Causal dependence in ability and actuality

Prerna Nadathur

Institute for Language and Information
Heinrich Heine University

May 1, 2020
ILLC, University of Amsterdam

Introduction: Two ways of *being able*

A report of Brown's performance at the shooting gallery:

(1) 'He hit three bull's-eyes in a row.'

I admit that we are entitled to conclude:

(2) '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.

(3) '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 . . . 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 . . .

"The story reveals the ambiguity of expressions from the 'being able' family. [. . .] **'Was able' sometimes means 'had the ability', and sometimes means 'did'.**" (Thalberg 1972)

Introduction: Two ways of *being able*

(4) This morning, Marja was able to swim across Lake Harriet.
$\rightsquigarrow$ *Marja did swim across Lake Harriet.*

- doesn't tell us anything about Marja's swimming in general
- odd if she didn't swim across the lake (this morning)
- **external viewpoint:** a lake-crossing event which began and ended this morning

(5) In her twenties, Marja was able to swim across Lake Harriet.
$\rightsquigarrow$ *Marja had the ability to swim across Lake Harriet.*

- a general assessment of her swimming ability (at a past time)
- okay if she never actually crossed Lake Harriet:

  (5') In her twenties, Marja was able to swim across Lake Harriet, but she always swam in Lake Nokomis instead.
- **internal viewpoint:** a persistent skill/competence, which might have begun in her teens and continue into her thirties

Introduction: Two ways of *being able*

In aspect-marking languages, the contrast is grammatically marked:

- **perfective aspect** corresponds to the external view
- **imperfective aspect** corresponds to the internal/ongoing view

In these languages, the contrast extends to abilitative uses of the possibility modal:

(6) French: **pouvoir**(=*can*)

a. *Marja* **a pu** *traverser le lac à la nage, #mais elle ne l'a pas traversé.* [did]
'Marja could-PFV swim across the lake, #but she didn't cross it.'

b. *Marja* **pouvait** *traverser le lac à la nage, mais elle ne l'a jamais traversé.* [had the ability]
'Marja could-IMPF swim across the lake, but she never crossed it.'

(also in Greek, Hindi, Russian, . . .)

Introduction: Two ways of *being able*

Even in English, certain uses of **can** seem ambiguous:

- suppose we modify the shooting range story:

  (1') When you met Brown for the first time at the shooting gallery yesterday, you saw him miss the bullseye a few times, and then hit it three times in a row. After that you stopped paying attention. Later, a friend asks you about Brown's performance. You say:

  "Brown can hit the bullseye three times in a row."

- in one sense, this is true: he did hit the bullseye three times in a row, and you saw it
- in another sense, it seems premature: you don't have very much information about his shooting history, so it's hard to justify saying that he has this ability

Introduction: Three related puzzles

1. the apparent ambiguity is systematic with expressions of ability (*be able/can*):
   - what relates did and had the ability, and where does the contrast come from?

2. modal verbs like **can** are about possibility, not actuality:
   - in the did use, we must be referring to an actual event
   - in the had the ability use, we both want 'repeatability', but also don't require direct evidence:

   (5') In her twenties, Marja was able to swim across Lake Harriet, but she always swam in Lake Nokomis instead.

3. the external-internal (perfective-imperfective) distinction aligns with the did vs had the ability meanings:
   - why should the viewpoint/aspect make a difference to interpretation?

Introduction: Ability and actuality

The **did** interpretation is due to an **actuality inference** or an **actuality entailment** (Bhatt 1999):

(4') This morning, Marja was able to swim across Lake Harriet, ?!but she didn't cross it.
actuality inference

(6a) *Marja a pu traverser le lac à la nage, #mais elle ne l'a pas traversé.*
'Marja could-PFV swim across the lake, #but she didn't cross it.'
actuality entailment

Goals of the talk:

1. What do expressions of ability mean?
2. What is the connection between ability, actuality, and the possibility meaning usually associated with **can**?
3. What role does aspect play in pushing us to one interpretation or the other?

Part I

Ability and possibility: what is an ability?

Part I: Ability modals

Actuality entailments are mysterious from a modal standpoint:

- ability modals are (often) treated as **circumstantial possibility modals:**

$$S \text{ can}_{\text{ability}}\ A := \Diamond_{\text{circ}} A(S)$$

(7) Marja can/is able to swim across Lake Harriet.
∼ In at least one of the worlds which preserve the circumstances of the lake, Marja's strength, mental discipline, muscle memory, etc, she swims across Lake Harriet.

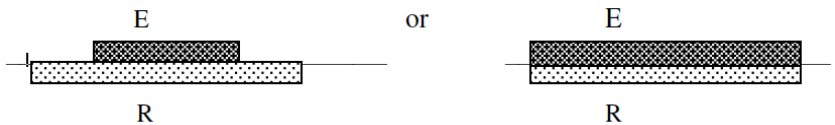
- entailments arise with ability modals, but not with other modal flavours* (Hacquard 2006) *precise characterization is debated

(8) 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.'

Part I: Adding aspect

There's no obvious reason why adding the perfective should force actualization:

- the perfective aspect 'looks at events from the outside': event time is contained within reference time (Bhatt & Pancheva 2005)



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

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

(10) *Marie a été belle.* $\rightsquigarrow$ Marie is no longer beautiful.
'Marie was-PFV (has been) beautiful.'

- this is what happens with **periphrastic ability constructions:**

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

Part I: Ability modals

Ability modals don't behave like circumstantial possibility operators!
(Austin 1961, Thalberg 1972, Kenny 1976)

- **Alethic** modals (circumstantial, epistemic) validate axiom T

T: $P \rightarrow \Diamond P$

(12) I am in San Francisco and I see a clump of dahlias growing.
✓ Dahlias can grow in San Francisco.

- **so:** if S $\text{can}_{\text{ability}}$ $A := \Diamond_{\text{circ}} A(S)$, we expect: $A(S) \rightarrow S$ $\text{can}_{\text{ability}}$ A

It's not clear that this holds for ability-**can**:

(13) Suppose Tara is a beginning golfer, who 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.
? Tara $\text{can}_{\text{ability}}$ make a hole in one.

Claim: it's at least difficult to decide on (13) (Maier 2018)

Part I: Ability modals

The problem is about reliability/repeatability:

- as a beginning golfer, Tara doesn't have a reliable strategy or course of action for making a hole in one
- the 'pure chance' doesn't license the ability claim

Conclusion: circumstantial possibility is too weak for ability-**can**.

- necessity/requirement is obviously too strong:
  - Tara doesn't always need to make a hole-in-one for her to have the ability to do so
- we want something in between, that captures the idea of 'having a strategy'
- an ability is like a **hypothetical guarantee** (see also Brown 1988, Belnap 1991, Mandelkern et al 2017)

S $\text{can}_{\text{ability}}$ $A \sim$ 'It is possible for S to bring $A(S)$ about.'

Part I: Ability as a hypothetical guarantee

Proposal for ability-can: for agent S, 1-place predicate A

$$S \textbf{ can}_{\text{ability}} A$$

just in case there is some action H available to S such that if S does $H(S)$, then S will do $A(S)$

- possibility: $A(S)$ is possible, but doesn't have to take place
- for S, doing $H(S)$ represents a strategy for guaranteeing $A(S)$
- **question:** how are $H(S)$ and $A(S)$ conceptually connected?

This scheme makes sense of the golfing example (cf. Maier 2018):

- Tara doesn't have a strategy for making a hole in one
- but she might make a hole in one by pure chance
- NB: this takes *Tara can make a hole in one* to be ambiguous between ability-**can** and 'pure possibility'-**can**

A complex structure for ability

There are different ways we could formalize 'hypothetical guarantee':

- Brown (1988): $\exists$ over world-clusters embeds $\forall$ over worlds
- Louie (2014): $\exists$ over agent's actions embeds $\forall$ over worlds

Belnap (1991): $\Diamond_{\text{hist}}$ embeds a **stit** proposition

$$S \text{ can}_{\text{ability}}\ A := \Diamond_{\text{hist}}[S \text{ stit } A(S)]$$

- *stit* is 'a canonical form' for agentive claims (Belnap & Perloff 1988)

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

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

- defined over a branching time framework, with agent choice sets:

S *stit* A at $\langle w^*, t^* \rangle$ if S made a **prior choice** ensuring $A(S)(w^*)(t^*)$

Regardless: we need to say something about the way in which $H(S)$ (action, strategy, prior choice) guarantees $A(S)$

Interim summary: the three questions

1. **What do expressions of ability mean?**
2. What is the connection between ability, actuality, and possibility?
3. What is the role of aspect?

We've made progress on **Question 1**:

- an ability is a **hypothetical guarantee**: S has the ability to do A iff she has a strategy (possible course of action H) for A
- we still want to know how H and A are connected

  preliminary: $H(S)$ **brings about** $A(S)$

Question 2: Where does the actuality reading come from?

(6a) *Marja a pu traverser le lac à la nage.* [could-PFV]
→ Marja swam across the lake.

- **the problem:** this isn't a possibility meaning, and ability, as defined above, doesn't license $A(S) \rightarrow S$ *can* A!

Next: a closer look at the **actuality** interpretation of ability-**can**

Part II

Chasing the actuality interpretation

Part II: *Being able* as *managing*

Bhatt (1999) pointed out the existence of actuality entailments:

(14) Hindi: **saknaa**(=can), same pattern as French **pouvoir**

a. *Nikhil havaii-jahaaz uɽaa* **sakaa**, *#lekin us-ne havaii-jahaaz nahĩĩ uɽaayii.*
'Nikhil could-PFV fly the plane, #but he didn't fly the plane.'

b. *Nikhil havaii-jahaaz uɽaa* **saktaa** *thaa, lekin us-ne havaii-jahaaz kabhi nahĩĩ uɽaayii.*
'Nikhil could-IMPF fly planes, but he never flew a plane.'

Bhatt's claim: the actualized interpretation doesn't just mean *did*

(15) a. **could-pfv** = *managed to*
(14a) ≡ Nikhil managed to fly the plane.

b. **could-impf** = *had the ability to*
(14b) ≡ Nikhil had the ability to fly the plane.

Part II: *Being able* as *managing*

Bhatt's generalization:
Actualized **be able** and perfectively-marked ability-**can** have the same meaning as **managed to** claims.

Actuality-able and **managed** have the same logical consequences:

(4) This morning, Marja was able to swim across Lake Harriet.
$\sim$ Marja managed to swim across Lake Harriet.

(6a) *Marja* **a pu** *traverser le lac à la nage, #mais elle ne l'a pas traversé.* [French]
'Marja could-PFV swim across the lake, #but she didn't cross it.'
$\equiv$ Marja **managed** to swim across the lake, #but she didn't cross it.

(14a) *Nikhil havaii-jahaaz uɽaa* **sakaa**, *#lekin us-ne havaii-jahaaz nahĩĩ uɽaayii.* [Hindi]
'Nikhil could-PFV fly the plane, #but he didn't fly the plane.'
$\equiv$ Nikhil **managed** to fly the plane, #but he didn't fly the plane.

Part II: *Being able* as *managing*

Bhatt's generalization:
Actualized **be able** and perfectively-marked ability-**can** have the same meaning as **managed to** claims.

Actuality-able and **managed** also license the same additional inferences:

(16) I **managed** to sit through Wagner's 'Siegfried' last night.
   a. *suggests:* Sitting through 'Siegfried' was difficult for me
   b. *suggests:* I intended to sit through 'Siegfried'
   c. *suggests:* It was unexpected that I sat through 'Siegfried.'

(17) I **was able** to sit through 'Siegfried' last night.
   a. *suggests:* Sitting through 'Siegfried' was difficult for me
   b. *suggests:* I intended to sit through 'Siegfried'
   c. *suggests:* It was unexpected that I sat through 'Siegfried.'

Part II: *Managing* and *doing*

Question: What does it mean to *manage to* do something?

> *All that takes place when John* **manages to do** *something is that he does it. . . .* **managing to do** *is inseparable . . . from* **doing***; it is the same event.*
>
> (Karttunen 1971)

Manage gives rise to different inferences in different cases:

	difficulty	intention	unlikely
"Without intending to, Ms. Streisand managed to synthesize the problem of diversity mania."	✗	✗	✓
"By 1998, gun manufacturers had easily managed to bypass the laws by making small alterations to their weapons."	✗	✓	?
"The social democrats managed to strengthen their position as Denmark's strongest political force, as expected."	?	✓	✗

Part II: *Managing* and *doing*

Goal: assign a meaning to *manage* that captures this variability

- what do inferences about difficulty, intention, unlikelihood have in common?
- some obstacle must be overcome/some condition must be met for the *manage*-complement to occur (cf. Karttunen 2014)
- *because*-clauses tell us how this condition was handled

  (18) I managed to buy the ring because it was cheap.
  (vs: I bought the ring because it was cheap)

- *because* elaborates on a causal chain (Baglini & Francez 2016)

> **Manage to** *P* backgrounds the **causal necessity** and **causal sufficiency** of some action or event for the realization of *P* (Nadathur 2016)

Part II: *Managing* and causal dependence

Manage belongs to a class of **implicative verbs**:

(19) a. I **managed** to sit through 'Siegfried' last night.
→ I sat through 'Siegfriend' last night.

b. I didn't **manage** to sit through 'Siegfried' last night.
→ I didn't sit through 'Siegfried' last night.

(20) a. Marja **dared** to open the door. → Marja opened the door.

b. Marja didn't **dare** to open the door.
→ Marja didn't open the door.

Verbs like **dare** are specific about the causal condition:

- **dare** presumes (presupposes) that (acting with) courage is necessary/sufficient for opening the door
- **dare** informs us whether or not Marja acted with the necessary/sufficient courage
  - if she did, then she opened the door
  - if she did not, then she didn't (and couldn't) open the door

Part II: *Managing* and causal dependence

Causal dependence captures bringing-about relationships:

- define dependencies in a **causal network model** (directed acyclic graph; Schulz 2011, Pearl 2000)
  - nodes are events or propositions, and can take on truth values (0, 1, undetermined)
  - arrows represent causal relevance links ($P \rightarrow Q$ if P is a causal influencer of Q)
- it comes along with a set of equations defining the causal links
  - given an initial setting for the nodes, we can use these equations to calculate *causal consequences* (**normal causal developments**)
- **main idea:** causal dependence relations (necessity, sufficiency) are labels for certain structural configurations in a dynamics
- these labels appear as basic components in lexical semantic representations

Part II: Causal dependencies

Given two events C and E, and a background situation s which does not fix the occurrence of C ...

(21) C is **causally sufficient** for E relative to s if

a. s does not produce E as a normal causal development

the effect wasn't already inevitable

b. $s' = s + C$ does produce E as a normal causal development

the cause guarantees the effect

(22) C is **causally necessary** for E relative to s if

a. s does not guarantee E

b. $s' = s + C$ has a supersituation s'' which does not fix E, but has it as a normal causal development

the cause makes the effect possible

c. there is no supersituation s'' of s' which makes (b) true but does not have C as a normal causal development

the effect was not possible without the cause

Part II: *Managing* and causal dependence

Proposal for manage: for agent S, 1-place predicate A

S **manage to** A

a. presupposes the existence of an action H for S such that $H(S)$ is causally necessary and sufficient for $A(S)$
b. asserts that $H(S)$ occurred (S did H)

Manage isn't specific about the type of causal condition:

- if $H(S)$ occurs, it causally guarantees **(=brings about)** $A(S)$
- if $H(S)$ does not occur, $A(S)$ is precluded

(16) I **managed** to sit through 'Siegfried' last night.

a. *presupposes:* being patient (e.g.) was necessary/sufficient for sitting through the opera
b. *asserts:* I was patient at the opera last night
c. **conclusion:** I sat through 'Siegfried' (due to patience)

Part II: *Managing* and causal dependence

Proposal for manage: for agent S, 1-place predicate A

S **manage to** A

a. presupposes the existence of an action H for S such that $H(S)$ is causally necessary and sufficient for $A(S)$
b. asserts that $H(S)$ occurred (S did H)

But it does seem to require **causal** necessity and sufficiency:

(23) **Context:** *Being 21 is necessary and sufficient for the legal consumption of alcohol. Amira has been eager to try a glass of wine for a long time, but has refrained because she is too law-abiding. She just turned 21.*
??Yesterday, Amira **managed** to drink a glass of wine.

- (23) backgrounds a deontically necessary/sufficient condition
- to rationalize the use of *manage*, we draw inferences about non-legal conditions (the difficulty of obtaining wine, Amira's potential distaste for it)
- these inferences are about potential **causal** obstacles for $A(S)$

Part II: *Managing* and causal dependence

Proposal for manage: for agent S, 1-place predicate A

S **manage to** A

a. presupposes the existence of an action H for S such that $H(S)$ is causally necessary and sufficient for $A(S)$
b. asserts that $H(S)$ occurred (S did H)

Causal dependence allows us to explain the 'variable' inferences:

- if I am notoriously impatient, then sitting through the opera was difficult/unlikely because being patient was difficult/unlikely
- in the gun manufacturing example, making small alterations was necessary/sufficient for bypassing the law

(24) "By 1998, gun manufacturers had easily managed to bypass the law by making small alterations . . ."

- the causal condition here requires deliberate action/intention

Part II: *Being able* as *managing*

Proposal for manage: for agent S, 1-place predicate A

$$S \textbf{ manage to } A$$

a. presupposes the existence of an action H for S such that $H(S)$ is causally necessary and sufficient for $A(S)$
b. asserts that $H(S)$ occurred (S did H)

This should look familiar!

Proposal for ability-can: for agent S, 1-place predicate A

$$S \textbf{ can}_{\text{ability}} A$$

just in case there is some action H available to S such that if S does $H(S)$, then S will do $A(S)$

The key difference:

- the condition $H(S)$ for *manage* is not hypothetical
- ability-**can** doesn't resolve the status of $H(S)$

Part II: *Being able* as *managing*

Recap:

- the **ability** reading of **be able/can** tells us that there is some possible strategy for S to take to bring about $A(S)$
- this doesn't give us a handle on the **did** reading for **be able/can**
- to explain the **did** reading, we pursued Bhatt's idea that actualized **be able/can** has the same meaning as **managed**:
  - **manage** backgrounds a causal condition ($\sim$ strategy) for the complement, and tells us whether or not this strategy was acted on
  - the **manage/did** reading of **can/be able** tells us that x acted on a condition (strategy) for bringing about $A(S)$
  - what happened to the possibility?

Interim summary: the three questions

1. **What do expressions of ability mean?** ✓
2. **What is the connection between ability, actuality, and possibility?**
   - the ability reading seems to involve possibility
   - the manage/did reading does not, but does share structure with the ability reading
   - **problem:** the point of modals like *can* is to express possibility!

Recall: ability/actuality readings map onto aspect contrasts

(6a) *Marja* **a pu** *traverser le lac à la nage, #mais elle ne l'a pas traversé.*
'Marja could-PFV swim across the lake, #but she didn't cross it.'

(6b) *Marja* **pouvait** *traverser le lac à la nage, mais elle ne l'a jamais traversé.*
'Marja could-IMPF swim across the lake, but she never crossed it.'

This brings us to **Question 3: What is the role of aspect?**

Part III

Ability, actuality, and aspect

Part III: Splitting the difference

There's a class of *enough* constructions that license 'implicative' inferences:

(25) a. Juno **was fast enough** to win the race.
$\rightsquigarrow$ *Juno won the race.*

b. Juno **was** not **fast enough** to win the race.
$\rightarrow$ *Juno did not win the race.*

(26) a. Marja **was brave enough** to open the door.
$\rightsquigarrow$ *Marja opened the door.*

b. Marja **was** not **brave enough** to open the door.
$\rightarrow$ *Marja did not open the door.*

Compare (26) to (20):

(20) a. Marja **dared** to open the door.
$\rightarrow$ *Marja opened the door.*

b. Marja didn't **dare** to open the door.
$\rightarrow$ *Marja didn't open the door.*

Part III: Implicative *enough* constructions

Enough inferences are sensitive to aspect (Hacquard 2005):

(27) 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 didn't win.'

b. *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.'

(28) a. *Marja* **a été assez courageuse** *pour ouvrir la porte, #mais elle ne l'a pas fait.*
'Marja was-PFV brave enough to open the door, #but she didn't do it.'

b. *Marja* **était assez courageuse** *pour ouvrir la porte, mais elle ne l'a jamais fait.*
'Marja was-IMPF brave enough to open the door, but she never did it.'

Part III: Non-implicative *enough* constructions

There are systematic exceptions:

(29) a. Amira **was old enough** to drink alcohol.

No strong inference about Amira's drinking.

b. Amira **was** not **old enough** to drink alcohol.

No strong inference that she did not drink.

(30) a. *Amira* **a été**/**était** **assez grande** *pour boire de l'alcool.*

$\not\rightarrow$ Amira drank alcohol.

'Amira was-PFV/was-IMPF old enough to drink alcohol.'

b. *Amira n'***a** *pas* **été**/*n'***était** *pas* **assez grande** *pour boire de l'alcool.*

$\not\rightarrow$ Amira did not drink alcohol.

'Amira was-PFV/was-IMPF not old enough to drink alcohol.'

When the relationship between the matrix adjective and the complement is **deontic**, no implicative behaviour (Hacquard 2005)

Part III: Non-implicative *enough* constructions

Exceptions with a circumstantial relationship (Nadathur 2017):

(31) a. Nima **was tall enough** to reach the top shelf.
No strong inference about Nima reaching the shelf

b. Nima **was** not **tall enough** to reach the top shelf.
→ *Nima didn't reach the top shelf.*

(32) a. (!)*Nima* **a été assez grand** *pour atteindre l'étagère du haut, mais il ne l'a pas fait.*
'Nima was-PFV tall enough to reach the top shelf, but he didn't do it.'

b. *Nima* **était assez grand** *pour atteindre l'étagère du haut, mais il ne l'a jamais fait.*
'Nima was-IMPF tall enough to reach the top shelf, but he never did it.'

These exceptions involve **static** (non-actionable) matrix properties (*tall*, *old*, *pretty*)
(vs. **dynamic/actionable** properties, e.g. *fast*, *loud*)

Part III: *Enough* constructions

Why look at *enough* constructions?

- they offer a bridge between **manage**/implicatives and 'pure' ability claims
  - they seem closer in meaning to implicatives than ability claims
  - but they pattern with ability claims in terms of aspectual marking, and the licensed conclusions
- because they have a more complex compositional structure than ability claims, they give us a view on what meaning components produce the key contrasts
- the first step is to understand why certain *enough* constructions are implicative and others are not:
  - we've already seen that a **causal** relationship is important
  - the **static/dynamic** contrasts in circumstantial cases tell us about the basic nature of a strategy/available action in an ability claim

Part III: Semantics of *enough* constructions

Enough constructions are modalized degree comparatives

(von Stechow et al 2004, a.o.)

(33) Juno is fast enough to win the race.
$\sim$ Juno is as fast as she must be to make winning the race possible.

Components of the construction:

(a) gradable ADJ (of variable type): $[\![\text{fast}]\!]^w := \lambda d \lambda x.\text{SPEED}(x)(w) \geq d$
(b) complement proposition (for degree measurement/comparison)
(c) a comparative and modal operator: an equative *enough* incorporates necessity ($\sim$ *as* ADJ *as is required*)

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

(35) Juno be fast enough to win the race
$= \{d : \forall w' \in \text{ACC}(w)[\text{win}(j)(w') \rightarrow \text{SPEED}(j)(w') \geq d]\} \subseteq \{d : \text{SPEED}(j)(w) \geq d\}$

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)

Part III: *Enough* and necessity

These semantics lead to a **necessity presupposition:** there is a minimum degree d_{nec} which makes it possible for Juno to win:

(36) $\exists d_{\text{nec}} : \forall w' \in \text{Acc}(w)[\text{ADJ}(x)(w') < d_{\text{nec}} \rightarrow \neg Q(x)(w')]$

Both static and dynamic *enough* constructions involve necessity:

(31a) Nima **was tall enough** to reach the top shelf.

a. ≡ *Nima was as tall as he had to be in order for him to reach the top shelf.*

b. ≡ *There was some minimum height h_{nec} such that, if Nima's height was less than h_{nec}, he could not reach the top shelf*

c. → **Being h_{nec} tall was necessary for reaching the shelf.**

(25a) Juno **was fast enough** to win the race.

a. ≡ *Juno was as fast as she needed to be to win the race.*

b. ≡ *There was some minimum speed s_{nec} such that, if Juno's speed was less than s_{nec}, she could not win the race*

c. → **Being s_{nec} fast was necessary for winning the race.**

Part III: *Enough* and necessity

The necessity condition (causal or not) explains the negative/failure implications in circumstantial cases:

(20b) Marja didn't **dare** to open the door.

a. *presupposes:* acting with courage is causally necessary for opening the door

b. *asserts:* Marja didn't act with courage

c. **conclusion:** Marja didn't open the door

(37) *Juno n'***a été** *pas* **assez rapide** *pour gagner la course.*
'Juno was-PFV not fast enough to win the race.'

a. *presupposes:* there is a speed s_{nec} which is necessary for winning the race.

b. *asserts:* Juno is not s_{nec} fast (i.e. she is slower than s_{nec})

c. **conclusion:** Juno did not win the race.

Part III: The semantics of *enough* constructions

With the basic semantics:

- like implicatives, *enough* constructions:
  - presuppose a **necessary condition** for their complements
  - assert that this **condition was satisfied**
- unlike implicatives:
  - the modal flavour of an *enough* construction is not pre-set: it can be epistemic, deontic, circumstantial
  - no **sufficient condition** is presupposed

This makes the right predictions for:

- **deontic** *enough* constructions: no positive or negative entailments (adding sufficiency would make bad predictions, contra Hacquard)
- **static**-adjective circumstantial constructions (only negative entailments)

. . . but it cannot explain the positive implicative inferences of **dynamic**-adjective constructions under perfective aspect

Part III: *Enough* and sufficiency

We need sufficiency to get the positive inference:

(20a) Marja **dared** to open the door.

a. *presupposes:* acting with courage is causally sufficient for opening the door

b. *asserts:* Marja acted with courage

c. **conclusion:** Marja opened the door

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

a. **we need (38) to presuppose:** there is a speed s_{suff} ($= s_{\text{nec}}$) which is sufficient for winning the race.

b. *asserts:* Juno is s_{suff} fast

c. **conclusion:** if (38a), then Juno won the race.

Two problems:

1. how can the perfective introduce sufficiency?
2. there's no speed s such that *having* that speed (e.g. being capable of speed s) can, by itself, be sufficient

Part III: Static vs. dynamic properties

The key difference between the *enough* constructions that behave like *manage* and those that do not has to do with the adjective:

- *fast, brave, nimble* are **dynamic** (actionable) properties:
  - describe the capacity for actions which are characterized by speed, courage, dexterity, etc.
- *tall, old, pretty* are **static** properties:
  - they are states that an individual can be in, but they don't characterize actions/behaviour
- **upshot:** dynamic properties characterize action and have implicative inferences, static properties don't characterize action, and don't generate inferences

Why does this make a difference?

- what are we reasoning about when we assess whether Nima is tall enough to reach the top shelf, or Juno is fast enough to win the race?

Part III: Static *enough* constructions

(31a) Nima is tall enough to reach the top shelf
$\sim$ *Nima has the necessary/required height which enables him to reach the top shelf*

Another way of thinking about this:

- look at a set of alternative circumstances in which Nima's height varies (but other facts stay the same)
- across those alternatives where he reaches the top shelf, there's a certain minimum height he must have
- **observation:** alternatives where he reaches the top shelf also involve an action (attempt to reach the shelf)
  - the attempt is independent of his height (though height is an enabling condition for success)

Part III: Dynamic *enough* constructions

(39) Juno is fast enough to win the race.
$\sim$ *Juno has the speed required for winning the race.*

We do the same thing:

- across those alternatives where Juno wins, there's a minimum speed she must have
- latent speed isn't enough: she has to act
  - here, the action *is characterized by speed*
  - Juno's acting on her capacity brings about winning
  - dynamic properties automatically encode sufficiency: **manifesting the necessary speed causes the win**
- **upshot:** (39) presupposes the existence of a speed $s_{n/s}$ such that a manifestation of $s_{n/s}$ is causally necessary and causally sufficient for winning the race.
  - NB: if manifesting speed $s_{n/s}$ is causally necessary for winning, having the capacity for $s_{n/s}$ is itself necessary for winning

Part III: The meaning of dynamic *enough* constructions

Proposal for dynamic enough constructions: for agent S, 1-place predicate A, dynamic ADJ

S **is** ADJ **enough to** A

a. presupposes the existence of a degree $d_{n/s}$ of ADJ such that instantiating $d_{n/s}$-ADJ(S) is causally necessary and causally sufficient for $A(S)$

b. asserts that S has the capacity to instantiate $d_{n/s}$-ADJ(S)

This looks more like ability than like *manage*:

- assertion is the key difference between *be* ADJ *enough* and *manage*
- *manage* tells us that the causing action was taken, so we conclude that $A(S)$ occurred
- *be* ADJ *enough* only asserts that the causing action is possible (ability!)
- **crucially:** if we have some way of concluding that this capacity was acted on, then we can conclude that $A(S)$ occurred

Part III: Deus ex machina?

This is (actually!) progress:

- dynamic adjectives have two (semi) interchangeable interpretations

(40) a. Alvin is polite.
b. Alvin is being polite.

> *. . . the non-progressive characterizes a person; the progressive reports on behaviour . . .*
> (Goldsmith & Woisetschlaeger 1982, p.85)

- English 'bare' dynamic adjective attributions are at least ambiguous between eventive and stative readings:

(41) Juno was loud/fast.
a. **eventive (action):** Juno did something loud/quickly
b. **stative:** Juno had the capacity for doing things loudly/quickly

Part III: Deus ex machina?

Aspect to the rescue!

- the perfective/imperfective contrast forces the crucial choice between eventive and stative readings

(42) a. *Juno* **a été assez rapide** *pour gagner la course.*
'Juno was-PFV fast enough to win the race.'
eventive (action): *Juno instantiated the causally necessary/sufficient speed* $s_{n/s}$.

b. *Juno* **était assez rapide** *pour gagner la course.*
'Juno was-IMPF fast enough to win the race.'
stative: *Juno had the capacity to manifest speed* $s_{n/s}$.

Question: why does this happen?

- the perfective aspect requires a complete event, having 'natural' boundaries and involving some dynamic process
- capacities, as properties of individuals (states that individuals can be in), don't have natural boundaries or dynamicity

Part III: Viewpoint aspect and boundaries

The perfective aspect has **selectional restrictions**, doesn't automatically combine with property attributions:

(Moens & Steedman 1988, de Swart 1998, Bary 2009)

(43) ??*Nima a été grand.*
int: 'Nima was-PFV tall.'

NB: explains the problem with (24a), *Nima was-PFV tall enough to reach the top shelf*

We can combine states with the perfective if we have a natural way of reinterpreting them (**coercing** them into the right shape):

(44) **Inchoative** aspectual coercion:
Amira a été assez grande pour boire de l'alcool.
'Amira was-PFV old enough to drink alcohol.'
→ Amira *became* old enough to drink alcohol (turned 21).

Dynamic-capacity attributions have a natural reinterpretation: **instantiation!**

(45) Alvin is being tactful. → Alvin is acting on a capacity for tact.

(46) *Juno a été rapide.* → Juno acted on a capacity for speed.
'Juno was-PFV fast.'

Part III: Interpreting dynamic *enough* constructions

Proposal for dynamic enough constructions: for agent S, 1-place predicate A, dynamic ADJ

S **is** ADJ **enough to** A

a. presupposes the existence of a degree $d_{n/s}$ of ADJ such that $\text{INST}(d_{n/s}\text{-ADJ}(S))$ is causally necessary and causally sufficient for $A(S)$

b. asserts that S has the capacity to instantiate $d_{n/s}\text{-ADJ}(S)$

(42b) *Juno* **était assez rapide** *pour gagner la course.*
'Juno was-IMPF fast enough to win the race.'

a. *presupposes:* there is a speed $s_{n/s}$ such that the event of Juno instantiating $s_{n/s}$ (running at speed $s_{n/s}$) is causally necessary/causally sufficient for her to win the race.

b. *asserts:* [stative] Juno has the capacity to instantiate speed $s_{n/s}$

c. **conclusion:** It is possible for Juno to win the race (because of her speed capacity); Juno has the ability to win the race.

Part III: Interpreting dynamic *enough* constructions

Proposal for dynamic enough constructions: for agent S, 1-place predicate A, dynamic ADJ

S **is** ADJ **enough to** A

a. presupposes the existence of a degree $d_{n/s}$ of ADJ such that $\text{INST}(d_{n/s}\text{-ADJ}(S))$ is causally necessary and causally sufficient for $A(S)$

b. asserts that S has the capacity to instantiate $d_{n/s}\text{-ADJ}(S)$

(42a) *Juno* **a été assez rapide** *pour gagner la course.*
'Juno was-PFV fast enough to win the race.'

a. *presupposes:* there is a speed $s_{n/s}$ such that Juno's instantiating $s_{n/s}$ is causally necessary/sufficient for winning.

b. *asserts:* [eventive] Juno instantiated (ran at) speed $s_{n/s}$

c. **conclusion:** Juno won the race (her acting on her speed capacity brought about her race win)

Under instantiative coercion induced by perfective aspect, **be fast enough** behaves like **manage**

Part III: Tying things together

Enough constructions have the same structure as ability claims:

(47) S **is** ADJ **enough to** A
S has the capacity to act in a way that is causally necessary/sufficient for $A(S)$; this action is an instantiation of some particular level of ADJ

(48) S **can/is able to** A
S has an available action H such that $H(S)$ brings about $A(S)$

We can now fill in the gaps:

- the **bringing-about** connection between $H(S)$ and $A(S)$ is about **causal dependence**: $H(S)$ is causally necessary and causally sufficient for $A(S)$
- now: **having an available action/strategy** is a dynamic capacity, like **being fast enough**
- **in which case:** aspect will have the same effect on the interpretation of **ability-can/be able** claims as it does on dynamic **enough** claims

Part III: Tying things together

Proposal for ability-can: for agent S, 1-place predicate A

$$S \textbf{ can}_{\text{ability}} A$$

just in case S has the capacity for some action H such that $H(S)$ is causally necessary and sufficient for $A(S)$

Under the imperfective aspect, this just expresses the possibility of $A(S)$, in view of S's capacities

- but with perfective-induced **instantiative coercion:**

(49) *Olga a pu soulever cette table.* 'Olga could-PFV lift this table.'

a. *presumes:* Olga had the capacity for an action H such that Olga's doing H is causally necessary/causally sufficient for Olga to lift the table

b. *asserts:* [eventive reinterpretation] Olga did H

c. **conclusion:** Olga lifted the table

Conclusions

Conclusions: Back to the three questions

1. What do expressions of ability mean?
   - S **can/is able to do** A just in case S has the capacity to act in a way (H) that causes $A(S)$ to occur

$$\textit{presuppose: } H(S) \xrightarrow[\text{c-nec}]{\text{c-suff}} A(S)$$
$$\textit{assert: } \Diamond_{\text{circ}}\, H(S)$$

2. What is the connection between ability, actuality, and possibility?
   - $A(S)$ is **possible** in view of S's capacities
   - $A(S)$ gets **actualized** if S acts on her capacity
3. What is the role of aspect?
   - the imperfective leaves **was able** (and past-tense **can**) as a state/property description, which expresses a latent capacity
     → ability
   - the perfective forces eventive reinterpretation: instantiative coercion turns the latent capacity into an assertion that S acted on the capacity (did H) → actuality

Conclusions

The puzzle we started with:

- why is there a systematic ambiguity in expressions of ability and possibility?
- how do the *ability* and *actuality* meanings map to a conception of possibility, and to each other?

The explanation:

- the two interpretations share a single basic structure
- . . . connected to possibility via the 'availability' of a strategy/course of action
- the 'ambiguity' isn't encoded, but arises in interpretation
  - from context in English
  - from combination with grammaticalized aspect in French, Hindi, etc

Conclusions: actuality inferences are implicative inferencs

Three constructions which give rise to complement inferences:

- always-entailing: implicative verbs
- aspect-sensitive: ability modals, (dynamic) *enough* constructions

The semantic components of actuality and implicative entailments:

(i) the existence of a condition $H(S)$ which is **both necessary and sufficient** for the complement $A(S)$
(ii) a **causal** interpretation of necessity/sufficiency
(iii) an assertion **establishing** $H(S)$

Actuality entailments are implicative entailments:

- implicative verbs lexically encode (i)-(iii)
- (i)-(iii) arise compositionally for *enough* and ability modals
  - matrix-complement relationship for *enough* constructions can vary in modal flavour
  - ability modals are always causal
  - adding perfective aspect to an at-base stative capacity attribution produces the assertion in (iii)

Conclusions: a positive consequence

The complex structure of ability modals is motivated by their logical properties:

- it also explains an apparent tense asymmetry in ability claims

(50) Brown aimed, fired, and hit the bullseye three times in a row.

a. He **was able** to hit the bullseye three times in a row. ✓

b. He **can/is able to** hit the bullseye three times in a row. ✗/**?**

S **can**-PFV/**was able to** *A* isn't licensed by observing *A*(*S*)

- instead, past-tense ability claims report on event structure:
- *S* **was able to** *A* conveys that, as it turned out, some action *H* that *S* actually took had the causal consequence *A*(*S*)
- so the event has the right structure for an ability claim (even though the strategy might not have been clear in advance)
- this may also explain 'accidental' readings for ability (e.g. Malagasy, Tagalog; Paul et al 2016, Alonso-Ovalle & Hsieh 2017)

Conclusions: some open questions

Ability modals look different from other uses of *can/pouvoir*:

- causal condition $H(S)$ seems to appear under $\Diamond$, not prejacent $A(S)$
- Belnap's (1991) *stit* formalization might get around this problem:

$$S \text{ can}_{\text{ability}} A := \Diamond_{\text{hist}}[S \text{ stit } A(S)]$$

- the crucial notion is agent choice
- but, some entailing ability modals are not (strictly) agentive

(51) This elevator was able to lift 15 people

Other entailing modals are sensitive to agentivity:

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

- Hacquard (2006): some deontics have actuality entailments
- Mari (2016): the right characterization is **teleological** modals
- **a way forward:** historical possibility as causal, goal-oriented modality
  $\sim$ prejacent as a *telos* from subject **or** speaker perspective

Conclusions: causation in language

The causal dependence analysis does real work here:

- previous accounts of ability didn't capture the non-accidental relationship between 'strategy' and consequence
- here, **hypothetical guarantee** and the associated notion of bringing-about is cashed out out in terms of causal dependence (of a particular sort)
- this structure interacts with aspect to produce actuality inferences
- causal structure is crucial to reconciling the various interpretations with a unified semantic account

Big picture for the causal-modeling approach:

- causal dependencies of different types are encoded in semantic meaning (e.g., periphrastic causatives; Nadathur & Lauer 2020)
- these dependencies have important interactions with other components of meaning (e.g., aspect)
- the account presented here illustrates that causal reasoning is deeply embedded in the use and interpretation of language, even where the language involved is not overtly causal in nature

References

1. Baglini, R. & I. Francez. 2016. The implications of managing. *Journal of Semantics* 33.
2. Bary, C. 2009. Aspect in Ancient Greek. Ph. D., Radboud University.
3. Belnap, N. 1991. Backwards & forwards in the modal logic of agency. *Philosophy & Phenomenological Research* 51.
4. Belnap, N. & M. Perloff. 1988. Seeing to it that: a canonical form for agentives. *Theoria* 54.
5. Bhatt, R. 1999. Ability modals and their actuality entailments. *WCCFL* 17.
6. Bhatt, R. & R. Pancheva. 2005. The syntax and semantics of aspect. LSA course notes.
7. Brown, M. 1988. On the logic of ability. *Journal of Philosophical Logic* 17.
8. Hacquard, V. 2005. Aspects of too and enough constructions. *SALT* 15.
9. Hacquard, V. 2006. Aspects of modality. Ph. D., MIT.
10. Homer, V. 2011. French modals and perfective. *WCCFL* 28.
11. Karttunen, L. 1971. Implicative verbs. *Language* 47.
12. Karttunen, L. 2014. Three ways of not being lucky [slides]. *SALT* 24.
13. Kenny, A. 1976. Human ability and dynamic modalities. In *Essays of Explanation and Understanding*, Reidel.
14. Louie, M. 2014. Actuality entailments in Blackfoot (Sleepers and Imposters). *Workshop on Structure and Constituency in the Languages of the Americas* 18.
15. Maier, J. 2018. Ability, modality, and genericity. *Philosophical Studies* 175.
16. Mandelkern, M., G. Schultheis & D. Boylan. 2017. Agentive Modals. *The Philosophical Review* 126.
17. Mari, A. 2016. Actuality entailments: when the modality is in the presupposition. *Logical Aspects of Computational Linguistics* 2016.
18. Moens, M. & M. Steedman. 1988. Temporal ontology and temporal reference. *Computational Linguistics* 14.
19. Nadathur, P. 2016. Causal necessity and sufficiency in implicativity. *SALT* 26.
20. Nadathur, P. 2017. Implicative inferences and causality in *enough* and *too* constructions. *Amsterdam Colloquium* 21.
21. Nadathur, P. & S. Lauer. 2020.Causal necessity, causal sufficiency, & the implications of causative verbs. *Glossa*, t.a.
22. Pearl, J. 2000. *Causality.* Cambridge University Press.
23. Schulz, K. 2011. If youd wiggled A, then B would've changed. *Synthese* 179.
24. von Stechow, A., S. Krasikova & D. Penka. 2004. The meaning of German um zu: necessary condition and enough/too [handout]. *Workshop on Modal Verbs and Modality*.
25. de Swart, H. 1998. Aspect shift and coercion. *Natural Language & Linguistic Theory* 16.
26. Thalberg, I. 1972. *Enigmas of Agency: Studies in the Philosophy of Human Action.* Allen Unwin.

Appendix: Instantiative coercion

Theories of aspectual coercion propose **formal coercion operators:** (Bary 2009)

- **inchoative** coercion (INCH): picks out the initial point (transition) into a state, often triggered by presence of lexical items like *suddenly*

  (52) *Soudain, Anne a été triste.* → Anne *became* sad suddenly.
  'Suddenly, Anne was-PFV sad.'

- **maximal** coercion (MAX): a maximal instance of a state (cessation inferences)

  (10) *Marie a été belle.* ⇝ Marie is no longer beautiful.
  '[In those days], Marie was-PFV beautiful.'

- type mismatch between input predicate and perfective's selectional restrictions induces a coercion operator (de Swart)

$$\mathrm{PFV}(P_{\text{stative}}) \xrightarrow{\text{mismatch!}} \mathrm{PFV}(C_{\text{stative}\to\text{eventive}}(P_{\text{stative}}))$$

- choice of specific $C_{\text{stative}\to\text{eventive}}$ is context-dependent

Appendix: Instantiative coercion

Instantiative coercion is a new operator (but effects previously observed; Goldsmith & Woisetschlaeger, Moens & Steedman, de Swart):

- **here:** selectively applies to predicates that hold of individuals *in view of* capacity for action characterized by a particular property
  - i.e. Juno is fast *in view of* doing things that are describable as *fast*
- one way to do it:
  - a meaning postulate establishes 'witness' relationship between stative adjective *fast* and adverb *fast*

(53) $[\![\text{fast}_{\text{stative}}]\!] := \lambda w \lambda e \lambda x.$
$[\Diamond \exists e'[e' \sqsubseteq e \wedge \text{fast}_{\text{eventive}}(w)(e') \wedge \text{AGENT}(e') = \text{THEME}(e) = x]]$

- INST ($C_{\text{stative}\rightarrow\text{eventive}}$) introduces a witness event (underspecified)

(54) $[\![\text{INST}]\!] := \lambda w \lambda Q \lambda P \lambda e.$
$[\exists e'[e \sqsubset e' \wedge Q(e)(w) \wedge \text{QUANT}(Q) \wedge P(e')(w) \wedge \text{WITNESS}(Q, P)]]$

- with lexical triggers, we can get inchoative coercion (and no entailment):

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

Not possible in Hindi!

Appendix: Instantiative coercion

Homer (2011) observes instantiative coercion effects, calls it **actualistic**:

(56) a. *La maison a coûté 100,000 euro.* → The house was bought.
'The house cost-PFV 100,000 euro.'

b. *La maison coûtait 100,000 euro.* ↛ The house was bought.
'The house cost-IMPF 100,000 euro.'

- actualistic coercion is less restrictive than instantiative coercion
- for Homer, it realizes the complements of ability modals directly:
  - ability modals ($\Diamond_{\text{circ}}$) are stative, ACT selects temporally overlapping contextually-relevant eventive predicate
- incorrectly predicts actuality entailments from perfective **static-adjective** *enough* constructions (*be tall enough to*):
  - ACT should allow instantiation of the *enough*-complement directly, because it's a salient action
- **NB:** Homer (2019) updates the definition of ACT, introduces necessity/sufficiency presuppositions (still wrong predictions for *enough* constructions)

INST avoids this because actuality entailments are (causal) consequences of coerced events