

Causal semantics for implicative verbs

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Introduction: implicative inferences

Implicative verbs are characterized by complement inferences:

(Karttunen 1971)

- (1) Morgan **managed** to solve the riddle.

→ *Morgan solved the riddle*

- inferences are **non-defeasible, reverse** under matrix negation:

- (2) a. Morgan **managed** to solve the riddle, #but she did not solve it.

- b. Morgan **did not manage** to solve the riddle, #but she solved it.

- ...leading to the conclusion that implicative verbs **entail** the truth of their complements

Implicative verbs in Finnish

Many other verbs have this inferential profile:

manage, dare, condescend, bother, remember ...

Manage/succeed in Finnish:

- (3) a. Eman **onnistu-i** kuitenkin pakenema-an.
Eman succeed-PST.3SG however flee-INF.ILL
'Eman managed to flee.' → *Eman fled.*
- b. Eman **e-i** **onnistu-nut** kuitenkaan
Eman NEG-3SG succeed-SG.PP however
pakenema-an.
flee-INF.ILL
'Eman didn't manage to flee.' → *Eman did not flee.*

Implicative verbs in Finnish

Implicatives are a Finnish speciality (data from L. Karttunen):

verb	example	translation
<i>muistaa</i>	Hän <i>muisti</i> sulkea oven	3SG remembered to close the door
<i>uskaltaa</i>	Hän <i>uskalsi</i> mennä ulos	3SG dared to go out
<i>juljeta</i>	Hän <i>julkesi</i> olla eri mieltä	3SG had the impudence to disagree
<i>mahtua</i>	Hän <i>mahtui</i> kulkemaan ovesta	3SG fit through the door
<i>maltaa</i>	Hän <i>maltoi</i> odottaa	3SG had the patience to wait
<i>hennoa</i>	Hän <i>hennoi</i> tappaa kissan	3SG had the heart to kill the cat
<i>ehsiä</i>	Hän <i>ehsi</i> ampuu karhun	3SG had the time to shoot the bear
<i>kehdata</i>	Hän <i>kehtasi</i> olla alasti	3SG was unashamed to be naked

Also: *tohtia* ('be bold enough to'), *rohjeta* ('have the courage to'), *iljetä* ('bring oneself to'), *päästä* ('get to'), *röyhjetä* ('have the arrogance to'), *viitsiä* ('bother to') *raaskia* ('overcome one's pity to'), *hirvitä* ('be bold enough to') ...

See also:

Flint 1980 (*Semantic structure in the Finnish lexicon*, Columbia Ph.D.)

Karttunen 2012 (Simple & phrasal implicatives, *Proceedings of *SEM*)

The logical problem of implicatives

The implicative inferential profile sets up a puzzle:

- ① For individual x , one-place predicate P , and implicative I :

$$(i) I(x, P) \rightarrow P(x) \qquad (ii) \neg I(x, P) \rightarrow \neg P(x)$$

- ② and since (i) and (ii) are logical converses, we expect (iii):

$$(iii) I(x, P) \equiv P(x)$$

Problem: (iii) is obviously wrong

- (4) Solomon **managed** to build the temple
 \neq Solomon built the temple
- (5) Juno **dared** to enter the cave \neq Juno entered the cave

The logical problem of implicatives

Analytical challenge:

Capture (i)-(ii) compositionally, while avoiding the “intuitively unacceptable conclusion” that an implicative assertion is indistinguishable from an assertion of its complement

(Karttunen 1971, p.343)

Solution: equivalence is blocked by implicatives' presuppositions

- an implicative is felicitous only when its presuppositions are met, but its complement is not similarly constrained
- **so:** $I(x, P)$ and $P(x)$ have different discourse/update effects

Implicatives and their presuppositions

The approach from presupposition seems promising:

- Karttunen & Peters (1979): *managing* takes effort

(4) Solomon **managed** to build the temple.

a. *Entails*: Solomon built the temple.

b. *Presupposes*: It **required effort** for Solomon to build the temple.

- Similar ‘requirement’ inferences from other verbs:

<i>language</i>	<i>verb</i>	<i>complement requires</i>
English	<i>dare</i>	courage, daring
	<i>condescend</i>	suppressing disdain
Finnish	<i>hennoa</i>	hard-heartedness, fortitude
	<i>ehitiä</i>	time
	<i>iljetä</i>	suppressing aversion

Implicatives and their presuppositions

Requirement inferences pass **presupposition projection tests**:

- (6) Solomon **did not manage** to build the temple.
→ *Building the temple required effort*
- (7) Juno **did not dare** to enter the cave.
→ *Entering required courage*
- (8) Hän **e-i henno-nut** noust-a.
he.NOM NEG-3SG have.heart-PP.SG rise-INF
'He didn't have the heart to get up.
→ *Getting up required fortitude*
- (9) Marja **e-i iljen-nyt** katso-a.
Marja NEG-3SG bring.self-PP.SG look-INF
'Marja couldn't bring herself to look.'
→ *Looking required overcoming aversion*

The ingredients of an analysis

Generalizing across Finnish and English data:

- implicatives presuppose conditions for their complements
- these conditions represent **potential obstacles** to complement realization (cf. Karttunen 2014)

Explananda:

- (A) an implicative assertion $I(x, P)$ entails its complement $P(x)$; its negation entails $\neg P(x)$
- (B) $I(x, P)$ conditions $P(x)$ on x overcoming a potential obstacle
- (C) Given (A), overcoming the obstacle is **both necessary and sufficient** for $P(x)$

Road map

- ① The 'direct assertion' account of *manage*
- ② Baglini & Francez (2016): challenges, *manage* & causal dependence
- ③ **Proposal:** causal necessity and causal sufficiency in implicativity
- ④ Conclusions

The implications of *manage*

Karttunen & Peters (1979) focus on **manage**:

- **Fact A** (two-way entailment) is captured by taking an implicative to only contribute a presupposition

The 'direct assertion' account

For agent x and one-place predicate P , **manage**(x, P):

- (i) Asserts: $P(x)$
- (ii) Presupposes: $P(x)$ was **effortful** for x

- **Fact B**: presupposition (ii) blocks **manage**(x, P) $\equiv P(x)$

Question (Fact C): what is the relationship between **effort** and the necessity/sufficiency of overcoming a potential obstacle?

The direct assertion account of *manage*

Attempt: *effort* is necessary, sufficient for *manage*-complement

- with effort, complement is realized:

(4) Solomon **managed** to build the temple.

→ *Solomon built the temple*

- **but:** where the complement fails, effort need not be lacking

(6) Solomon **did not manage** to build the temple.

→ *Solomon did not build the temple.*

(10) Even though he tried hard, Solomon **did not manage** to build the temple.

Conclusion: direct assertion doesn't capture the right necessity/sufficiency relationships

The case of the vanishing presupposition

Not all uses of *manage* presuppose effort:

- others suggest *trying* (“active attempt”; Givón 1973), *intention*, or even *unlikelihood*

(11) Solomon *managed* to build the temple.

a. → *Solomon tried to build the temple.*

b. → *Solomon intended to build the temple.*

c. → *It was unlikely that S would build the temple.*

- acceptable uses of *manage* can fail to indicate effort, intention
(Coleman 1975)

(12) a. Harry *managed* to insult Ursula without trying.

b. My neighbors *managed* to schedule their one wild party of the year on the night before my exam.

The case of the vanishing presupposition

Coleman proposes strength-ranked presuppositions:

intention > effort/difficulty > unlikeliness

- in a given context, the strongest tenable presupposition must be satisfied (see also Dalrymple et al 1998)

But: *manage* is fine where any one of the presuppositions holds
(cf. Baglini & Francez 2016)

- (13) γ Without intending to, Ms. Streisand **managed** to synthesize the problem of diversity mania.
 \nrightarrow intention, $? \rightarrow$ difficulty, \rightarrow unlikeliness
- (14) γ By 1998, gun manufacturers easily **managed** to bypass the laws.
 \rightarrow intention, \nrightarrow difficulty, $? \rightarrow$ unlikeliness
- (15) γ The social democrats **managed** to strengthen their position, as expected.
 \rightarrow intention, $? \rightarrow$ difficulty, \nrightarrow unlikeliness

The presuppositions of *manage*

Baglini & Francez (2016):

- to explain the ‘vanishing’ presuppositions, we need to adopt an alternative approach
- *manage* must have weak (non-specific) presuppositional content
- ... which can be realized, given context, as any one of intention, effort, or unlikeliness

Baglini & Francez’s insight:

The presuppositional content of *manage* has to do with **causal dependence**: specifically, with the causal conditions under which the *manage*-complement is realized

A causal approach to *manage*

The catalyst account

(Baglini & Francez)

For agent x and one-place predicate P , *manage*(x, P):

- (i) *Presupposes*: The familiarity (salience and truth) of a **catalyst**, or *causally necessary but causally insufficient situation* for the realization of $P(x)$
- (ii) *Asserts*: The catalyst **actually caused** $P(x)$

Two novel components:

- ① presupposition is couched in terms of **causal dependence**
 - there are (underspecified) conditions for $P(x)$
- ② *manage* has a non-trivial assertion

The real work lies in how **causal necessity, sufficiency**, and **actual cause** are formalized.

A positive consequence of non-trivial assertion

Observation (Karttunen 1971): *because*-clauses are interpreted differently when modifying *manage* and its complement

- (16) a. John **managed** to buy the ring because it was cheap.
↘ cost as enabler
- b. John bought the ring because it was cheap.
↘ cost as motivator

(contrasts with the interpretation of temporal and locative adverbials; Karttunen 1971, pp.346–347)

- on a direct assertion approach; the *because*-clause should modify the same assertion in (16)a-b
- for B&F, the *because*-clause in (16)a modifies **actual cause** (i.e., the **causal chain** leading to $P(x)$), not $P(x)$

A causal approach to *manage*

Baglini & Francez cash out the key dependencies in terms of a special notion of **causal entailment** (Schulz 2011):

- a **structural equation causal model** (Pearl 2000) comprises:
 - an acyclic graph with propositional variables as nodes
 - arrows (directed edges) indicating causal flow
$$P \xrightarrow{\text{causally influences}} Q$$
 - truth functions indicating how the value of a variable depends on its immediate ancestors
- a **situation** is a three-way valuation of variables
- given a situation, use the graph to calculate **causal consequences**
 - s **causally entails** ϕ iff ϕ 's truth follows from s

A causal approach to *manage*

Causal dependence relations, informally:

- for B&F, a **catalyst** is a **causally necessary** but **causally insufficient** situation for the *manage*-complement $P(x)$
- a situation s will be **causally sufficient** for ϕ if s guarantees the truth of ϕ as a causal consequence
- s is **causally necessary** for ϕ if all legitimate causal 'pathways' to the truth of ϕ make s true

Baglini & Francez additionally define **actual cause**:

- A situation s **actually causes** ϕ in a world w iff $s(\phi) = u$, $w(\phi) = 1$, and w is causally consistent with s

The catalyst account of *manage*

The catalyst account of **manage**:

For agent x and one-place predicate P , *manage*(x, P):

- (i) *Presupposes*: The familiarity (salience and truth) of a **catalyst**, or *causally necessary but causally insufficient situation* for the realization of $P(x)$
- (ii) *Asserts*: The catalyst **actually caused** $P(x)$

Assertable where:

- $P(x)$ is contextually possible (consistently causally realizable), but not guaranteed
- some additional condition needs to be realized for $P(x)$

The additional condition is ensured by (ii) (via **actual cause**)

Illustration: the Dreyfus scenario

- (17) **Context.** Dreyfus was wrongfully convicted of treason; he never had any intention of spying for Germany, or made any attempt to do so.
- a. ??Dreyfus **didn't manage** to spy for Germany.

The problem:

- (17) requires a point at which the world could have developed *in a causally normal fashion* into one where Dreyfus spied
- no such point existed: Dreyfus did not take the required actions, never intended to spy, no causal pathway to his spying

For B&F:

(17) is bad because there's no **causally necessary but causally insufficient catalyst** for Dreyfus to spy

→ presupposition failure!

The catalyst account of *manage*

Explananda:

- (A) $I(x, P) \rightarrow P(x); \neg I(x, P) \rightarrow \neg P(x)$
- (B) $I(x, P)$ conditions $P(x)$ on x overcoming a potential obstacle
- (C) Overcoming the obstacle is **necessary & sufficient** for $P(x)$

Fact A: catalyst proposal captures the characteristic entailments

- *manage*(x, P) presupposes the truth of a catalyst s , and asserts that s **actually caused** $P(x)$: this forces $P(x) = 1$
- \neg *manage*(x, P) presupposes the truth of s , and asserts that s **did not actually cause** $P(x)$: this forces $P(x) = 0$

The catalyst account of *manage*

Explananda:

- (A) $I(x, P) \rightarrow P(x); \neg I(x, P) \rightarrow \neg P(x)$
- (B) $I(x, P)$ conditions $P(x)$ on x overcoming a potential obstacle
- (C) Overcoming the obstacle is **necessary & sufficient** for $P(x)$

Fact B: the **causal insufficiency** of the **catalyst** is associated with the potential obstacle for $P(x)$

- since the catalyst s does not guarantee $P(x)$, some other causal condition for $P(x)$ must remain open
- solves the 'vanishing presupposition' problem: a **causally-necessary condition** for $P(x)$ must be left unresolved by the catalyst, it's precise nature is contextually fixed

The catalyst account of *manage*

Explananda:

- (A) $I(x, P) \rightarrow P(x); \neg I(x, P) \rightarrow \neg P(x)$
- (B) $I(x, P)$ conditions $P(x)$ on x overcoming a potential obstacle
- (C) Overcoming the obstacle is **necessary & sufficient** for $P(x)$

Fact C:

- for (insufficient) catalyst to **actually cause** $P(x)$, any other necessary conditions for $P(x)$ must be contextually satisfied
- if the catalyst does not actually cause $P(x)$, at least one catalyst-external necessary condition must remain unsatisfied
- **so:** presupposed catalyst insufficiency + asserted actual cause = some catalyst-external condition(s) for $P(x)$ are both necessary and sufficient in context

Complicating the catalyst

B&F mandate a **determinative catalyst-external cause** for $P(x)$

- breaks down beyond *manage*:

- (18) a. He **dared** to kill the cat. \rightarrow *He killed the cat*
b. He **did not dare** to kill the cat. \rightarrow *He did not kill the cat*

- (19) a. Hän **henno-i** tappa-a kissa-n
he.NOM have.heart-PST.3SG kill-INF cat-GEN/ACC
'He had the heart to kill the cat' \rightarrow *He killed the cat*
b. Hän **e-i henno-nut** tappa-a kissa-a
he.NOM neg-3sg have.heart-PP.SG kill-INF cat-PART
'He did not have the heart to kill the cat'
 \rightarrow *He did not kill the cat*

- (a) suggests a particular attribute's presence; (b) its absence
- ideally, the named necessary/sufficient condition should be encoded in presuppositional content

Complicating the proposal: one-way implicatives

A second problem: one-way implicative verbs

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

verb	example	translation
<i>osata</i>	Hän ei osannut lukea	He did not know how to read
<i>pystyä</i>	Hän ei pystynyt tappelemaan	He was not able to fight
<i>ylettää</i>	Hän ei ylettynyt ottamaan käpyä	He was not tall enough to pick the pine cone
<i>tarjeta</i>	Hän ei tarjennut mennä ulos	He was not warm enough to go out

Karttunen 2012, 2014: these have a $--$ pattern ($++ / --$ for *manage*)

One-way implicatives

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

Problems for the catalyst account:

- no way to relax positive entailments from $++/--$ case: weakening necessity loses desired negative entailment!
- no way to modify non-trivial assertion without breaking expected negation relationship
- **moreover:** (20a) suggests presence of strength (compare positive *dare*)

Causal necessity and sufficiency in implicativity

Revised desiderata:

- ① implicative assertions highlight a **causal prerequisite** that is *in question* (potential obstacle) for their complements
- ② lexically-specific implicatives (*dare, hennoa*) show that the prerequisite determines complement value
- ③ **so**: complement value is computed via **background causal dependence** and prerequisite assertion
- ④ one-way implicatives should be captured by **a minimal change to presupposed content** (not assertion)

Causal necessity and sufficiency in implicativity

The prerequisite account

(Nadathur 2019, 2022)

For two-way implicative I , agent x , 1-place predicate P , $I(x, P)$:

- i. *Presupposes*: the existence of a one-place predicate A such that $A(x)$ is **causally necessary** for $P(x)$ in context
- ii. *Asserts*: $A(x)$
- iii. *Presupposes*: $A(x)$ is **causally sufficient** for $P(x)$

Implicatives vary w.r.t. the nature and specificity of A :

- *dare, uskaltaa, hennoa* name specific conditions for $P(x)$
- *manage, onnistua* presuppose underspecified causal conditions,
- preserves benefits of B&F proposal (contextual presupposition resolution for *manage*, *because*-clause contrast)

Causal necessity and sufficiency of facts

We evaluate **causal dependence** of one fact on another *relative* to a given context (implicitly a 'catalyst' situation):

- X is **causally necessary** for Y relative to s if $s + X$ is **causally necessary** for Y
all consistent causal pathways from s to Y go through X
- X is **causally sufficient** for Y relative to s if $s + X$ is **causally sufficient** for Y
adding X to s guarantees Y

Supporting evidence

Prerequisite $A(x)$ must be both necessary and sufficient:

- two-way implicatives are infelicitous where other causal conditions for the complement are left unsettled

- (21) **Context.** A hunter lost count of the number of times he had fired his gun and was not sure if he had any bullets left . He decided to check after eating something, and put it down to get some food from his pack. While he had both hands occupied, he saw a bear coming towards him. Did he shoot it?

#Hän **eht-i** ampu-a karhu-n
he.NOM have.time-PST.3SG shoot-INF bear-GEN/ACC
'He had enough time to shoot the bear'

- also out under matrix negation
- informant comment: "you cannot use *ehtiiä*, because if he didn't have any bullets, he could not have shot the bear"

Supporting evidence

The prerequisite account **precisifies** Karttunen's schema (p.352):

In the following, 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 sentence that manifests itself as the infinitival complement of that verb in the surface structure. I assume that, in the representation of the main clause, $v(S)$ constitutes the central part of the proposition to which negation, modals, and time and locative references are attached. Leaving out these other details, the semantic analysis of the whole sentence can be represented by the following schema:

- (37) PRESUPPOSITION: $v(S)$ is a necessary and sufficient condition for S .
PROPOSITION: $v(S)$.

- the “central part” of the proposition is the assertion resolving the prerequisite $A(x)$
- $A(x)$ is necessary & sufficient for $P(x)(= S)$

Supporting evidence for the prerequisite account

Question: do we really need causal dependence?

Non-causal necessity/sufficiency isn't enough:

- (22) **Context.** Being 21 is legally necessary, sufficient to drink alcohol. Amira has been eager to try wine for a long time, but hasn't yet because she is very law-abiding. She just turned 21. ??Yesterday, Amira **managed** to drink a glass of wine.
- 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 $P(x)$

Extending the account: one-way implicatives

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

- **want to:** eliminate ++ entailment w/out changing assertion
- **now:** *jaksa* simply drops the sufficiency presupposition
- both one- (--) and two-way (+ + / - -) verbs assert prerequisite satisfaction
- failure of necessary prerequisite produces -- entailment
- satisfying a necessity-only prerequisite does not guarantee the complement, so we don't get the ++ inference

Extending the account: one-way implicatives

Predicting a ++ implicature in (20a):

- (20) a. Hän **jakso-i** noust-a.
he.NOM have.strength-PST.3SG rise-INF
'He had the strength to rise.' \rightsquigarrow **He rose.**

- a necessary condition is also sufficient where it is the **only unresolved necessary condition**
- implicature involves **circumscriptive reasoning**:
(“what you see is all there is”; Kahneman 2011)
 - only one necessary condition is mentioned, so we infer it to be the **only relevant such condition**
 - similar reasoning for **conditional perfection**
(sufficiency to necessity; Geis & Zwicky 1971, Karttunen 2012)

A final extension: polarity-reversing implicatives

The implicative paradigm is even richer than we have seen:

- polarity-reversing two-way implicatives (+ – / – +)

- (22) a. Juri **failed** to open the door.
→ *Juri did not open the door.*
- b. Juri **did not fail** to open the door.
→ *Juri opened the door.*
- (23) a. Hän **laiminlö-i** korjat-a virhee-n
he.NOM neglect-PST.3SG repair-INF error-GEN/ACC
'He neglected to correct the error'
→ *He did not correct it*
- b. Hän **e-i laiminlyö-nyt** korjat-a virhe-ttä
he.NOM NEG-3SG neglect-PP.SG repair-INF error-PART
'He didn't neglect to correct the error'
→ *He corrected it*

Polarity-reversing implicatives

Two-way: + – / – +

verb	example	translation
<i>unohtaa</i>	Hän <i>unohti</i> sulkea oven	3SG forgot to close the door
<i>välttyä</i>	Hän <i>välttyi</i> joutumasta kiini	3SG avoided getting caught

One-way: – +

<i>häikäillä</i>	Hän ei <i>häikäillyt</i> ottaa lahjuksia	3SG didn't have scruples against taking bribes
<i>siekailla</i>	Hän ei <i>siekaillut</i> hypätä katolta	3SG didn't waste time jumping off the roof
<i>ujostella</i>	Hän ei <i>ujostellut</i> näyttää picture	3SG wasn't shy to show his picture
<i>kainostella</i>	Hän ei <i>kainostellut</i> pyytää apua	3SG was not too bashful to ask for help
<i>epäroidä</i>	Hän ei <i>epäroinyt</i> ottaa osaa	3SG did not hesitate to take part

Extending the account: polarity-reversing implicatives

To capture polarity-reversing verbs:

- prerequisite $A(x)$ is causally necessary/sufficient for **complement failure**
- matrix negation precludes complement failure: $-+$ inference
- for two-way verbs: positive assertion ($A(x)$) guarantees complement failure ($+ -$) inference
- positive implicature (at best) for one-way polarity-reversers:

(24) Juri **hesitated** to ask for help. \rightsquigarrow *She didn't ask for help*

Question: are there sufficiency-only implicatives? ($++$, $+ -$)

- space is occupied by **causative verbs**
- $++$: *make, let* (Nadathur & Lauer 2020; poss. also *get, have, force*); $+ -$: *prevent* (Karttunen 2012)
- Finnish causatives and implicatives are structurally distinct

Summary

Logical puzzle: despite two-way entailment, implicatives & complements have different discourse effects

- difference in *not-at-issue* content, but tough to pin down
- B&F 2016: cash out in terms of **causal dependence**
- **here:** implicative presuppositions highlight **causally-determinative (necessary & sufficient) prerequisites** for their complements
 - *manage/onnistua* are special (bleached) cases
- causal analysis extends readily to
 - **lexically-specific** (*dare/uskaltaa*) & **one-way** verbs (*jaksaa*)
 - **polarity-reversers** (*neglect/laiminlyödä, hesitate/epäroidä*)

Possible extensions/connections:

- sufficiency causatives (English/German: Nadathur & Lauer 2020)
- the Finnish modal inventory (Flint 1980, Chark 2021)

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