

Necessity, sufficiency, and actuality: Causal dependence in implicative inferences*

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1 Introduction

Three constructions that license ‘actuality’ inferences:

(I) **implicative verbs** (Karttunen, 1971)

- implicative verbs **entail** the realization of their complements.

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

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

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

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

(III) **ability modals** and **be able** (Bhatt, 1999)

- past-tense *be able* **implicates** the realization of its complement

(3) (Yesterday,) Rebecca **was able** to swim across Lake Harriet.
 \leadsto *Rebecca swam across Lake Harriet.*

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These constructions are linked by the special case of *actuality entailments*:

- in aspect-marking languages like French (Greek, Hindi, etc), something surprising happens in the perfective aspect¹
 - perfectly-marked ability modals **entail** (rather than just implicating) their complements (Bhatt, 1999)

(4) *Rebecca a pu traverser le lac à la nage, #mais elle ne l'a pas traversé.*
 'Rebecca can-PFV swim across the lake, #but she didn't cross it.'
 - the same thing happens with perfectly-marked E&T constructions (the expected implicature is strengthened to full entailment; Hacquard, 2005)

(5) *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.'
- the convergence of complement entailments leads Bhatt (1999) and Hacquard (2005) to treat actuality entailments as true implicative entailments:
 - on their view, shared entailment patterns reflect underlying semantic similarity
 - **proposal:** E&T constructions and ability modals have the same (complement-entailing) lexical semantics as implicatives.

A problem: if all three constructions (I)-(III) share the same semantics, why do the inference patterns only match under perfective aspect?

- E&T constructions (6) and ability modals (7) only produce actuality entailments in the perfective, not under imperfective marking (or in English)

(6) *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.'

(7) *Rebecca pouvait traverser le lac à la nage, mais elle ne l'a jamais traversé.*
 'Rebecca can-IMPF swim across the lake, but she never crossed it.'
- implicative entailments, on the other hand, are not affected by aspectual marking

(8) *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.'

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

¹The 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.

	PFV	IMPF	English
implicatives	\vdash	\vdash	\vdash
E&T	\vdash	\leadsto	\leadsto
ability modals	\vdash	\leadsto	\leadsto

Table 1: Actuality inference patterns by aspect

Today: an account of ‘defeasible implicativity’ in E&T constructions

1. The lexical semantics of implicative verbs:
 - causal dependencies and prerequisites for complement entailment
2. The semantic components of E&T constructions:
 - adjectival degree comparatives with a modal component
 - necessity, but not (always) sufficiency
3. Actuality inferences in E&T constructions:
 - updated E&T semantics
 - actuality entailments are a special case: adjective type and aspect
 - further predictions of the account
4. Recap and outlook

2 A causal semantics for implicative verbs

Goal: rather than treating implicative entailments as a ‘black box,’ we want to see how they are derived in the semantics of implicative verbs

Karttunen (1971) characterizes implicatives by their complement entailment pattern; crucially, the polarity of the entailment reverses with negation in the matrix clause.²

- (10) a. Solomon managed to build a temple. \vdash *Solomon built a temple.*
b. Solomon did not manage to build a temple. \vdash *Solomon did not build a temple.*

²Implicatives are therefore distinct from **factive** predicates like *regret*, which presuppose (rather than entail) their complements. The distinction shows up in the projective behavior of the complement in each case: negating a factive has no effect on the truth value inferred for the factive complement.

The logical problem: *manage to X* entails *X*, and *not manage to X* entails *not X*, but *manage to X* and *X* are clearly not equivalent assertions.

Basic solution: implicatives are associated with presuppositional content

- *manage to X* gives rise to implications that do not follow from *X* alone
 - (11) Solomon managed to build a temple.
 - a. \leadsto Solomon intended to build a temple.
 - b. \leadsto Solomon made an attempt to build a temple.
 - c. \leadsto It was difficult for Solomon to build a temple.
 - d. \leadsto It was unlikely that Solomon would build a temple.
- the implicative assertion is only felicitous when its presuppositions are satisfied
- *X* is not restricted to these contexts
- consequently, an implicative assertion will not always follow in contexts where its bare complement is assertable

Analytical task:

- (a) spell out the presuppositional content
- (b) show how this combines with asserted content to derive complement entailments (and implications like 11a-11d)

2.1 Necessary and sufficient conditions

- looking at *manage* alone, it is difficult to pin down the presuppositional content (see Coleman, 1975; Karttunen and Peters, 1979; Bhatt, 1999)
 - as indicated in (11), intention, effort, difficulty, and unlikelihood all seem to be possible candidates
 - none of these inferences is universal, however (Coleman; Baglini and Francez, 2016)
- English and Finnish have a wide range of implicatives, however, many of which are more specific than *manage*:
 - **dare** suggests that the implicative complement required daring/courage
 - (12) a. She dared to open the door. \vdash *She opened the door.*
 - b. She did not dare to open the door. \vdash *She did not open the door.*
 - Finnish **hennoa**(=*have.the.heart*) suggests that the complement required ‘heart’/fortitude

- (13) a. *Hän henno-i tappa-a kissa-n*
 he.NOM have.the.heart-PST.3SG kill-INF cat-GEN/ACC
 ‘He had the heart to kill the cat’ \vdash *He killed the cat.*
- b. *Hän e-i henno-nut tappa-a kissa-a.*
 he.NOM NEG-3SG have.the.heart-PP.SG kill-INF cat-PART
 ‘He did not have the heart to kill the cat.’ \vdash *He did not kill the cat.*

Karttunen’s proposal:

“... let us ignore the individual differences among implicative verbs and try to state more precisely in what respect they are all alike. Let v stand for any implicative verb and S for the ... infinitival complement of that verb I assume that, in the representation of the main clause, $v(S)$ constitutes the central part of the proposition ... Leaving out ... details, the semantic analysis of the whole sentence can be represented by the following schema.” (p.352)

(14) **Schema:**

- a. *presupposition*: $v(S)$ is a necessary and sufficient condition for S
 b. *proposition*: $v(S)$

- while underspecified, this proposal derives the desired entailments:³
 - a positive implicative assertion conveys that a sufficient condition for the complement was met
 - a negative assertion conveys that a necessary condition was not met

Open question: what constitutes the “central part of the proposition,” $v(S)$?

- with verbs like *dare* and *hennoa*, $v(S)$ is the assertion that the lexically-specified prerequisite was met (Nadathur, 2016)

(15) a. She dared to open the door, #but she didn’t have the courage.
 b. She didn’t dare to open the door, #but she had the courage.
- what about *manage*?
 - under schema (14), difficulty, unlikelihood, etc, cannot be the main presupposition (though we should still be able to explain them)
 - *manage* is semantically bleached, compared to *dare*, *hennoa*, etc

³This proposal has largely been obscured due to the later Karttunen and Peters (1979) account of *manage*, which took the view that *manage* provided no assertive content beyond that of its complement

- **proposal:** *manage* presupposes an abstract prerequisite
- we can refine this:
 - there are restrictions on the type of necessity/sufficiency that *manage* can reference
 - a context which backgrounds a legal (deontic) necessary/sufficient condition does not make *manage* felicitous:

(16) a. *Context:* being 21 is legally necessary and legally sufficient for drinking alcohol in the United States. Juno turned 21 yesterday.

b. ?Juno managed to drink alcohol.
 - instead, we infer a different sort of condition: e.g., that Juno has to overcome her aversion to alcohol, or figure out where to buy it
 - broadly, it looks like the necessary and sufficient condition must be **circumstantially** associated with the complement

Baglini and Francez (2016)’s insight:

the relationship between an implicative’s presupposition and its complement is about **causal dependence**

2.2 Causal dependence

Proposal (Nadathur, 2016):

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

- causal dependencies are cashed out via Schulz (2011)’s **dynamics** for causal entailment
 - a dynamics D is a representation of our causal information in a discourse context
 - D encodes which propositions (actions/events) are causally linked to others
 - D encodes the nature of the dependencies
 - D can be updated, referenced, and manipulated by both at-issue and not-at-issue content

The Dreyfus scenario

(adapted from Baglini and Francez, 2016)

Suppose Dreyfus intends (INT) to spy for Germany:

- (a) then he will collect secrets about the French army (SEC) SEC = INT
- (b) if he has the nerve (NRV) as well as the intention to spy, he will send out a message (MSG) to make contact MSG = INT \wedge NRV
- (c) if it so happens that a German is listening on that frequency (LST), and the message is not intercepted (BRK), he will establish a communications line (COM) COM = MSG \wedge LST \wedge \neg BRK
- (d) he will use this line to pass information to the Germans, thereby spying (SPY) SPY = SEC \wedge COM

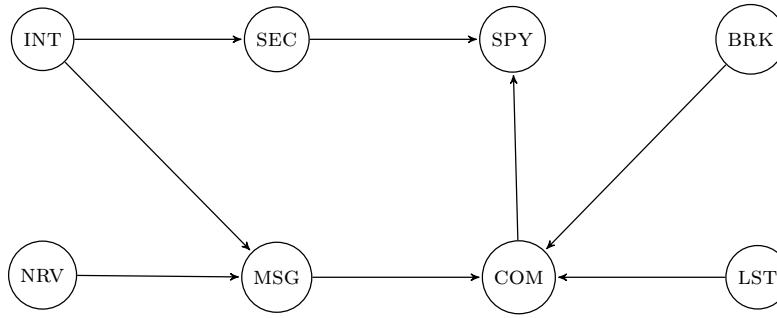


Figure 1: A dynamics for the Dreyfus example

Context 1: Dreyfus intends to spy, and has collected info

INT = SEC = 1

- (18)
 - a. Dreyfus dared to send a message to the Germans. \checkmark [NRV is nec, suff]
 - b. ?/#Dreyfus dared to make contact with the Germans. \times [BRK, LST unresolved]
 - c. ?/#Dreyfus dared to spy for the Germans. \times [BRK, LST, COM unresolved]
- (19)
 - a. Dreyfus managed to send a message to the Germans. \checkmark [\sim NRV = 1]
 - b. Dreyfus managed to make contact with the Germans. \checkmark [\sim NRV = 1, MSG = 1, LST = 1, BRK = 0]
 - c. Dreyfus managed to spy for the Germans. \checkmark [\sim NRV = 1, MSG = 1, LST = 1, BRK = 0, COM = 1]

Context 2: Dreyfus is very daring, but does not intend to spy.

INT = 0, NRV = 1

- *dare* (18a-18c) is infelicitous; NRV is not sufficient in context
- *manage* (19a-19c) is infelicitous; given INT = 0, there can be no necessary/sufficient condition for MSG, COM, SPY

Upshot:

- implicative verbs background the contextual causal necessity and causal sufficiency of some condition (or situation) for their complement
- lexically-specific verbs like *dare* tell us what this condition is
- since it's non-specific, *manage* 'bundles' causal conditions:
 - we infer difficulty, unlikelihood, etc, based on our knowledge of the dynamics
- Karttunen's $v(S)$ is the assertion that the prerequisite was satisfied
- in resolving the open condition (as at-issue content), an implicative utterance determines the complement's truth value as a consequence of presupposition and assertion
- **NB:** (17) formulates the necessity/sufficiency presupposition in two independent parts:
 - dropping one or the other predicts different inference patterns
 - there are **one-way implicatives** that only presuppose necessity:

- (20) a. *Hän jakso-i noust-a.*
 he.NOM have.strength-PST.3SG rise-INF
 'He had sufficient strength to rise.' \nVdash *He rose.*
- b. *Hän e-i jaksa-nut noust-a.*
 he.NOM NEG-3SG have.strength-PP.SG rise-INF
 'He did not have sufficient strength to rise.' \vdash *He did not rise.*

Implicatives unpacked:

- on the present proposal, (two-way) implicative entailments have **3 key components**
 - (a) coincidence of a necessary and sufficient condition for the complement
 - (b) the causal interpretation of necessity/sufficiency
 - (c) an assertion that the necessary/sufficient condition was satisfied

	<i>presupp</i>	<i>modality</i>	<i>assert</i>	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

- looking ahead, we predict that E&T constructions will be implicative (complement-entailing) just in case all three conditions are met

3 Implicativity in *enough* and *too* constructions

3.1 The semantic components of *enough* and *too* constructions

E&T constructions are analyzed as degree comparatives with a modal component (Bierwisch, 1987; Meier, 2003; von Stechow et al., 2004; Schwarzschild, 2008):

- a real degree (e.g., Juno’s speed in the actual world) is
 - attributed to the sentential subject (e.g., Juno)
 - measured with respect to a modally-determined degree (e.g., the speed needed to win a salient race)
- components of the construction:
 - (a) gradable adjective (of variable type)
 - individual-level: *tall*
 - stage-level: *hungry*
 - actionable: *fast*
 - (b) complement proposition (for degree measurement/comparison)
 - (c) a comparative (and modal) operator: *enough*, *too*

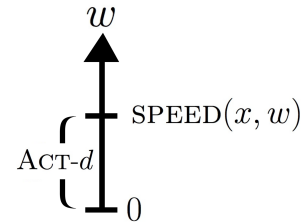
The truth conditions we want can be paraphrased as follows:

- (21) a. Juno is fast enough to win the race.
 Juno is as fast as she must be to make winning the race possible.
- b. Juno is too slow to win the race.
 Juno is slower than she can be for winning the race to be possible.

Composition (see also von Stechow et al., 2004):

- gradable adjectives relate individuals and (downward-closed) sets of degrees on a scale

$$(22) \quad \llbracket \text{fast} \rrbracket^w := \lambda d \lambda x. \text{SPEED}(x)(w) \geq d$$



where $\text{ACT-}d = \{d : \llbracket \text{fast} \rrbracket^w(x)(d)\}$

- *enough* is an equative (*as* ADJ *as*) with a universal modal:⁴ it takes three arguments (an individual x , a predicate of individuals Q , and a gradable adjective P)

$$(23) \quad \llbracket \text{enough} \rrbracket^w := \lambda Q_{est} \lambda P_{dest} \lambda x_e. \{d : \forall w' \in \text{ACC}(w)[Q(x)(w') \rightarrow P(d)(x)(w')]\} \subseteq \{d : P(d)(x)(w)\}$$

- *true* if the set of degrees d such that x is at least d -ADJ ($P(d)(x)$) in every world where $Q(x)$ holds is a subset of the set of degrees d such that x is at least d -ADJ in the world of evaluation

Derivation: let w^* be the world of evaluation

- (24) a. $\llbracket \text{Juno be fast enough to win the race} \rrbracket^{w^*}$
 b. $\{d : \forall w \in \text{ACC}(w^*)[\text{win}(j)(w) \rightarrow \text{SPEED}(j)(w) \geq d]\} \subseteq \{d : \text{SPEED}(j)(w^*) \geq d\}$
- the set MOD- d of degrees d such that Juno is at least d -fast in every world in $\text{ACC}(w^*)$ where she wins the race is a subset of the set ACT- d of degrees d such that Juno is at least d -fast in w^* .

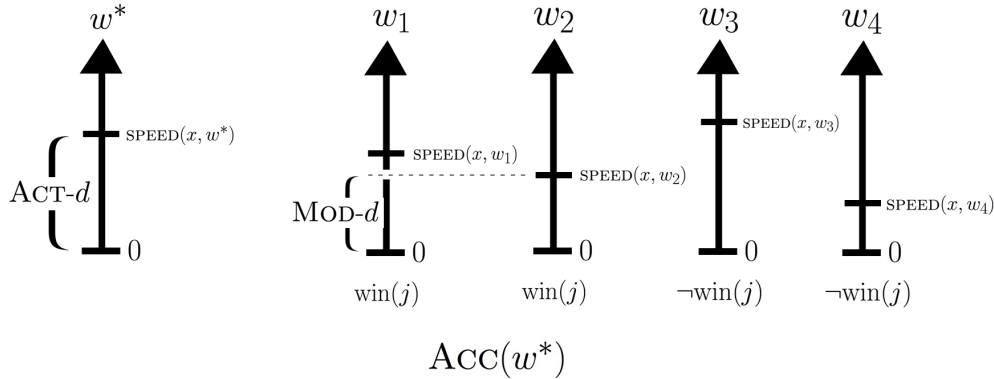


Figure 2: Representation of (24)

- this amounts to: Juno's maximum degree of speed in the actual world (w^*) is greater than her maximum degree of speed in the slowest world where she wins the race (w_2)
- in other words: (24) is *true* if Juno's actual speed makes it possible for her to win (i.e., there is an accessible world where she wins with that speed or less)

This leads to a **necessity condition**:

- an *enough* construction is infelicitous if there is no accessible world in which the complement occurs

⁴Its dual, *too*, is a comparative (*more* ADJ *than*) with an existential modal (von Stechow et al., 2004).

- we presuppose that there is at least one accessible world in which, e.g., Juno wins the race

$$(25) \quad \exists w' \in \text{ACC}(w) : Q(x)(w') \quad [w_1, w_2 \text{ in Figure 2}]$$

- since she has a speed in every world, it follows that the set of degrees of Juno's speed in every world where she wins is not empty ...

$$(26) \quad \text{MOD-}d = \{d : \forall w' \in \text{ACC}(w)[Q(x)(w') \rightarrow (\text{ADJ}(x)(w') \geq d)]\} \neq \emptyset$$

- ... and that there is a (minimum) degree d_{nec} which makes it possible for Juno to win:

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

On these semantics:

- like implicatives, E&T constructions presuppose a **necessary condition** (27) for their complements
- like implicatives, E&T constructions assert that this **condition was satisfied**
- unlike implicatives, the **modality** (type of necessity) of an E&T construction is **not predetermined**

– the adjective-complement relationship can be legal/deontic:

$$(28) \quad \text{Juno was old enough to drink.}$$

– or circumstantial:

$$(29) \quad \text{Juno was tall enough to reach the branch.}$$

$$(2) \quad \text{Juno was fast enough to win the race.}$$

- unlike implicatives, **no sufficient condition** for the complement is presupposed

Current predictions:

	<i>presupp</i>	<i>modality</i>	<i>assert</i>	pos-infer	neg-infer
implicatives	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \rightarrow \neg X$	deontic	A	$\nvdash X$	$\nvdash \neg X$
E&T	nec: $\neg A \rightarrow \neg X$	circumst.	A	$\nvdash X$	$\vdash \neg X$

Table 3: Predictions for E&T actuality inferences

- **deontic E&T constructions:** Table 3 predictions upheld (no entailments)
 - (30) 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 (30b), a legally-necessary condition is not met, but the real world need not be one in which laws are obeyed
- **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:
 - (31) 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:
 - (32) 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?

To figure out what’s going on here, we take a closer look at the facts about aspect

3.2 Adding sufficiency

Recall: perfectly-marked E&T constructions **entail** their complements (Hacquard’s generalization)

- (33) 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 (2005), we **do not want a sufficiency presupposition** across the board:

- (34) **Sufficiency condition** (for E&T constructions):

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

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

(35) ‘**Implicative**’ presupposition (for E&T constructions):

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

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 (35) 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

(36) *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 perfectly-marked E&T constructions with actionable capacities, but in an **intuitively wrong** way:

(37) *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 (35): *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 (37)

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 (35) 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* ($\triangleright_{\text{caus}}$) for realizing the E&T complement $Q(x)$:

$$(38) \quad \textbf{Actionable-capacity sufficiency condition: } \text{DO-ADJ}(x)(d_{\text{nec}}) \triangleright_{\text{caus}} Q(x)$$

Crucially, however, **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

$$(39) \quad \text{ADJ}(x)(w) \geq d_{\text{nec}} \sim \Diamond[\text{DO-ADJ}(x)(d_{\text{nec}}) \triangleright_{\text{caus}} Q(x)]$$

	<i>presupp</i>	<i>modality</i>	<i>assert</i>	pos-infer	neg-infer
implicatives	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \rightarrow \neg X$	deontic	A	$\nvdash X$	$\nvdash \neg X$
E&T, static	nec: $\neg A \rightarrow \neg X$	circumst., non-caus	A	$\nvdash X$	$\vdash \neg X$
E&T, actionable	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	causal	$\Diamond A$?	?

Table 4: Predictions for E&T actuality inferences

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.

- we need the perfective aspect to do this work
- specifically, in order to replace the question marks in Table 4 with the right facts about aspect:
 - we no longer need the perfective to introduce a sufficiency condition, since this is built into the structure of an actionable capacity
 - instead, we need the perfective to ‘peel off’ the possibility operator

4 Actuality inferences in E&T constructions

Proposal: the semantics of *enough* constructions

Let S be a proposition of the form $S = x \text{ be ADJ enough to } Q$, 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) S presupposes a degree d_{nec} that is necessary for the possibility of $Q(x)$:

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

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

$$\llbracket S \rrbracket^w = \text{ADJ}(x)(w) \geq d_{\text{nec}}$$

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

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

4.1 Aspect-governed actuality inferences

Actionable-capacity E&T constructions align almost exactly with the lexical semantics of implicatives:

- they presuppose the coincidence of a necessary and causally sufficient condition for the realization of their complements
- the necessity and sufficiency have a causal flavour
- 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:
 - (40) Juno was loud.
 - a. *eventive*: Juno did (something) loud/loudly.
 - b. *stative*: Juno had the capacity do (something) loud/loudly.

(41) Juno was fast enough to win the race.

a. *eventive*: Juno ran at a speed of at least d_{nec}

b. *stative*: Juno can run at a speed of at least d_{nec}

- contexts that privilege the eventive reading (41a) activate the sufficiency condition, producing actuality inferences:

(42) I didn't know Juno was a runner, but I saw her at the 5K yesterday! She was fast enough to win! \leadsto *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 choice of an aspectual marker forces a choice between eventive and stative readings
- perfective aspect (in general) selects for eventive predicates (Dowty, 1986)
- perfective aspect combines with statives via **aspectual coercion** (Moens and Steedman, 1988; de Swart, 1998)

- *love*, in (43) is coerced into an **inchoative** reading, returning its onset point:

(43) *Jupiter a aimé Europa.* \rightarrow *Jupiter fell in love with Europa.*
 ‘Jupiter loved-PFV Europa.’

- actionable capacities lend themselves to ‘**actualistic**’ coercion (Homer, 2011), returning an action characterized by the actionable adjective:⁵

(44) *Juno a été rapide.* \rightarrow *Juno did something quickly.*
 ‘Juno was-PFV fast.’

- **as a result**, perfectly-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

(33) *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*: $\text{DO-SPEED}(j)(d_{\text{nec}})$ 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

⁵Homer (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.

- (45) *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:

- (46) *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:

- (47) a. $\llbracket \text{GEN} \rrbracket^w := \lambda Q_{st} [\forall w' \in \text{NORM}(w) [Q(w')]]$
b. GEN(Juno not be fast enough to win the race)
 $\forall w \in \text{NORM}(w^*) [(\exists d_{\text{nec}} : \neg(\text{SPEED}(j)(w) \geq d_{\text{nec}}) \rightarrow \neg \text{win}(j)(w))$
 $\quad [\text{SPEED}(j)(w) < d_{\text{nec}}]$
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:

- (48) *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.

	<i>presupp</i>	<i>modality</i>	<i>assert</i>	pos-infer	neg-infer
implicatives	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	causal	A	$\vdash X$	$\vdash \neg X$
E&T	nec: $\neg A \rightarrow \neg X$	deontic	A	$\not\vdash X$	$\not\vdash \neg X$
E&T, static	nec: $\neg A \rightarrow \neg X$	circumst., non-caus	A	$\not\vdash X$	$\vdash \neg X$
E&T, actionable	nec: $\neg A \rightarrow \neg X$ suff: $A \rightarrow X$	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)

4.2 Differences between implicatives and E&T inferences

The original question:

Why do the inference patterns of implicatives and E&T constructions differ?

- implicative entailments are built into implicative lexical semantics
- E&T entailments arise compositionally, from a particular combination of aspect and adjective type

- in general, E&T constructions presuppose only a necessary condition for the realization of their consequent
- in the special case of actionable-capacity E&T constructions, 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:

(49) *Juno réussissait à gagner la course.*

‘Juno managed-IMPF to win the race.’

Over some past period of time, Juno habitually/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.

(9) *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:

(45) *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

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

Table 6: Implicative and E&T inference patterns

5 Summary and outlook

Recap: E&T complement inferences are sensitive to aspect; implicative entailments are not

- the lexical semantics of implicatives establishes three components for entailment:
 - (a) a presupposed necessary and sufficient condition for the complement
 - (b) causal dependence of the complement on this condition
 - (c) the assertion that the condition was met (eventive)
- across the board, E&T constructions presuppose a necessary condition for their complements
 - the asserted content and inference patterns vary according to modal flavour and adjective type
 - the representation of actionable capacities incorporates causal sufficiency
 - actionable-capacity attributions are at base stative, but can be coerced (by the perfective aspect) into eventive readings

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

- (4) *Rebecca a pu traverser le lac à la nage, #mais elle ne l'a pas traverser.*
'Rebecca can-PFV swim across the lake, #but she didn't cross it.'
 - (7) *Rebecca pouvait traverser le lac à la nage, mais elle ne l'a jamais traverser.*
'Rebecca can-IMPF swim across the lake, but she never crossed it.'
- Bhatt (1999)'s original proposal was to treat ability modals as implicatives (as *manage*)
 - we have seen why the 'full' implicative route will not work
 - an understanding of the components of implicative entailments helped us make sense of the E&T patterns
 - **next steps:** represent abilities in the same way as actionable capacities – as potentials for a causing action with the result specified in the modal complement

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