(S)$, we'd like this to be **causal** necessity/sufficiency

- **NB:** we need $A(S)$ to represent an actionable capacity (like DO-FAST(S)) for the aspectual coercion to work

14

- some evidence that coercion is involved in the ability modal cases as well: we can privilege other readings

 (51) *Olga a soudain pu soulever un frigo, mais ne l'a pas fait.*
    Olga could-PFV suddenly lift a fridge, but she did not do it.'

- the overall structure involved in *enough/too* constructions involves a process terminating in a punctual event: ability modals should also have a telic/accomplishment structure

5 (Some of the) open questions

Shouldn't we be worried that ability modals look so different from other uses of *can/pouvoir*?

- the 'choice' is under the historical-possibility operator, rather than the modal prejacent
- the *stit* view lets us get around this, if we take the prejacent to be a *stit* proposition, as in (10)
- but, we still need to think about what to do with ability modals that aren't, strictly speaking, agentive:

 (52) This elevator was able to lift 15 people.

Are there other modals that produce actuality entailments?

 (53) a. *Le doyen m'a permis d'entrer dans la bibliothèque, mais je ne suis pas entrée.*
     'The dean permitted-PFV me to enter the library, but I didn't enter.'

    b. *La carte m'a permis d'entrer dans la bibliothèque, #mais je ne suis pas entrée.*
     'The card permitted-PFV me to enter the library, #but I didn't enter.'

- Hacquard (2006, 2009) observes that certain uses of deontic modals appear to produce entailments
- the necessity counterparts of AE-producing possibility modals also seem to entail (but retain a different meaning)
- a way forward: Mari (2015) suggests that the right characterization is **goal-oriented** modalities: the modal prejacent ϕ represents a *telos* for some agent, which gives us the choice-goal structure relevant here

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