Causal semantics for implicative verbs

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Abstract

Implicative verbs (e.g., *manage, dare*) are characterized by a pattern of complement inferences (Karttunen, 1971). English *manage* entails its complement; the entailment reverses polarity with matrix negation, and is accompanied in both cases by a projective inference to the complement's non-triviality (Coleman, 1975; Karttunen and Peters, 1979). I draw on data from Finnish and English to argue that the implicative inferential profile is derived from backgrounded relations of *causal necessity* and *causal sufficiency* (defined with respect to the structure of a formal causal model; Pearl 2000; Schulz 2011) which link the lexical content of an implicative verb to the realization of its complement. The proposal builds on Baglini and Francez's (2016) causal analysis of *manage*, but significantly revises the earlier proposal to offer a treatment which accounts not only for English *manage*, but extends to the lexical semantics of the full implicative class, including 'polarity-reversing' verbs like *fail*, lexically-specific verbs like *dare*, and their Finnish counterparts. Unlike earlier analyses, the proposed causal semantics also provides a natural explanation of the commonalities between two-way entailing verbs like *manage* and a related class of weaker 'one-way' implicatives such as Finnish *jaksaa* ('have the strength'), which entail complement truth values under only one matrix polarity, but generate strong pragmatic implicatures in the two-way implicative pattern under the non-entailing polarity.

1 Introduction

Across the languages in which they occur, **implicative verbs** systematically license inferences about the truth of their complements (Karttunen, 1971). As (1)-(2) show for English *manage* and Finnish *onnistua* ('succeed', 'manage'), implicative complement inferences have the force of entailments, crucially reversing under matrix negation (and thus distinguishing implicative verbs from complement-presupposing factives like *know* and *regret*; Kiparsky and Kiparsky 1970).

(1) a. Mika **managed** to solve the riddle. → *Mika solved the riddle.*
b. Mika did not **manage** to solve the riddle. → *Mika did not solve the riddle.*

(2) 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 pakenema-an.
Eman NEG-3SG succeed-SG.PP however flee-INF.ILL
'Eman did not manage to flee.' → *Eman did not flee.*

The two-way implicative entailment pattern in (1)-(2) sets up an interesting (pseudo-)logical puzzle. Taking I to represent an arbitrary implicative, with x its subject and P a one-place predicate (so that $P(x)$ represents the reconstructed implicative complement), we have the following relationships:

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

Entailment (ii) is the converse of (i), inviting the conclusion that the implicative assertion $I(x, P)$ and its complement $P(x)$ are logically equivalent, as in (iii).

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

Relations (i) and (ii) evidently hold for *manage* and *onnistua*, but (iii) does not. The analytical challenge of implicative verbs, then, is to derive the inference patterns in (i)-(ii) while avoiding the "intuitively unacceptable conclusion" in (iii) (Karttunen; p.343): i.e., while maintaining the distinction between an implicative's assertion and that of its complement. Following Karttunen, the failure of (iii) is typically attributed to presuppositional (*not at-issue*) content associated with the implicative verb I (Givón, 1973; Coleman, 1975; Karttunen and Peters, 1979; Bhatt, 1999, among others), but pinning down the precise nature of this content—as well as its interaction with the at-issue contribution of an implicative claim—has proven surprisingly difficult.

This paper presents an account on which the characteristic inferential profile of implicative verbs is derived from causal dependence relations embedded in their lexical semantics. I argue that implicatives introduce a salient prerequisite, which is presupposed to be *causally necessary* and *causally sufficient* for the realization of the complement. Simultaneously, implicative claims assert the satisfaction of this prerequisite, so that complement entailments follow as (causal) consequences when presupposition and assertion are taken together. The proposed prerequisite analysis diverges in both content and structure from the received approach (Karttunen and Peters 1979), on which an implicative like *manage* piggybacks on the assertion of its complement, and is thus taken to contribute semantically only in the not at-issue dimension.

The core of my proposal—that implicatives impose constraints on causal relationships in their utterance contexts—builds on but significantly revises a recent causal analysis of *manage*. Baglini and Francez (2016) propose that *manage* presupposes the truth of a salient causally necessary but crucially insufficient *catalyst* situation for the realization of its complement, and asserts that this catalyst was efficacious in the reference context (i.e., that complement realization was *actually caused* by the catalyst). While the catalyst approach to *manage* significantly improves on the prior Karttunen and Peters approach, I show that Baglini and Francez's proposal does not yet offer a fully satisfactory treatment of implicative semantics. For instance, the catalyst approach falls short as an analysis of lexically-specific verbs like English *dare* and its Finnish counterpart *uskaltaa*, which, alongside the standard complement entailments, also license polar inferences about particular (prerequisite) properties of their subjects.

(3) a. Ana **dared** to enter the cave. → *Ana entered the cave.*
prerequisite inference: Ana was daring.

b. Ana did not **dare** to enter the cave. → *Ana did not enter the cave.*
prerequisite inference: Ana was not daring.

(4) a. Juno **uskals-i** avat-a ove-n.
Juno dare-PST.3SG open-INF door-GEN/ACC
'Juno dared to open the door.' → *Juno opened the door.*
prerequisite inference: Juno was daring.

b. Juno e-i **uskalta-nut** avat-a ove-a.
Juno NEG-3SG dare-SG.PP open-INF door-PART
'Juno did not dare to open the door.' → *Juno did not open the door.*
prerequisite inference: Juno was not daring.

In (3)-(4), (non-)realization of a lexically-specified prerequisite (courage or daring) appears to be determinative for complement realization. Both the specification of and the polar inferences associated with this prerequisite are incompatible with the catalyst approach: since 'daring' is present in (3a) and (4a) but evidently lacking in (3b) and (4b), it cannot be identified with the established (already-realized) *catalyst* in Baglini and Francez's presupposition. *Dare* and *uskaltaa* are typical of the English and Finnish implicative paradigm; these and other lexically-specific implicatives thus motivate a revised and crucially restructured causal account on which implicative verbs do not highlight an insufficient but realized catalyst cause, but instead background the relevance of an unresolved, (causally) determinative prerequisite, whose truth value is settled by the implicative assertion.

I show that *manage* and *onnistua* can be treated as special semantically-underspecified cases on such a revised 'prerequisite' analysis: like lexically-specific verbs, they invoke causally-necessary and causally-sufficient prerequisites for their complements, but fail to specify the nature of the prerequisite. The revised account also improves on both 'direct assertion' (Karttunen and Peters, 1979) and catalyst (Baglini and Francez, 2016) approaches insofar as it allows a unified treatment of the two-way entailment profile of core implicative cases (like *manage, dare*, and their Finnish counterparts) and a related class of 'one-way' implicative verbs like Finnish *jaksaa* ('have strength'; 5), which share the overall inferential profile of two-way verbs, but weaken the complement inference in one direction to at best a strong pragmatic implicature (Karttunen, 1971, 2012).

(5) a. Sampo **jakso-i** noust-a.
Sampo have.strength-PST.3SG rise-INF
'Sampo had strength to rise.' $\rightsquigarrow$ ($\not\rightarrow$) *Sampo rose.*
prerequisite inference: Sampo had strength.

b. Sampo e-i **jaksa-nut** noust-a.
Sampo NEG-3SG have.strength-PP.SG rise-INF
'Sampo did not have strength to rise.' $\rightarrow$ *Sampo did not rise.*
prerequisite inference: Sampo did not have strength.

In tying implicative inferences to formally-defined causal dependencies, this paper contributes to a rapidly growing body of work which explores the utility of **causal models** in explicating linguistic inference across the lexical and sentential levels. I formalize causal relations in terms of the *structural equation models* of Pearl (2000), which have been fruitfully employed in the semantic analysis of counterfactual conditionals (Schulz, 2011; Kaufmann, 2013; Henderson, 2014; Ciardelli et al., 2018; Santorio, 2019, among others), as well as in the lexical analysis of *causative* verbs (Nadathur and Lauer, 2020; Baglini and Bar-Asher Siegal, 2020; Bassel et al., 2020). The causal approach to *manage* and other implicatives extends the use of causal models to the lexical analysis of language that does not directly predicate causation, but instead invokes causal information in its presuppositional contribution. In so doing, the paper proposes that causal structure plays a role across both at-issue and not at-issue dimensions of meaning.

2 The division of labour in implicative semantics

2.1 The ingredients of an analysis

Karttunen (1971) suggests that the false equivalence between an implicative assertion and its complement (relation (iii) in the introduction) is blocked by presuppositional material associated with the implicative verb. The idea is that an implicative constrains its appropriate contexts

of utterance in ways which its bare (reconstructed) complement does not. As a result, the implicative assertion can be used in a strict subset of the contexts where its complement is appropriate, so that use of the implicative construction licenses inferences which do not follow from the complement alone.

Karttunen's suggestion has been widely adopted in work on implicative *manage*, although consensus on the precise presuppositional content has proven surprisingly elusive (Coleman, 1975; Baglini and Francez, 2016). Perhaps most prominently, Karttunen and Peters (1979) argue that *manage* introduces a projective inference of effort or difficulty, so that (1a) and (1b) both convey that solving the riddle required effort on Mika's part (see also Bhatt 1999).

(1) a. Mika **managed** to solve the riddle. → *Mika solved the riddle.*
presumes: Solving the riddle was effortful for Mika.

b. Mika did not **manage** to solve the riddle. →*Mika did not solve the riddle.*
presumes: Solving the riddle was effortful for Mika.

Looking beyond *manage*, 'requirement' inferences also seem to attach to other implicative verbs. Alongside their characteristic entailments, each of the verbs in (6) invokes some condition or factor which operates as a *prerequisite*—that is, which is understood to be needed for the realization of the implicative's complement. English *dare* in (6a) indicates a need for daring (courage or boldness), as does Finnish *uskaltaa* ('dare'; 4). *Condescend*, in (6b), suggests that attending the meeting required Mr. Sinha to suppress his inherent disdain; Finnish *viitsiä* ('bother'; 6c) indicates a need for active interest or engagement, while *malttaa* ('have patience'; 6d) indicates a need for patience.

(6) a. $^{\gamma}$I **dared** to open an umbrella indoors.[1] → *I opened the umbrella.*
presumes: Opening an umbrella indoors required daring (from me).

b. $^{\gamma}$Mr. Sinha **condescended** to meet the tainted persons.
→ *Mr. Sinha met the tainted persons.*
presumes: Meeting the tainted persons required Mr. Sinha's condescension.

c. Hän **viits-i** vastat-a.
he.NOM bother-PST.3SG answer-INF
'He **bothered** to answer.' → *He answered.*
presumes: Answering required him to take an interest.

d. Marja **maltto-i** odotta-a.
Marja have.patience-PST.3SG wait-INF
'Marja had the patience to wait.' → *Marja waited.*
presumes: Waiting required patience from Marja.

Each of these 'requirement' inferences projects through negation, supporting a presuppositional diagnosis (per the 'family of sentences' tests; Chierchia and McConnell-Ginet 1990).

(7) a. I did not **dare** to open an umbrella indoors. → *I did not open an umbrella.*
presumes: Opening an umbrella indoors requires daring.

b. Mr. Sinha did not **condescend** to meet with the tainted persons.
→ *Mr. Sinha did not meet with the tainted persons.*
presumes: Meeting the tainted persons required Mr. Sinha's condescension.

c. Hän e-i **viitsi-nyt** vastat-a.
he.NOM NEG-3SG bother-PP.SG answer-INF

[1]Examples marked with γ were found on the internet (Horn, 2010). Sources are given in the appendix.

'He didn't **bother** to answer.' → *He did not answer.*
presumes: Answering required him to take an interest.

d. Marja e-i **maltta-nut** odotta-a
Marja NEG-3SG have.patience-SG.PP wait-INF
'Marja did not have the patience to wait.' → *Marja didn't wait.*
presumes: Waiting required patience from Marja.

Extrapolating from these data allows us to establish analytical desiderata for a satisfactory account of implicative semantics. I take it as uncontroversial that implicatives indicate that some prerequisite condition must be satisfied in order for their complements to be realized. Based on the data in (6)-(7), these prerequisites involve properties which the implicative subject can realize (act on) in pursuit of complement realization. Building on an observation from Karttunen (2014), then, I suggest that verbs in the implicative class minimally background the existence of a *potential obstacle*, which must be overcome—by means of some prerequisite action—if the implicative complement is to be realized.

From this perspective, the chief dimension of semantic variation between verbs lies in what is lexicalized about the nature of the implicative obstacle—or rather, about the sort of activity that is needed to overcome it. The verbs in (6)-(7) are all specific in their characterization of this activity; *manage* and *onnistua* ('succeed', 'manage'; 2), on the other hand, are not. Despite this, *manage* and *onnistua* conform to the prerequisite generalization, insofar as Karttunen and Peters's presumption of effort might readily follow from a presupposition or background specification which indicates the existence of a potential obstacle for complement realization, but which is not precise about either the obstacle or the means by which it can be overcome.

I take the following to be the central facts about implicative meaning at the class level:

(A) $I(x, P)$ conditions the realization of $P(x)$ on x overcoming a *potential obstacle* for $P(x)$. This conditioning relationship blocks entailment from $P(x)$ to $I(x, P)$.

(B) Asserting $I(x, P)$ non-defeasibly conveys (entails) $P(x)$; $\neg I(x, P)$, conveys (entails) $\neg P(x)$

(C) Given (B), overcoming the potential obstacle to $P(x)$ (by fulfilling some prerequisite condition) is both *sufficient* and *necessary* for x to realize $P(x)$ in context

The negated examples in (7) provide evidence that the conditioning relationship in Fact A belongs to the projective (*not at-issue*; Potts 2005) content of an implicative. In developing a treatment of implicative semantics, the task is now to determine the precise division of semantic labour which can capture Facts A-C across the full range of verbs.

2.2 Direct assertion and its discontents

The overwhelming majority of work on implicatives has focused on the semantics of English *manage* (Givón, 1973; Coleman, 1975; Karttunen and Peters, 1979; Baglini and Francez, 2016, among others).[2] Karttunen and Peters's proposal, given in (8), remains the best known of these accounts. Taking ostensible justification from Karttunen's (1971)'s observation that "all that takes place when John *manages to do* something is that he does it [...]" (1971; pp.349–350), Karttunen and Peters propose that *manage* asserts only the semantic content of its reconstructed complement, but adds to this the presupposition that realizing this complement was difficult or

[2]With the notable exception of Flint (1980), there has been little systematic investigation of the rich Finnish implicative paradigm.

effortful for the implicative subject.[3] I refer to this as the 'direct assertion' account, since it holds that *manage*'s characteristic complement entailments arise, directly, as the asserted content of an implicative claim.

(8) **The direct assertion account of *manage*.** (Karttunen and Peters, 1979).
Given an agent x and a one-place predicate P, *x managed to P*:

i. *Asserts:* x did $P(x)$ $(P(x) = 1)$

ii. *Presupposes:* $P(x)$ was effortful for x

We have already seen that the requirement (effort) inference in (8)ii projects through matrix negation. Additional support for Proposal (8) comes from the embedded use of *manage* in (9):

(9) I just discovered that Solomon **managed** to build the temple.

a. *Entails:* I just discovered that Solomon built the temple.

b. *Does not license:* I just discovered that building the temple was effortful for Solomon.

c. *Licenses:* Building the temple was effortful for Solomon.

The embedding verb in (9), *discover*, belongs to Karttunen's (1973) class of presupposition 'holes'. It is therefore expected to embed any entailments of its complement clause, but to project the presuppositions of its complement without modification. This is precisely what we see in (9) for the proposed implications of *manage*. In using (9), a speaker naturally conveys that the building of the temple is a new discovery, thus embedding (8)i under *discover*. The speaker is further committed to the truth of the unembedded presupposition (9c), but not to the embedded presupposition in (9b).

Despite the success of these predictions, and despite Karttunen and Peters's apparent initial success in capturing both the projective effort inference (Fact A, broadly construed) and the two-way pattern of complement entailment associated with *manage* (Fact B), several challenges remain for the direct assertion account which call into question not only the content of (8)i-ii, but also the proposed division of semantic labour between asserted and projective content. As I argue below, these challenges motivate turning to an alternative approach.

First, while the effortfulness of the *manage* complement can reasonably be identified as a potential obstacle to its realization, it is not immediately clear from (8) how the effort requirement proposed by Karttunen and Peters should be related to the prerequisite condition which is both necessary and sufficient for overcoming the potential obstacle (and thus for realizing an implicative's complement, per Fact C). For verbs like *dare* or *malttaa* ('have the patience'), a lexically-specified prerequisite (daring or patience, respectively) is understood to be present where the implicative complement is realized (whence the sufficiency relationship), and absent where the complement fails (giving rise to necessity; see Section 4.2 for further discussion).

(3) a. Ana **dared** to enter the cave. → *Ana entered the cave.*
presumes: Daring was required for Ana to enter the cave.
indicates: Ana was daring (and so she entered the cave).

b. Ana did not **dare** to enter the cave. → *Ana did not enter the cave.*
presumes: Daring was required for Ana to enter the cave.
indicates: Ana was not daring (and so she did not enter the cave).

[3] In Karttunen and Peters (1979), the effort inference is described as conventional implicature rather than presupposition; however, since one of the goals of that paper is to unify projective phenomena, the change in label is perhaps not that significant. I do not provide a detailed adjudication between the two classifications here, but take the view that the projective content of implicatives seems to align less closely with current theories of conventional implicature (e.g. Potts, 2005) than with the admittedly heterogeneous behavior of presuppositions (see Tonhauser et al., 2013).

(10) a. Marja **maltto-i** odotta-a.
Marja have.patience-PST.3SG wait-INF
'Marja had the patience to wait.' → *Marja waited.*
presumes: Patience was required for Marja to wait.
indicates: Marja was patient (and so she waited).

b. Marja e-i **maltta-nut** odotta-a.
Marja NEG-3SG have.patience-SG.PP wait-INF
'Marja did not have the patience to wait.' → *Marja didn't wait.*
presumes: Patience was required for Marja to wait.
indicates: Marja was not patient (and so she did not wait).

Insofar as a *manage* claim indicates effort on the subject's part regardless of matrix (or complement) polarity, effort does not seem to bear the same relationship to the realization of a *manage* complement as the necessary and sufficient prerequisites of lexically-specific implicatives bear to their complements: compare (11) to (3), (10).

(11) a. Solomon **managed** to build the temple. → *Solomon built the temple.*
indicates: Solomon worked toward/put effort into building the temple.

b. Solomon did not **manage** to build the temple.
→ *Solomon did not build the temple.*
indicates: Solomon worked toward/put effort into building the temple.

To make matters worse, the effort inference in (8)ii may not even capture the full range of projective content associated with *manage* claims. Givón (1973) suggests, for instance, that *manage* instead presupposes that its subject actively and intentionally tried to bring about the complement; a weaker form of this inference isolates intentionality. Both inferences seem to be licensed by (11), and both project through matrix negation:

(11) a. Solomon **managed** to build the temple.
i. *Licenses:* Solomon tried to build the temple.
ii. *Licenses:* Solomon intended to build the temple.

b. Solomon did not **manage** to build the temple.
i. *Licenses:* Solomon tried to build the temple.
ii. *Licenses:* Solomon intended to build the temple.

Coleman (1975) further complicates the picture by observing that *manage* can be felicitous in contexts which support neither effort nor intention on the part of the subject:

(12) a. Harry **managed** to insult Ursula without even trying.
b. Harry's dog **managed** to wake him up every time he fell asleep on the couch.
c. My neighbors **managed** to schedule their one wild party of the year on the night before my exam.

(12a) explicitly denies that Harry attempted to insult Ursula—and, accordingly, suggests that doing so was not effortful. (12b) is acceptable whether or not the dog intends to wake Harry, and (12c) certainly does not require that the neighbors meant to cause problems for the speaker, nor that it took any particular effort from them to do so.

To explain these data, Coleman suggests that the 'vanishing' effort and intention inferences are in each case supplanted by a weaker presupposition—namely, that realizing the complement was *a priori* unlikely. Her idea is that the presuppositional contribution of *manage* varies systematically between the three options in (13): intention, effort/difficulty, and unlikeliness.

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

a. Solomon intended to build the temple.

b. Building the temple required effort for Solomon.

c. It was unlikely that Solomon would build the temple.

On Coleman's view, presuppositional variation is governed by a strength-based ordering of (13a)-(13c), with intention as the strongest possible presupposition, followed by effort, and only then by unlikeliness. In any given context, the strongest tenable presupposition is expected to hold, subsuming the weaker ones (see also Fillmore 1975 on *frame theories* of meaning). Thus, if intention is ruled out, as in (12a), we might instead expect a presupposition of effort.[4] If effort also fails, then the context must support unlikeliness. In other words, Coleman predicts *manage* to be infelicitous if—and only if—unlikeliness (the weakest presupposition) fails.

Baglini and Francez (2016) show that these hierarchically-ordered presuppositions do not provide a satisfactory general account of the malleable not at-issue contribution of *manage*. It is crucial for Coleman that the validity of a stronger presupposition necessitates the validity of the weaker ones (see also Dalrymple et al., 1998, p.198). Against this requirement, Baglini and Francez provide natural examples which show that *manage* can be felicitous in contexts that support one of the intention, effort or unlikeliness inferences, to the exclusion of the others.[5] (14a)-(14c) illustrate the same point: each example precludes one or more of the proposed presuppositions, while leaving the others intact. Crucially, *manage* can be felicitous in contexts where Coleman's weakest potential presupposition (complement unlikeliness) fails.

(14) a. #Without intending to, Ms. Streisand actually managed to synthesize the problem of diversity mania.
$\not\rightsquigarrow$ intention, $\not\rightsquigarrow$ difficulty, $\rightsquigarrow$ unlikeliness

b. #By 1998, four years after a federal ban on assault weapons took effect, gun manufacturers had easily managed to bypass the laws by making small alterations to their weapons.
$\rightsquigarrow$ intention, $\not\rightsquigarrow$ difficulty, ? $\rightsquigarrow$ unlikeliness

c. #The social democrats (Socialdemokratiet) managed to strengthen their position as Denmark's strongest political force as expected during local elections.
$\rightsquigarrow$ intention, ? $\rightsquigarrow$ difficulty, $\not\rightsquigarrow$ unlikeliness

Thus, while it seems clear that *manage* places (not at-issue) constraints on its utterance context (as per Karttunen 1971), it is evidently difficult to offer a precise characterization of these constraints. One explanation suggests itself immediately: it might simply be the case that the inferences so far proposed have been too specific. If this is correct, then the way forward involves adopting a more general view of *manage*'s presupposition—in other words, establishing a presupposition which distills presumptions of intention, difficulty/effort, unlikeliness, etc., down to some common semantic core. Such a presupposition would, ideally, capture the impression that realizing the implicative complement is in some way nontrivial (see also Bhatt 1999), but remain general enough to capture inferences of intention, effort/difficulty, or unlikeliness as reflexes of the specific contexts in which they arise.

[4] Coleman (1975) focuses on *manage*, but argues that implicatives like *happen* and polarity-reversing *fail* (see Section 5.4) also invoke strength-ordered presuppositional content; she suggests that ranked presuppositions (along with complement entailment) are thus an implicative class feature.

[5] Examples (1a)-(1b) are from Baglini and Francez (2016): (1a) explicitly denies difficulty, but nevertheless presumes effort, and (1b) denies unlikeliness, but supports both effort and intention.

(1) a. Clad in civilian clothes and having passports, they easily **managed** to get back over the Volga.

b. Now it's becoming obvious that Fork will **manage** to kill someone important.

Setting aside the puzzle of malleable presuppositions, a perhaps more fundamental problem for Proposal (8) remains. This has to do with the structure of asserted content. According to Karttunen and Peters, *manage* itself contributes nothing to the at-issue dimension, instead simply co-opting the asserted content of its complement proposition. While this evidently predicts the desired two-way pattern of complement entailment (Fact B), it cannot explain the behaviour of *manage* claims under specific types of adverbial modification.

Karttunen (1971) observes that temporal and locative modifiers attached to the main implicative claim are straightforwardly 'inherited' by the complement:

(15) a. Yesterday, Mika **managed** to solve the riddle.
→ *Yesterday, Mika solved the riddle.*

b. At the door, Juri finally **managed** to apologize.
→ *At the door, Juri finally apologized.*

The entailments in (15) are consistent with the direct assertion account, insofar as any at-issue modification of the *manage* claim should apply directly to its at-issue content (i.e., the complement proposition).

The pattern fails, however, when *manage* is modified by a *because*-adverbial. (16a) does not license an inference to its modified complement: the modifying *because*-clause in fact receives an altogether different (default) interpretation when applied to the *manage*-complement in (16b).

(16) a. Juno **managed** to open the safe because it was unlocked.

b. Juno opened the safe because it was unlocked.

In (16a), the modifying *because*-clause is naturally interpreted as explanatory, indicating how or why Juno succeeded in opening the safe (in other words, providing information about how a potential obstacle was circumvented). In (16b), however, the same clause supplies information about Juno's motivation—suggesting, for instance, that her actions were guided by idle curiosity. These two interpretations are largely complementary: the explanatory reading is at best marginal for (16b), and the motivational reading is ruled out for (16a).

This is unexpected if *manage* and its complement make identical at-issue contributions, as the implicative and complement claims should then behave the same way under all processes that modify asserted content. The simplest explanation for the contrast in (16) is that the proposed assertion (8)i of the direct assertion account is incorrect: i.e., that either the implicative or its complement asserts something that the other does not.

2.3 An alternative approach

Baglini and Francez (2016) offer a new approach to implicative *manage* which aims to address the problems with a 'direct assertion' analysis. Although I will argue that their proposal must be significantly revised, the implicative semantics I ultimately propose builds on its key innovations. It is, therefore, well worth setting out Baglini and Francez's analysis in some detail, and considering how it improves on Karttunen and Peters (1979) with respect to the desiderata established in Section 2.1 (Facts A-C), as well as where it falls short. I begin here with a brief informal overview of Baglini and Francez's 'catalyst' account of *manage*. Section 3 then introduces the relevant technical machinery, Section 4 offers a detailed evaluation of Proposal (17), and Section 5 offers a new analysis that addresses the issues identified in Section 4.

The first major innovation of Baglini and Francez's approach is in its treatment of implicative assertions. Baglini and Francez argue that the *because*-clause contrast illustrated in (16) is evidence of a non-trivial difference between the at-issue contribution of a *manage* claim and that

of its bare (reconstructed) complement. Consequently, they propose a new division of labour between *manage*'s assertion and presupposition: on their analysis, the truth of the implicative complement is crucially not directly asserted by *manage*, but instead derived (as entailment) from the joint effect of presupposition and assertion. The revised account I propose in Section 5 differs from Proposal (17) in the specific content of both presupposition and assertion, but sides with Baglini and Francez over Karttunen and Peters in treating complement entailments as derived (rather than directly asserted) consequences of implicative claims.

In parallel with their adjustments to (not) at-issue structure, Baglini and Francez take a broad view of the apparent malleability of *manage*'s presuppositions, arguing that the data in (12)-(14) can be explained by taking the not at-issue contribution of *manage* to be relatively abstract in nature. Since—as per (12)-(14)—what *manage* projects varies with contextual cues, Baglini and Francez argue that such an 'abstract' presupposition should be formulated in a manner which lends itself easily to context-driven pragmatic enrichment.

The central insight of Proposal (17)—and an element which is retained in my own proposal in Section 5—is that implicative presuppositions operate by imposing causal constraints on the relationship between the context situation and the realization of a particular complement proposition. The catalyst proposal in (17) achieves this by backgrounding a relationship of causal necessity and causal insufficiency between (a set of) established facts in the utterance context and the *manage*-complement. The causal link is completed via the proposed assertion in (17)ii, which establishes that the relevant background situation *actually caused* the complement to occur. Informally speaking, Baglini and Francez take *manage* to assert that a particular causally-relevant background situation was efficacious in the reference context (i.e., precipitated the actual realization of the complement), while negating *manage* denies efficacy (resulting in non-realization of the complement).

(17) **The catalyst account of *manage*.** (Baglini and Francez, 2016)
Given an agent x and a one-place predicate P, x *managed to* A:

i. *Presupposes:* The familiarity (salience and truth) of a **catalyst**, or *causally necessary but causally insufficient situation*, for the truth of $P(x)$

ii. *Asserts:* The catalyst **actually caused** $P(x)$

Proposal (17) thus treats implicative complement entailments as causally-derived consequences of the main assertion, distinguishing $manage(x, P)$ assertorically from its complement $P(x)$ while maintaining an explanation of the characteristic implicative entailment pattern. Moreover, since (17)i only requires the existence of a particular causal dependence relationship, but does not specify details about the make-up of a catalyst situation (or about what might help or hinder its efficacy), Proposal (17) appears to offer an intuitive pragmatic account of the enrichments to projective content observed in (12) and (14).

The real test of Proposal (17) rests in the precise formulation of its key causal dependence relations: *causal necessity, causal (in)sufficiency,* and *actual cause*. Following Baglini and Francez, I introduce Schulz's (2011) **causal dynamics** framework as a basis for the relevant definitions and the technical machinery employed in the rest of the paper. Section 4 returns to a detailed formal examination of the catalyst proposal, arguing that, while Baglini and Francez improve substantially on the earlier direct assertion approach and broadly succeed in deriving the main implications of *manage*, the account remains incomplete. More importantly, although the general notion of a catalyst does (at least at first) appear to capture the relative 'non-specificity' (or semantically-bleached nature) of *manage*, as compared to implicatives like *dare* (3) and *malttaa* ('have the patience'; 10), its formulation in Proposal (17) prevents the account from extending naturally to the treatment of lexically-specific verbs, and thus to a class-level treatment of im-

plicative semantics. Consequently, I will argue that the proposed causal relationships (between background information, assertion, and the implicative complement) must be revised.

3 Modeling causal dependencies

This section introduces the notion of a **causal model**. My aim in so doing is to demonstrate that relations which can be articulated over the structure of a causal model play an explanatory role in semantic inference. The choice in particular of Schulz's (2011) dynamics framework, which belongs to the school of **structural equation modeling** (SEM) developed by Pearl (2000), is motivated by a desire for mutual intelligibility with a growing body of work employing causal models as a tool for semantic analysis (including, but not limited to, Baglini and Francez 2016). As far as I am aware, nothing in the following discussion hinges fundamentally on the use of SEM, and the types of models built within this framework are certainly not the only ones which support an approach on which linguistic causation subsumes multiple distinct causal dependency relations.[6] In the interests of focusing on the main investigation, however, I leave the exploration and comparative evaluation of modeling alternatives as a topic for future research (see, e.g., Wolff and Song 2003; Sloman et al. 2009; Livengood and Rose 2016 for relevant experimental work).

3.1 Preliminary remarks

The use of causal models is motivated in part by a need to distinguish between causal relations of necessity and sufficiency and their alethic or metaphysical counterparts (Nadathur and Lauer, 2020). Causal necessity and sufficiency describe relationships that hold when consideration is restricted to particular courses of events—intuitively, those which are 'normal' or 'stereotypical', insofar as they proceed according to a set of expectations based on (established) facts about the world, and generalized knowledge of the typical consequences of these facts. Reasoning about causal expectations relies on three things: a starting context (or set of facts about the world), a set of (relevant) causal laws, and a mechanism for using the latter to derive the causal consequences of the former.

Consider the following scenario:

(18) **The automated door scenario.**

a. Ria is in a subway train which has an automated door. She can open the door just in case (a) she presses the 'open' button, and (b) the train is at a standstill.

b. At the moment, the train is at a standstill, and Ria has not pressed the button.

In this example, (18a) describes a relevant set of causal laws, and (18b) provides a specific starting (background) context. Taking (18a) and (18b) together leads us naturally to certain conclusions about the state of the door: we expect that the door will not open in this context, unless Ria presses the button before the train begins to move. We derive these expectations, intuitively, by applying the causal laws in (18a) to work out the *normal causal consequences* of the situation in (18b).

A structural equation causal model is one way of formalizing this type of reasoning (Pearl, 2000). The basic components of such a model are a set of unvalued propositional variables (broadly representing states and/or events, which may be indexed to worlds and times), and a set of causal arrows linking these variables. The model is thus a network of directed (one-way) links between propositional variables, in which the existence of a particular arrow indicates

[6] This is sometimes described as a *pluralistic* view, to contrast it with approaches that associate all (lexical) causal meaning with a single dependence relation (e.g., CAUSE; Dowty 1979).

that a true or false valuation of its origin variable exerts a causal influence on the value of its destination. I take the relation of *causal relevance*, as represented by such arrows, to be atomic within a mental model of causation.

In this framework, a minimal representation for (18) involves three propositional variables. Let the opening of the door be represented by variable O, so that an assignment of 1 (true) to O corresponds to the door being open, and an assignment of 0 corresponds to the door being closed; u-valuation indicates that the state of the door is undetermined or unknown. Similarly, let B represent whether or not Ria has pressed the button, and S whether or not the train is at a standstill. Per (18a), the value of O depends on the values of B and S; B and S do not depend on any other variables. Figure 1 provides a corresponding graphical representation.

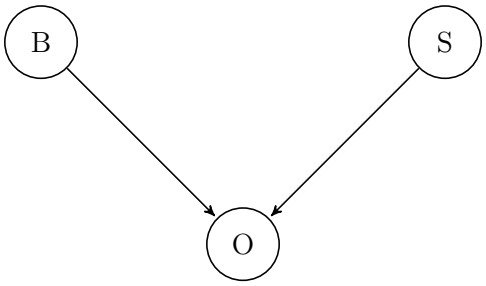

Figure 1: Network model for the automated door

Figure 1 does not capture all of the information in (18a), since it does not specify the nature of the dependencies between O, B, and S. This information is provided by (a set of) *structural equations*, in this case specifying that O will take value 1 just in case B and S are both 1-valued. We can write this as $O := B \wedge S$ or the equivalent truth table in (19).

(19) Structural equation(s) for the automated door:

B	S	O
0	0	0
0	1	0
1	0	0
1	1	1

Since (18) involves only one causally dependent variable (the state of the door), the appropriate minimal causal model includes only one structural equation.

The situation s described by (18b) assigns the value 0 to B and 1 to S. This corresponds to the second line of the truth table in (19); thus, assuming that the evaluation world is causally normal, we conclude that, as a consequence of s, the train door should not be open. This type of reasoning is formalized below as *causal entailment.*

I will treat causal network models as contextually-governed discourse parameters, which intersect with and represent part of the world knowledge of a language user (see also Nadathur 2019; Baglini and Bar-Asher Siegal 2020). Lexically-referenced causal dependence relationships are neither themselves atomic nor reducible to purely logical terms, but instead describe particular configurations of causal relevancies (arrows): *causal necessity* and *causal sufficiency* are thus descriptors (or convenient labels) for relationships which have a recurrent role in linguistic representations; given a particular discourse context, these relations capture presumed structural relationships between salient objects and events.

3.2 Dynamics for causal entailment

Following Schulz (2011), I define a causal **dynamics** as representation of (contextually-relevant) causal laws, together with the formal operations used to calculate causal consequences (normal causal developments) of an initial *situation*. A dynamics induces a particular notion of **causal entailment**, which I will use to define **causal necessity** and **causal sufficiency**, in a conceptual parallel with the relationship between logical necessity and sufficiency and the notion of logical entailment (see also Baglini and Francez).

A *dynamics* encodes the causal structure of a closed system like (18).

Definition 1 (Dynamics)**.** *A **dynamics** is a tuple $\mathcal{D} = \langle \Sigma, \beta, F \rangle$ where:*

(a) Σ *is a finite set of propositional variables*

(b) $\beta \subseteq \Sigma$ *is the set of* background variables*.*

(c) F *is a function that maps elements* $X \in \xi = \Sigma - \beta$ *to tuples* $\langle Z_X, f_X \rangle$*, where*

i. Z_X *is an* n*-tuple of elements of* Σ

ii. $f_X : \{0,1\}^n \rightarrow \{0,1\}$ *is a two-valued truth function from* n*-tuples on* $\{0,1\}$ *to* $\{0,1\}$

F *is* rooted *in* β*.*

Background (or *exogenous*; cf. Pearl 2000) variables are causally independent of the rest of Σ. The complement set ξ of *inner* (*endogenous*) variables depend on one another, as well as on β. For each inner variable X in $\mathcal{D}$, the function F associates X with (a) its set of immediate causal ancestors Z_X (i.e., the set of variables in Σ which originate arrows that terminate at X), as well as (b) the function f_X which encodes the nature of these direct dependencies (i.e., the structural equation pertinent to X). The requirement that F is *rooted* in β precludes circular chains of causation, by ensuring that a 'backwards walk' through the causal ancestors of any variable ends in β. $\mathcal{D}$ therefore comprises a *directed acyclic graph*, together with equations specifying how the values of inner variables depend on the values of their immediate causal ancestors.

Definition 2 (Rootedness)**.** *Let $\beta \subseteq \Sigma$ be a set of proposition letters, and F a function mapping elements of $\xi = \Sigma - \beta$ to tuples $\langle Z_X, f_X \rangle$ as above. Let R_F be the relation that holds between the letters X, Y if $Y \in Z_X$. Let R_F^T be the transitive closure of R_F. F is **rooted** in β if $\langle \Sigma, R_F^T \rangle$ is a poset and β is the set of its minimal elements.*

The graph in Figure 1, together with the structural equation in (19), provides a dynamics $\mathcal{D}_d = \langle \Sigma_d, \beta_d, F_d \rangle$ for the automated door scenario (18). $\Sigma_d = \{B, S, O\}$, with $\beta_d = \{B, S\}$ the set of background variables and the complement set $\xi_d = \{O\}$ as the set of inner (dependent) variables. Function F_d associates O with the set $Z_O = \{B, S\}$ and the function f_O from (19).

Schulz works with the strong three-way Kleene logic (Table 1), in which propositional variables are valued from $\{u, 0, 1\}$. A 0 or 1 valuation is called a **determination**, while a u-valued variable is **undetermined**. A u-valuation can, via causal computation, evolve into a determination, but a determination cannot be 'undone' in the regular course of causal reasoning. I refer to the determination of a single variable as a **fact**; **worlds** and **situations** can be defined in terms of complete valuations of Σ.[7]

[7] Schulz (2011) defines a dynamics over a language, $\mathcal{L}_\Sigma^{\gg}$, which is the union of the standard propositional language $\mathcal{L}_\Sigma$ (the closure of Σ under $\wedge, \vee, \neg$) with sentences of the form $\phi \gg \psi$, where $\phi, \psi \in \mathcal{L}_\Sigma$. Sentences of $\mathcal{L}_\Sigma$ are interpreted according to Table 1, while the interpretation of the (counterfactual) conditional operator $\gg$ is defined in terms of causal entailment (Definition 5). Implicative interpretation should in principle proceed alongside interpretations for $\mathcal{L}_\Sigma^{\gg}$. Since my purpose here is to introduce specific causal dependence relations

X	Y	$\neg X$	$X \vee Y$	$X \wedge Y$
0	0	1	0	0
0	1	1	1	0
0	u	1	u	0
1	0	0	1	0
1	1	0	1	1
1	u	0	1	u
u	0	u	u	0
u	1	u	1	u
u	u	u	u	u

Table 1: Strong Kleene logic

Definition 3 (Worlds, situations, and facts)**.** *Given a dynamics $\mathcal{D}$ over a set Σ:*

*(a) A **fact** is any assignment $\langle X, x\rangle$ where $X \in \Sigma$ and $x \in \{0, 1\}$*

*(b) A **situation** is any function $s : \Sigma \to \{u, 0, 1\}$*

*(c) A **world** is any function $w : \Sigma \to \{0, 1\}$*

Given a situation s, we would like to use the causal laws encoded by $\mathcal{D}$ to calculate relevant causal consequences. Schulz defines an operator $\mathcal{T}_\mathcal{D}$ which 'runs' the dynamics for one step.

Definition 4 (Causal update)**.** *Let $\mathcal{D}$ be a dynamics and s a situation. We define the situation $\mathcal{T}_\mathcal{D}(s)$ by:*

(a) if $X \in \beta$, then $\mathcal{T}_\mathcal{D}(s)(X) = s(X)$

(b) if $X \in \xi$, with $Z_X = \{X_1, \ldots, X_n\}$, then

i. if $s(X) = u$ and $f_X(s(X_1), \ldots, s(X_n))$ is defined, $\mathcal{T}_\mathcal{D}(s)(X) = f_X(s(X_1), \ldots, s(X_n))$

ii. if $s(X) \neq u$ or $f_X(s(X_1), \ldots, s(X_n))$ is undefined, $\mathcal{T}_\mathcal{D}(s)(X) = s(X)$.

Since Σ is finite, finitely many iterations of $\mathcal{T}_\mathcal{D}$ will exhaust the consequences of any situation s, producing a *fixed point* (see Schulz for proof). This result is used to define causal entailment.

Definition 5 (Causal entailment)**.** *Let $\mathcal{D}$ be a dynamics. A situation s **causally entails** a fact $\langle X, x\rangle$ iff the least fixed point s^* of $\mathcal{T}_\mathcal{D}$ relative to s assigns the value x to variable $X \in \Sigma$:*

$$s \models_\mathcal{D} \langle X, x\rangle \text{ iff } s^*(X) = x$$

A situation s thus causally entails a fact $\langle X, x\rangle$ if and only iff the maximal normal causal development of s contains the determination $\langle X, x\rangle$.

The iterated operator $\mathcal{T}_{\mathcal{D}_d}$ formalizes the reasoning we applied to (18b) (where the train is stopped but Ria has not pressed the button) to work out the (causal) consequence that the door remains shut. A single application of $\mathcal{T}_{\mathcal{D}_d}$ to the background situation $s = \{\langle B, 0\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$

within the SEM framework, I do not discuss $\mathcal{L}^{\gg}_\Sigma$, and refer the interested reader instead to Schulz (2007, 2011). In the framework provided here, the standard notion of a *proposition* corresponds to a valued propositional variable, also called a *fact* (Definition 3); $\langle X, 0\rangle$ corresponds to the proposition that X is false, $\langle X, 1\rangle$ to the proposition that X is true, and so on.

involves checking the value of O in the second line of the truth table in (19), and has as its result the situation $\mathcal{T}_{\mathcal{D}_d}(s) = \{\langle B, 0\rangle, \langle S, 1\rangle, \langle O, 0\rangle\}$. Since $\Sigma_d = \{B, S, O\}$, no further updates are possible, and $\mathcal{T}_{\mathcal{D}_d}(s) = s^*$, the least fixed point of $\mathcal{T}_{\mathcal{D}_d}$ on s. Since O is valued at 0 in s^*, we have $s \models_{\mathcal{D}_d} \langle O, 0\rangle$: situation s in (18b) causally entails that the door is shut.

3.3 Causal necessity and causal sufficiency

In identifying and defining causal dependence relations, our focus is on the different ways in which one fact or event can be causally involved in realizing another. Moreover, causes do not act alone. Any claim that cause C *brought about* effect E is necessarily evaluated with respect to a given context: evaluating a causal claim requires us to assess whether or not adding the occurrence of C to the set of established facts has the right sort of consequence for the realization of E. Binary causal dependence relations are therefore defined relative to a background situation.

Definition 6 (Augmenting a situation with a fact)**.** *Given a situation s and a fact $\langle X, x\rangle$, the situation $s[X \mapsto x]$ (re)assigns the value of X to x, but is otherwise identical to s.*

Augmenting a situation s with a fact $\langle X, x\rangle$ overrides an existing determination for X. We will usually be concerned with cases where the *domain* of s, defined below, does not contain X.

Definition 7 (Domain of a situation)**.** *The **domain** of a situation s is given by*

$$\mathrm{dom}(s) = \{X \in \Sigma \mid s(x) \neq u\}$$

Definition 8 (Supersituation)**.** *Given two situations, s and s', s' is a **supersituation** of s iff $\mathrm{dom}(s') \supseteq \mathrm{dom}(s)$ and for all $X \in \Sigma$ such that $X \in \mathrm{dom}(s)$, we have $s'(X) = s(X)$.*

Finally, the dynamics induces a notion of *consistency*, so that a situation is internally causally consistent if it contains no determination which breaks the causal rules with respect to the other determinations. A supersituation s' of a given situation s (internally consistent or otherwise) is *consistent with* s just in case s does not causally entail the negation of any determinations in s' which are not also determinations in s.

Definition 9 (Causal consistency)**.** *Let $\mathcal{D}$ be a dynamics for Σ.*

*(a) A situation s is **causally consistent** iff, for inner variables $X \in \xi = \Sigma - \beta$ such that $X \in \mathrm{dom}(s)$, we have:*

$$s[X \mapsto u] \not\models_{\mathcal{D}} \begin{cases} \langle X, 0\rangle & \text{if } s(X) = 1 \\ \langle X, 1\rangle & \text{if } s(X) = 0 \end{cases}$$

*(b) A situation s has a **consistent supersituation** s' iff s' is a supersituation of s and for all inner variables X such that $X \in \mathrm{dom}(s') - \mathrm{dom}(s)$, we have:*

$$s \not\models_{\mathcal{D}} \begin{cases} \langle X, 0\rangle & \text{if } s'(X) = 1 \\ \langle X, 1\rangle & \text{if } s'(X) = 0 \end{cases}$$

We can now define binary relations of causal necessity and sufficiency. Causal sufficiency of one fact $\langle X, x\rangle$ for another $\langle Y, y\rangle$ reduces to causal entailment, once the background situation s is augmented by $\langle X, x\rangle$. Causal necessity with respect to s captures the idea that the only causally consistent paths from s to the validation of $\langle Y, y\rangle$ involve (first) validating $\langle X, x\rangle$.

Definition 10 (Causal necessity and sufficiency of facts)**.** *Let $\mathcal{D}$ be a dynamics for Σ. Let s be a situation and let $\langle X, x\rangle, \langle Y, y\rangle$ be facts such that $s \not\models_{\mathcal{D}} \langle X, x\rangle, s \not\models_{\mathcal{D}} \langle Y, y\rangle$. Then:*

*(a) $\langle X, x\rangle$ is **causally sufficient** for $\langle Y, y\rangle$ relative to s iff $s[X \mapsto x] \models_{\mathcal{D}} \langle Y, y\rangle$. We write $\langle X, x\rangle \triangleright_s \langle Y, y\rangle$*

*(b) $\langle X, x\rangle$ is **causally necessary** for $\langle Y, y\rangle$ relative to s iff:*

i. there is a consistent supersituation s' of $s[X \mapsto x]$ such that $Y \notin \mathrm{dom}(s')$ and $s' \models_{\mathcal{D}} \langle Y, y\rangle$

ii. there is no consistent supersituation s' of s such that $Y \notin \mathrm{dom}(s')$ and $s' \models_{\mathcal{D}} \langle Y, y\rangle$ but $s' \not\models_{\mathcal{D}} \langle X, x\rangle$

We write: $\langle X, x\rangle \triangleleft_s \langle Y, y\rangle$.

These definitions capture intuitive ideas about (fact-based) necessity and sufficiency. Per 10a, causal sufficiency guarantees that a cause $\langle X, x\rangle$ completes a causal pathway for the effect $\langle Y, y\rangle$, thereby guaranteeing $\langle Y, y\rangle$. Causal necessity in 10b, on the other hand, simply 'opens up' the possibility of $\langle Y, y\rangle$; within a dynamics, a necessary cause $\langle X, x\rangle$ makes available one or more consistent pathways to $\langle Y, y\rangle$ (which were unavailable in the absence of the valuation $\langle X, x\rangle$). Insofar as $\langle X, x\rangle$ does not ensure $\langle Y, y\rangle$, there is an evident conceptual similarity between Definition 10b and a standard notion of counterfactual necessity.

I return to the automated door scenario to illustrate these definitions. Instead of the original situation in (18b), however, let us consider a different context, s_S, in which we know only that the train is currently at a standstill: $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$. In this context, pressing the 'open' button (i.e., determining $\langle B, 1\rangle$) is both causally necessary and causally sufficient for opening the door ($\langle O, 1\rangle$).

(20) **Fact-based causal dependencies in the revised door context.**

a. *Claim* (Causal sufficiency). Given $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$, $\langle B, 1\rangle \triangleright_{s_S} \langle O, 1\rangle$

1. Since, as illustrated in Figure 1, the value of O depends on the values of both B and S, s_S does not causally entail a determination for O. This satisfies the precondition in Definition 10, since $s_S \not\models_{\mathcal{D}_d} \langle O, 1\rangle$.
2. Augmenting s_S with fact $\langle B, 1\rangle$, results in a new situation $s'_S = s_S[B \mapsto 1] = \{\langle B, 1\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$. Situation s'_S corresponds to the fourth line of (19), where O takes value 1. Since the resulting situation $\mathcal{T}_{\mathcal{D}_\mathrm{d}}(s'_S) = \{\langle B, 1\rangle, \langle S, 1\rangle, \langle O, 1\rangle\}$ determines all of Σ_d, we have $\mathcal{T}_{\mathcal{D}_d}(s'_S) = s^*_S$, the least fixed point of s'_S on $\mathcal{T}_{\mathcal{D}_d}$.

Thus, $\langle O, 1\rangle$ is causally entailed by $s'_S = s_S[B \mapsto 1] = \{\langle B, 1\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$, and $\langle B, 1\rangle \triangleright_{s_S} \langle O, 1\rangle$.

b. *Claim* (Causal necessity). Given $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$, $\langle B, 1\rangle \triangleleft_{s_S} \langle O, 1\rangle$
Since the precondition $s_S \not\models_{\mathcal{D}_d} \langle O, 1\rangle$ holds, as per (20a), checking the causal necessity of $\langle B, 1\rangle$ for $\langle O, 1\rangle$ relative to s_S requires us to check only two more things.

1. For condition (i) in Definition 10b, consider the consistent supersituation s'_S of $s_S[B \mapsto 1]$ such that $s'_S = s_S[B \mapsto 1] = \{\langle B, 1\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$. $O \notin \mathrm{dom}(s'_S)$, and we have that $s'_S \models_{\mathcal{D}_d} \langle O, 1\rangle$ from above.
2. For condition (ii), we consider alternative consistent supersituations s''_S of $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$ which satisfy $O \notin \mathrm{dom}(s''_S)$. The only such s''_S available, given s_S and Σ_d, is the situation which maps B to 0 (i.e., in which the button is not pressed); $s''_S = \{\langle B, 0\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$. This is the situation described in (18b); we have already seen that $s''_S \models_{\mathcal{D}_d} \langle O, 0\rangle$, and so condition (ii) is satisfied.

Since $s'_S = s_S[B \mapsto 1]$ has a consistent supersituation (i.e., s'_S itself) which causally entails $\langle O, 1\rangle$, and s_S has no consistent supersituations which causally entail $\langle O, 1\rangle$ but not $\langle B, 1\rangle$, both conditions for causal necessity relative to s are satisfied, and $\langle B, 1\rangle \lhd_{s_S} \langle O, 1\rangle$,

It is essential that Definitions 10a-b are relativized to background situations which are not themselves sufficient for either cause or effect. In the case of causal sufficiency, if we allow the causing fact to be causally entailed by the background situation, we must also allow the effect to be entailed (since adding the causing fact is sufficient for the effect). The consequence of this is that any fact in a cause-entailing background situation becomes sufficient for the effect, even if it is not a causal ancestor of the effect. Allowing only the effect to be entailed by the background situation also causes problems: in this case, any fact not entailed by the background situation becomes sufficient for the effect. In the case of causal necessity, allowing the background situation to entail either cause or effect means that the background situation itself makes available a consistent causal pathway to $\langle Y, y\rangle$, obviating the causal role of $\langle X, x\rangle$.

3.4 Causal dependence relations for the catalyst proposal

Thus far, I have introduced the notions of a dynamics, causal entailment, and causal dependence relations between facts (with respect to a given background situation). These definitions will ultimately be put to work in the central proposal of this paper, introduced in Section 5. However, the definitions in 10 are not precisely the same as those needed to cash out Baglini and Francez's (2016) catalyst proposal (17): Baglini and Francez propose related but distinct notions of causal necessity and sufficiency between a situation (the catalyst) and a particular fact (the *manage* complement), as well as a relation of *actual cause*, which relates a situation and a fact in a given world. I provide these definitions below, before turning to a discussion of the catalyst proposal.[8]

Causal sufficiency of a situation for a fact is again a straightforward application of causal entailment: situation s is causally sufficient for a fact $\langle X, x\rangle$ just in case the truth of s guarantees the determination x for X. Causal necessity is more complicated, since it requires considering the consequences of revising the valuations of (causally-relevant) facts from the established context.

Definition 11 (Causal ancestors)**.** *Let $\mathcal{D}$ be a dynamics over Σ. Given a variable $X \in \xi = \Sigma - \beta$, the set of **causal ancestors** of X is given by* $\mathrm{Anc}(X) = \left\{ Y \in \Sigma \;\middle|\; R_F^T(X, Y) \right\}$*, where R_F^T is the transitive closure of the immediate ancestor relation R_F, as given in Definition 2.*

Definition 12 (Causal necessity and sufficiency of situations)**.** *Let $\mathcal{D}$ be a dynamics over Σ. Let s be a situation and let $\langle X, x\rangle$ be a fact.*

*(a) s is **causally sufficient** for $\langle X, x\rangle$ iff $s \models_{\mathcal{D}} \langle X, x\rangle$. We write $s \rhd \langle X, x\rangle$.*

*(b) s is **causally necessary** for $\langle X, x\rangle$ iff, for any situation s' with:*

i. $\mathrm{dom}(s) \cap \mathrm{Anc}(X) \subseteq \mathrm{dom}(s') \cap \mathrm{Anc}(X)$ *and*

ii. $\exists Y \in \mathrm{dom}(s) \cap \mathrm{Anc}(X)$ *with* $s(Y) \neq s'(Y)$ *and*

iii. $s'(X) \neq x$

we have $s' \not\models_{\mathcal{D}} \langle X, x\rangle$. We write $s \lhd \langle X, x\rangle$.

[8] Definitions 12a and 13 are equivalent to *causal sufficiency* and *actual cause* in Baglini and Francez (2016); 12b differs slightly from Baglini and Francez's original *causal necessity*. The update, due to Nadathur (2019), is a 'friendly' amendment to the original; it handles a technical edge case and does not affect the overall function of the catalyst proposal for *manage*. See Nadathur (2019), Chapter 3, for further explication.

Intuitively, a situation s is causally necessary for a fact $\langle X, x\rangle$ if there is no causally-consistent way to bring about a determination x for X without first making s true: that is, if all causal pathways to $\langle X, x\rangle$ in $\mathcal{D}$ validate the determinations in s. Definition 12 captures this intuitive notion by requiring that for any situation s' which (i) fixes values for all of ancestors of X that s determines, (ii) reverses the truth value that s assigns to some ancestor Y of X, and (iii) does not itself determine (and thus trivially entail) $\langle X, x\rangle$, we have that s' does not guarantee $\langle X, x\rangle$.

Example (21) illustrates Definitions 12a-b using the automated door example.

(21) **Situation-based causal dependence in the automated door scenario.** Let s_S be a situation for the door in (18a) in which the train is at a standstill, but the state of the button and the door are undetermined, $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$. Situation s_S is causally necessary but not causally sufficient for the door to open ($\langle O, 1\rangle$).

a. *Claim* (Causal insufficiency). Given $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$, $s_S \not\Rightarrow \langle O, 1\rangle$.
Situation s_S is causally complete (s_S is its own least fixed point on $\mathcal{T}_{\mathcal{D}_d}$); the only dependent variable in Σ_d is O, and we can only compute a determination for O if both B and S are determined. Consequently, $s^*_S(O) = s_S(O) = u$, and since $s_S \not\models_{\mathcal{D}_d} \langle O, 1\rangle$, we have $s_S \not\Rightarrow \langle O, 1\rangle$ by Definition 12a.

b. *Claim* (Causal necessity). Given $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}, s_S \lhd \langle O, 1\rangle$.

1. We need to consider alternative situations s' which differ from s_S on some determination from $\mathrm{Anc}(O)$, and which also do not determine O. There are three such alternatives, $s_\neg = \{\langle B, u\rangle, \langle S, 0\rangle, \langle O, u\rangle\}, s_B = \{\langle B, 1\rangle, \langle S, 0\rangle, \langle O, u\rangle\}$, and $s_{\neg\neg} = \{\langle B, 0\rangle, \langle S, 0\rangle, \langle O, u\rangle\}$.
2. (a) $s_\neg$ is causally complete, and since $s_\neg(O) = u$, $s_\neg \not\models_{\mathcal{D}_d} \langle O, 1\rangle$.
   (b) By (19), $\mathcal{T}_{\mathcal{D}_d}(s_B) = \{\langle B, 1\rangle, \langle S, 0\rangle, \langle O, 0\rangle\}$; therefore, $s_B \models_{\mathcal{D}_d} \langle O, 0\rangle$.
   (c) By (19), $\mathcal{T}_{\mathcal{D}_d}(s_{\neg\neg}) = \{\langle B, 0\rangle, \langle S, 0\rangle, \langle O, 0\rangle\}$; therefore, $s_{\neg\neg} \models_{\mathcal{D}_d} \langle O, 0\rangle$.

Since all alternative situations s' satisfying conditions (i)-(iii) of Definition 12b are such that $s' \not\models_{\mathcal{D}_d} \langle O, 1\rangle$, we have $s_S \lhd \langle O, 1\rangle$.

Proposal (17) requires one more definition. Per Definition 13, *actual cause* holds between a situation and a fact in a world which makes both true (see Baglini and Francez, p.554).[9]

Definition 13 (Actual cause)**.** *Given a dynamics $\mathcal{D}$, a world w, and a variable $X \in \Sigma - \beta$, a situation s* ***actually causes*** *fact $\langle X, x\rangle$ iff $s(X) = u$, $w(X) = x$, and w is consistent with s^* (the least fixed point of $\mathcal{T}_{\mathcal{D}}$ on s).*

I present one final illustration before turning to a closer examination of the catalyst proposal. Recall that a *catalyst* is defined as a situation which is causally necessary but causally insufficient for a particular proposition ϕ (e.g., the implicative complement). If we take ϕ to correspond to $\langle O, 1\rangle$ (the proposition that the train door is open), then, given $\Sigma_d = \{B, S, O\}$, the situation $s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$ is a potential catalyst for ϕ ($\langle O, 1\rangle$); this is proved in (21). Per

[9] A reviewer rightly observes that Definition 13 is too weak for the general case, as it does not require that the caused fact (or rather the variable which it determines) is causally dependent on $\mathrm{dom}(s)$. Consequently, a situation s_{ir} can *actually cause* an independent fact $\langle X, x\rangle$ (where $X \in \Sigma - \beta$, $\mathrm{Anc}(X) \cap \mathrm{dom}(s_{\mathrm{ir}}) = \emptyset$) in a causally normal world w, as long as facts external to s_{ir} in w are conducive to $\langle X, x\rangle$. This is not ideal: it is intuitively clear that s_{ir} plays no role in bringing $\langle X, x\rangle$ about in w. While this is a problem for Definition 13 in general, it is not really consequential for Baglini and Francez's (2016) account of *manage*, since the catalyst proposal (17) only considers actual causation between a catalyst and a particular proposition (the implicative complement) for which the catalyst is defined to be causally relevant.

A reasonable (and more intuitive) notion of actual cause is a topic of interest in the causal modeling literature, and a range of more developed definitions have been proposed. See, in particular, Pearl (2000), Halpern and Pearl (2005), Halpern (2015), and references therein.

Definition 13, the s_S *actually causes* the door to open in a world w in which s_S and $\langle O, 1\rangle$ both hold; s_S does not actually cause the door to open in a world w' where s_S holds but the door remains closed. Anticipating the discussion in Section 4, the catalyst proposal would predict a context for w in which s_S is salient to be appropriate for a positive use of *manage* (e.g., *Ria managed to open the door*), while the context s_S in w' would license and validate a negative *manage* claim (*Ria did not manage to open the door*).

4 *Manage* and other implicatives

4.1 A closer look at the catalyst proposal

Baglini and Francez's (2016) proposal is restated below:

(17) **The catalyst account of *manage*.**
Given an agent x and a one-place predicate P, x *managed to* P:

i. *Presupposes:* The familiarity (salience and truth) of a **catalyst**, or *causally necessary but causally insufficient situation*, for the truth of $P(x)$

ii. *Asserts:* The catalyst **actually caused** $P(x)$

I assume, with Baglini and Francez, that any utterance context carries as a discourse parameter a dynamics $\mathcal{D}$ which picks out a salient set Σ of propositional variables and encodes the relevant causal relationships between them. Against such a background, (17)i holds that assertions or denials of $manage(x, P)$ are only felicitous in contexts which verify a situation that satisfies Definition 12b but falsifies 12a with respect to the truth of $P(x)$. According to (17)i, then, a *manage* claim can only be uttered when some causally-relevant facts for $P(x)$ have been established, but when these facts are crucially not enough to guarantee $P(x)$'s realization. No such precondition applies to an arbitrary utterance of $P(x)$, so Proposal (17) makes good on Karttunen's (1971)'s suggestion that assertoric equivalence between a *manage* claim and its bare complement is blocked by the implicative's presuppositions.

Turning to (17)ii, the at-issue contribution of *manage* establishes whether or not *actual cause* holds between the 'familiar' catalyst (s) and the implicative complement $P(x)$. According to Definition 13, the polarity of the implicative claim determines whether s and $P(x)$ both hold in the evaluation world (in the positive case), or if at least one of the two fails (in the negative case). Since s is presupposed to hold, affirming actual cause ensures the truth of $P(x)$, giving us an entailment from $manage(x, P)$ to $P(x)$. Under negative matrix polarity, actual cause fails just in case $P(x)$ is false, giving us the entailment from $\neg manage(x, P)$ to $\neg P(x)$.

Recall the desiderata set out in Section 2.1 for an implicative verb I with subject x and complement $P(x)$:

(A) $I(x, P)$ conditions the realization of $P(x)$ on x overcoming a *potential obstacle* for $P(x)$. This conditioning relationship blocks entailment from $P(x)$ to $I(x, P)$.

(B) Asserting $I(x, P)$ non-defeasibly conveys (entails) $P(x)$; $\neg I(x, P)$, conveys (entails) $\neg P(x)$

(C) Given (B), overcoming the potential obstacle to $P(x)$ (by fulfilling some prerequisite condition) is both *sufficient* and *necessary* for x to realize $P(x)$ in context

The catalyst proposal (17) evidently captures Fact B. It also appears to capture (albeit indirectly) the notion of an *obstacle*, central to Facts A and C. By (17)i, any appropriate context for $manage(x, P)$ establishes only a partial cause for $P(x)$. Intuitively, if a catalyst s is to be

efficacious for (i.e., actually cause) $P(x)$ in a world w, s must be supplemented in w by causally-relevant facts which combine (consistently) with s to produce a causally sufficient situation for $P(x)$. The catalyst's insufficiency can therefore be construed as a potential obstacle for complement realization. Assuming that the evaluation world is causally normal (see also Nadathur 2019, pp.296–298), asserting that catalyst s actually caused $P(x)$ tells us whether or not its insufficiency was overcome: whether s was appropriately supplemented, thus realizing $P(x)$, or whether the needed supplementation did not occur, resulting in the failure of $P(x)$.

The final automated door context from Section 3.4 provides a helpful illustration. We saw that the situation s_S in which the train has stopped, but the status of both the button and the door are left undetermined ($s_S = \{\langle B, u\rangle, \langle S, 1\rangle, \langle O, u\rangle\}$) qualifies as a catalyst for $\langle O, 1\rangle$. Given s_S, whether or not the door opens hinges on whether or not Ria presses the door-opening button: the (open) valuation of B thus presents a potential obstacle for $\langle O, 1\rangle$ (see $\mathcal{D}_d$; Figure 1, equation 19). A positive claim (*Ria managed to open the door*) informs us not only that the door opened, but also licenses the inference that Ria pressed the door-opening button (setting $\langle B, 1\rangle$), thereby overcoming the obstacle. A negative claim (*Ria did not manage to open the door*) establishes that the door did not open, and also licenses the inference that Ria did not press the button ($\langle B, 0\rangle$): indeed, that the catalyst failed to actually cause $\langle O, 1\rangle$ *because* Ria did not supplement it in the appropriate, obstacle-overcoming way.

This also illustrates how Fact C is captured by the catalyst proposal. Once catalyst s_S is fixed, the truth value of complement O is fully determined by whether or not Ria presses the button: the fact $\langle B, 1\rangle$ is both causally necessary and sufficient for fact $\langle O, 1\rangle$ relative to s_B (as per Definition 10). In this context, the truth of B plays the role of the Fact C prerequisite whose fulfillment is necessary and sufficient (in context) for the implicative complement.[10]

This result—the existence of a necessary and sufficient obstacle-overcoming prerequisite—is not unique to the automated door scenario, but is a general consequence of Proposal (17). The backgrounded relationship between a familiar catalyst s and complement $P(x)$, together with *actual cause*, requires the existence of some condition which is determinative for $P(x)$ relative to s: given s, realizing this condition precipitates $P(x)$, while its failure (implied by a negative *manage* claim) produces $\neg P(x)$ as a causal consequence.[11] Since s is, by construction,

[10]While Proposal (17) is compatible with the notion of an obstacle, nothing ensures that the implicative subject x plays an active role in overcoming the obstacle, as suggested in Fact A. The causal condition required to supplement catalyst s_S in the door context (i.e., the Fact C prerequisite) does involve action by Ria, but this is an artefact of context, and does not follow from (17). Given $\mathcal{D}_d$, we can easily describe an alternative catalyst $s_B = \{\langle B, 1\rangle, \langle S, u\rangle, \langle O, u\rangle\}$ such that the supplementary (prerequisite) condition—here, $\langle S, 1\rangle$—is not influenced by Ria. Per (17), backgrounding s_B should make *manage* felicitous, even though Ria cannot act to overcome the obstacle (and thereby make s_B efficacious).

A reviewer finds this problematic for (17), but I agree with the prediction: (1a)-(1b) seem reasonable in a context which verifies s_B (i.e., where the efficacy of Ria's button press hinges on whether or not the train stops).

(1) a. Ria managed to open the door (because the train stopped).
b. Ria did not manage to open the door (because the train did not stop).

It is worth noting, however, that whether the context for *manage* verifies s_S or s_B, the complete (sufficient) situation for $\langle O, 1\rangle$ does involve action by Ria. If we redefine variable B so that the button is potentially pressed by someone other than Ria, she ceases to be an appropriate subject for *manage* regardless of the utterance background. Proposal (17) should ideally be revised, then, to require x's active involvement in either the catalyst or some (implicit) supplementary cause for $P(x)$.

It seems to me that felicity in contexts such as s_B, where x is only active in the utterance background, is specific to implicative *manage*. For lexically-specific verbs (discussed in Section 4.2), independently of any involvement in some catalytic background, the implicative subject x must be actively involved in the realization of an obstacle-overcoming prerequisite. This requirement is reflected in Proposal (32), offered in Section 5.

[11]The mandated prerequisite in the door illustration with catalyst s_S comprises the truth of a single variable ($\langle B, 1\rangle$). More generally, the prerequisite condition will be expressible as a sentence α of $\mathcal{L}_\Sigma$ (the closure of Σ

compatible with both $P(x)$ and its negation, it must further be the case that the prerequisite condition is causally relevant for $P(x)$ in $\mathcal{D}$, and that neither its truth nor falsity is entailed or precluded by s alone. In other words, the catalyst proposal indirectly mandates the existence of a catalyst-independent, causally-relevant condition for $P(x)$ whose truth is both unresolved (undetermined) and decisive for $P(x)$ relative to s.[12] The existence of such a condition means that Proposal (17) does in some sense capture Fact C; however, the prerequisite's causal role ultimately calls into question the intuition behind *actual cause*. I discuss the problem at the end of this section. Moreover, as Section 4.2 will show, the fact that the (implicit) prerequisite is not directly targeted (labeled or named) by either (17)i or (17)ii turns out to be a problem for the analysis of lexically-specific implicatives.

Insofar as the catalyst proposal captures Facts A-C (indirectly or otherwise), it represents an improvement over the direct assertion approach (Karttunen and Peters, 1979). Further, Baglini and Francez argue that formulating the not at-issue contribution of *manage* in causal terms also supplies a natural explanation for the context-sensitivity of *manage*'s projective content (cf. Coleman 1975). Since a dynamics is supplied as a discourse parameter, and *manage* does not identify specific propositions which comprise a familiar catalyst (or the associated prerequisite), what is known or uncovered in a specific context can variously support a key role for effort, intention, unlikeliness, or other factors. Example (22) illustrates:

(22) **The opera scenario** ($\mathcal{D}_o$). Suppose that Maya has no prior knowledge of opera, but her best friend (who has two tickets) asks her to go (ASK). Maya never says no to this friend, so she'll go (ATT) if she is asked. Whether or not Maya sits through the opera (STO) depends not only on her making the attempt to do so (ATT), but also on whether or not she dislikes it (DLO), whether or not it takes more than two hours (HRS), and on whether or not she has a drink at the intermission (ALC).

a. Maya **managed** to sit through the opera.

Figure 2 supplies the graphical model for (22), with corresponding equations in (23).

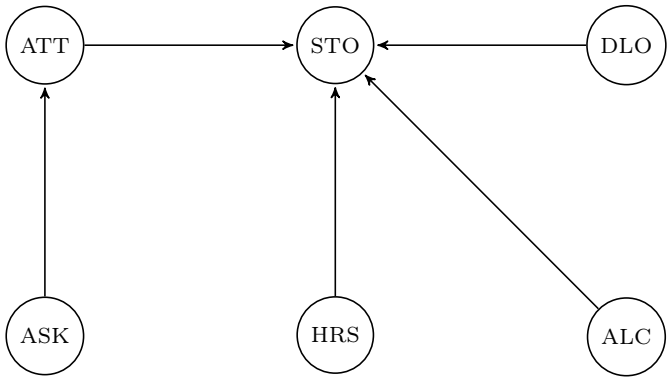

Figure 2: Dynamics $\mathcal{D}_{\text{o}}$ for the opera scenario

under $\wedge, \vee, \neg$). The requirement that α is causally sufficient and necessary for $P(x)$ relative to catalyst s amounts to the two-part claim (a) that any situation s' which consistently augments s with the truth of α (i.e., with a true-making determination of the variables in α) is such that s' causally entails $P(x)$, and (b) that any situation s'' which consistently augments s with a false-making determination for α is such that s'' causally entails $\neg P(x)$.

[12] Given a dynamics $\mathcal{D}$ for Σ, and two distinct variables $X, Y \in \Sigma$, X is *causally independent* of Y if $Y \notin \text{Anc}(X)$. X is causally independent of a situation s iff, for all $Y \in \text{dom}(s)$, X is causally independent of Y. Finally, a sentence $\alpha \in \mathcal{L}_\Sigma$ is causally independent of situation s iff some variable X which occurs in α is causally independent of s (so that s does not value α).

(23) Structural equations for $\mathcal{D}_o$:

a. $\textsc{att} := \textsc{ask}$

b. $\textsc{sto} := \textsc{att} \wedge (\neg\textsc{dlo} \vee \neg\textsc{hrs} \vee \textsc{alc})$

Given $\mathcal{D}_o$, the situation $s_{\textsc{ask}}$ which verifies only her friend's request represents a catalyst for Maya sitting through the opera: ($\mathrm{dom}(s_{\textsc{ask}}) = \{\textsc{ask}\}$, $s_{\textsc{ask}}(\textsc{ask}) = 1$. $\langle \textsc{ask}, 1\rangle$ guarantees that Maya attends the opera, by (23a) ($\tau_{\mathcal{D}_o}(s_{\textsc{ask}})(\textsc{att}) = 1$), and falsifying ASK (the only variable in $\mathrm{dom}(s_{\textsc{ask}})$) makes ATT false, precluding the truth of STO (by 23b); thus, $s_{\textsc{ask}}$ is causally necessary for Maya to sit through the opera ($s_{\textsc{ask}} \lhd \langle \textsc{sto}, 1\rangle$). However, since STO depends on the conjunction of ATT and ($\neg$DLO $\vee$ $\neg$HRS $\vee$ ALC), $s_{\textsc{ask}}$ is insufficient for Maya to sit through the opera ($s_{\textsc{ask}} \not\rhd \langle \textsc{sto}, 1\rangle$).

According to Proposal (17), then, (22a) is licensed when $s_{\textsc{ask}}$ is salient and true. Given $s_{\textsc{ask}}$, (22a) tells us that Maya succeeded in sitting through the opera, leading to the inference that ($\neg$DLO $\vee$ $\neg$HRS $\vee$ ALC) also held—i.e., that either Maya enjoyed the opera ($\langle \textsc{dlo}, 0\rangle$), it took less than two hours ($\langle \textsc{hrs}, 0\rangle$), or she had a drink at intermission ($\langle \textsc{alc}, 1\rangle$). Absent further information, we cannot draw any conclusions as to which of these possibilities precipitated $\langle \textsc{sto}, 1\rangle$: we readily infer that Maya tried (and presumably intended) to sit through the opera, but we have no reason to conclude that her doing so was either difficult or an unlikely outcome.

It is easy to see, however, that learning something further about the situation at hand might readily push us towards more specific conclusions. For instance, if it turns out that the opera was Wagner's *Siegfried* (with a conservative runtime of five hours), HRS is verified, offering Maya fewer paths to success and making it both more difficult for her to sit through the opera, and potentially also less likely that she would succeed. Similarly, (24) (also licensed by the catalyst $s_{\textsc{ask}}$) explicitly precludes a difficulty inference, but maintains Maya's intention.

(24) When she went to *Siegfried* with her best friend, Maya discovered that she liked opera, and easily managed to sit through the show.

Coleman's 'vanishing' presuppositions thus receive a natural explanation on the causal approach to *manage*. On the catalyst proposal, we see that particular inferences follow from how causal ancestors of $P(x)$ are sorted into a familiar (background) catalyst, as opposed to the unresolved variables which are contextually determinative for $P(x)$, taken together with what we learn (or fail to learn) about these determinative conditions from a given *manage* claim.

The causal approach in (17) also offers an account of the *because*-clause contrast in (16), repeated below. Baglini and Francez argue that distinguishing the at-issue contribution of $\mathit{manage}(x, P)$ from that of $P(x)$ explains why a *because*-clause receives different interpretations in (16a) and (16b). On Proposal (17), *because* in (16a) modifies the *actual cause* assertion, addressing the *why* of this relationship—that is, why the catalyst was in fact efficacious for $P(x)$ (despite its insufficiency). In (16b), however, *because* directly modifies the at-issue contribution of $P(x)$, explaining why Juno opened the safe rather than why she was able to do so.

(16) a. Juno **managed** to open the safe because it was unlocked.

b. Juno opened the safe because it was unlocked.

If this explanation is correct, (16a) indicates both that a discourse-familiar catalyst actually caused Juno to open the safe, and that the relation of actual cause held due to the state of the lock. Assuming (for concreteness) a causally necessary catalyst s comprising Juno's attempt to open the safe (e.g., by grasping the handle and pulling), s could be insufficient for a number of reasons: the handle might need to be turned, or the safe might be locked (requiring a key or a code to open). Without the *because*-clause, the claim that *Juno managed to open the*

safe asserts that s was efficacious, licensing the inference that some un(der)specified potential obstacle was (in fact) circumvented. Adding the *because*-clause as in 16a adds the information that the catalyst's efficacy was due to the safe being unlocked, thus identifying its potential to have been locked as the relevant potential obstacle. In other words, (16a) indicates that the state of the safe's lock was contextually causally decisive for the *manage*-complement.

Putting this together with the earlier discussion, modifying *manage* with a *because*-clause sheds light on the nature or composition of the unresolved catalyst-external prerequisite whose existence is mandated by the catalyst proposal. While I concur with Baglini and Francez that the contrast in (16) is best accounted for by differentiating the at-issue contributions of *manage*(x, P) and its complement, it seems to me that the existence of a contextually-determinative prerequisite, and one which is moreover targeted by *because*-modification, calls into question the appropriateness of (17)ii's predication of *actual cause* between an established catalyst and the implicative complement. In particular, if (16a) establishes (as per Baglini and Francez) that some familiar, causally-relevant situation was active in bringing Juno's safe-opening about, but was crucially insufficient for this outcome on its own, then *manage* necessarily conveys that the determinative (or proximate) cause of complement realization rested with the catalyst-external prerequisite, and not the catalyst at all. What I want to suggest, then, is that—by mandating the existence of an unresolved but contextually determinative condition which stands between the catalyst and its efficacy for $P(x)$—the catalyst proposal establishes a catalyst-external prerequisite as the (potential) proximate cause of *manage*'s complement. This runs directly counter to the intuition behind identifying a familiar catalyst as the *actual cause* of $P(x)$.[13]

Before moving to lexically-specific implicatives, I note one last problem for the catalyst approach: it turns out that there are acceptable contexts for *manage*(x, P) in which it is impossible to specify a causally necessary but insufficient catalyst for $P(x)$. The problem arises where $P(x)$ depends on a disjunction: example (25) is based on a suggestion from S. Peters (p.c.).

(25) **The transit scenario.** Suppose that Kayvan has exactly four possible ways of getting to school: he can take the city bus, bike, walk, or his mother can drive him. Suppose further that there was a snowstorm on Thursday night, and it remains very cold on Friday morning, so that neither biking nor walking is possible.

  a. Kayvan **managed** to get to school on Friday.

  b. Kayvan did not **manage** to get to school on Friday.

In this context, (25a) is a felicitous way to convey that Kayvan got to school (via either bus or car), while (25b) is appropriate if neither option worked out. However, since the success of either the bike or walking option would be enough to get Kayvan to school, their joint failure cannot be causally necessary here. What, therefore, could the licensing catalyst be? One possibility might be to model (25) by including a variable which corresponds to the proposition that Kayvan tries to go to school (presumably by pursuing one of the available modes of transportation), but, as far as I can tell, (25b) does not require Kayvan to make any particular attempt to travel: suppose, for instance, that he hears on the radio that the roads are closed due to snow. I see no obvious way of constructing a dynamics for (25a) which gets around the problem of necessity for disjunctive causes.[14]

[13] As observed above, the *actual cause* relation per Definition 13 is quite weak, so this objection is perhaps more terminological than formal: I find it counterintuitive to label a familiar catalyst as the 'actual cause' of the *manage* complement when complement realization necessarily has a more proximate cause. I will not engage here with the extensive literature on *causal selection* (see Hitchcock 2020 for an overview, and references therein), beyond noting that a 'final' or precipitating causal influence for effect E is more likely to be labeled *a* (or even *the*) *cause* of E than an established set of relevant but crucially contextually non-decisive facts (see Neeleman and van de Koot, 2012; Halpern and Hitchcock, 2015; Icard et al., 2017; Henne et al., 2021, among others).

[14] A similar problem arises for the opera dynamics $\mathcal{D}_o$ (Figure 2) in a context s_{AD} which establishes both that

Proposal (17) can accommodate data like (25) if we redefine a catalyst as a situation which comprises facts that are causally relevant but collectively insufficient for the implicative complement $P(x)$. Together with the assertion in (17)ii, however, this makes (25a) amount to the assertion that the background situation—which establishes only the impossibility of getting to school without a motorized vehicle—*actually caused* Kayvan to get to school in the evaluation world. This is entirely counterintuitive: given (25), the truth of (25a) licenses the conclusion that the actual world verified the disjunction of bus and car options, and, moreover, that it was the truth of this disjunction that actually caused Kayvan to reach his destination.

Thus, even if we redefine Baglini and Francez's notion of a *catalyst* to accommodate the empirical data, the proposed assertion of *actual cause* remains intuitively suspect. Moreover, even under the weaker catalyst conception suggested above, Proposal (17) continues to mandate the existence of a catalyst-external, causally determinative condition (in 25, the proposition that Kayvan took the bus or that he was driven by his mother), which I take to be strong motivation for account which focuses more explicitly on the role of an obstacle-overcoming prerequisite. As the next section shows, the case for such an account—that is, one which maintains a causal semantics for implicatives in the spirit of Baglini and Francez, and thus preserves many of their improvements over 'direct assertion' analyses, but which eschews the problematic concepts of *catalyst* and *actual cause*—is only strengthened by considering lexically-specific verbs.

4.2 Lexically-specific implicatives and catalyst-external causes

As observed earlier, *manage* represents a special, semantically-underspecified case within the implicative class. It is worth considering, therefore, whether Proposal (17) can be extended to more paradigmatic verbs, such as *dare* (26) and Finnish *hennoa* ('have the heart'; 27). Like the lexically-specific verbs in Sections 2.1-2.2, *dare* and *hennoa* introduce projective 'requirement' inferences, supplying specific information about a prerequisite for complement realization.

(26) a. He **dared** to kill the cat. → *He killed the cat.*
presumes: Daring was required for him to kill the cat.
indicates: He was daring (and so he killed the cat).

b. He didn't **dare** to kill the cat. → *He didn't kill the cat.*
presumes: Daring was required for him to kill the cat.
indicates: He was not daring (and so he did not kill the cat).

(27) 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.' → *He killed the cat.*
presumes: Hard-heartedness was required for him to kill the cat.
indicates: He was hard-hearted (and so he killed the cat).

b. Hän e-i **henno-nut** tappa-a kissa-a.
he.NOM NEG-3SG have.heart-SG.PP kill-INF cat-PART

Maya's friend has invited her to the show, and that Maya dislikes opera ($\text{dom}(s_{\text{AD}}) = \{\text{ASK}, \text{DLO}\}, s_{\text{AD}}(\text{ASK}) = s_{\text{AD}}(\text{DLO}) = 1$). Both (22a) and its negation seem felicitous in this context, depending on how the undetermined mitigating conditions (HRS and ALC) turned out. However, while s_{AD} is causally insufficient for $\langle \text{STO}, 1 \rangle$, it is not causally necessary according to Definition 12b: $\langle \text{STO}, 1 \rangle$ is realizable in situations s' which preserve the truth of ASK but in which Maya likes opera ($s'(\text{DLO}) = 0$).

One way around the opera problem might be to treat a 'familiar' catalyst as a subsituation of the utterance background, rather than its sum total: then the background s_{AD} is acceptable because it subsumes the original catalyst s_{ASK}. To make this work in general, we would need to add to (17)i the requirement that the full background does not entail the *manage*-complement's falsity (thus precluding positive *manage*). This refinement, however, is not enough to rescue an example like (25) on the catalyst approach, and so I do not propose to adopt it.

'He didn't have the heart to kill the cat.' → *He didn't kill the cat.*
presumes: Hard-heartedness was required for him to kill the cat.
indicates: He was not hard-hearted (and so he did not kill the cat).

The prerequisites invoked by *dare* and *hennoa* (daring and hard-heartedness, respectively) are understood to be determinative for complement realization in the reference context (see also 3, 10 in Section 2.2). These inferences are spelled out in (26)-(27). The positive (a) examples indicate that the subject satisfied (acted on) the relevant prerequisite, and that the cat was killed as a result; under negation in the (b) examples, we learn that the prerequisite was not satisfied, preventing the subject from killing the cat.

The relevance of a particular prerequisite—that is, the idea that the implicative subject must be daring (in 26) or hard-hearted (in 27) in order to kill the cat—is not sensitive to the polarity of the matrix clause, and is thus not at-issue. Consequently, any satisfactory account of these examples must include a specification of the appropriate prerequisite as part of the main verb's presuppositional contribution. Given the structure of Proposal (17), extending the catalyst approach to (26)-(27) would mean specifying daring or hard-heartedness to be part of a 'familiar' catalyst: this is evidently incompatible with the role played by these prerequisites. By (17)i, a familiar catalyst is not only salient, but also presupposed to hold in the utterance context: it is defined as a situation which obtains regardless of an implicative claim's polarity. By contrast, the status of a lexicalized prerequisite is affected by negation: daring and hard-heartedness are realized in the positive (a) claims above, but lacking in the negative (b) examples. Moreover, this difference in the truth-value status of a relevant prerequisite drives the characteristic two-way pattern of complement entailments.

The same relationships between polarity, prerequisite status, and complement realization extend to other lexically-specific implicatives, such as English *bother* (28; see also Finnish *viitsiä* in 6c, 7c) and Finnish *malttaa* ('have the patience'; 10). In (28), Juno's engagement (active interest or suppression of apathy) is understood to be a precondition for her response. (28a) indicates that she acted on the prerequisite, and thus managed to respond; (28b) indicates that she did not engage, and so failed to respond. Similarly, positive *malttaa* in (10a) indicates that Marja waited as a result of being patient (the relevant prerequisite), while (10b) conveys that she was not patient and so did not wait.

(28) a. Juri **bothered** to respond to my email. → *Juri responded to my email.*
b. Juri didn't **bother** to respond to my email. → *Juri didn't respond to my email.*

(10) a. Marja **maltto-i** odotta-a
Marja have.patience-PST.3SG wait-INF
'Marja had the patience to wait.' → *Marja waited.*
b. Marja e-i **maltta-nut** odotta-a
Marja NEG-3SG have.patience-SG.PP wait-INF
'Marja did not have the patience to wait.' → *Marja didn't wait.*

Extrapolating from these examples, lexically-specific implicative verbs presuppose the existence of a specific but unresolved (contextually-unsettled) prerequisite, whose resolution is determinative for the implicative complement. This is the basis of Fact C, as established in Section 2.1. Following Baglini and Francez, I take the prerequisite to be *causally* determinative (i.e., causally necessary and causally sufficient) for complement realization; further support for this assumption is given in Section 5. Section 4.1 showed that the existence of just such a determinative (albeit unnamed) condition is mandated by the catalyst proposal for *manage*: the discussion in this section has demonstrated that, since lexically-specific verbs name their

prerequisites, these verbs must invoke determinative conditions more or less directly, instead of as (rather roundabout) consequences of a catalyst's familiarity.

While the not at-issue contribution of lexically-specific verbs cannot be incorporated into a catalyst as per (17)i, it turns out to be fairly straightforward to instead reconcile the catalyst view of *manage* with the prerequisite perspective suggested here. Where *dare* or *hennoa* lexicalizes a particular prerequisite, say $A(x)$, (the realization of some property or condition A by x) as causally determinative for complement $P(x)$, *manage* simply leaves the nature of A underspecified, and thus subject to contextual enrichment. Broadly speaking, this inverts the intuition behind a catalyst. From the prerequisite perspective, the not at-issue contribution of *manage* introduces an unresolved, causally-determinative condition for the implicative complement. Just as the existence of such a condition follows from the familiarity of a catalyst, the (prior) satisfaction of some situation (set of facts) s which is causally relevant for (and at least conducive to) the truth of $P(x)$ follows from the presupposed relevance of a causally-determinative prerequisite.[15]

From this perspective, *manage* (and its Finnish counterpart *onnistua*) can be seen as generic (or generalized) alternatives to lexically-specific verbs. A context licensing the use of an implicative may or may not contain information about the nature of a causal prerequisite for a particular complement proposition $P(x)$: the choice of a particular implicative will be governed by what, if anything, is known about the causal chain for $P(x)$. A speaker who intends to indicate the relevance of courage for $P(x)$, for instance, might select *dare* (or Finnish *uskaltaa*) as the matrix verb, while *manage* (or *onnistua*) are available as alternatives if the speaker is unable or unwilling to be specific about the prerequisite for $P(x)$. Focusing on a prerequisite's relevance, rather than on the settled causal background (as per Proposal 17) thus offers a means of unifying the semantics of *manage* with that of more specific implicatives, while maintaining the causal background structure that Baglini and Francez recruit to account for Coleman's (1975) vanishing presuppositions, as well as the *because*-clause contrast in 16.

4.3 One-way implicatives

Additional motivation for adopting the prerequisite perspective (as opposed to the catalyst view) comes from a class of **one-way implicatives**, such as Finnish *pystya* ('be able'; 29). One-way verbs have an inferential profile which is structurally similar to that of *manage, dare*, and their Finnish counterparts, but these verbs only generate complement entailments under one matrix polarity (see also Karttunen 2012). A negated *pystya* claim, as in (29b), entails the negation of its complement, but (29a) only licenses a defeasible implicature to the complement's realization:

(29) a. Maarit **pysty-i** tappelema-an.
Maarit able-PST.3SG fight-INF
'Maarit was able to fight.' $\not\rightarrow$ ($\rightsquigarrow$) *Maarit fought.*

b. Maarit e-i **pysty-nyt** tappelema-an.
Maarit NEG-3SG able-SG.PP fight-INF
'Maarit was not able to fight.' $\rightarrow$ *Maarit did not fight.*

Any satisfactory account of two-way implicatives must minimally derive the characteristic two-way pattern of entailment (Fact B), and thus cannot provide an 'off the shelf' analysis of one-

[15] More precisely, if a particular condition $A(x)$ is the only thing standing between x and the realization of complement $P(x)$, it must be the case that any non-A causal ancestors of $P(x)$ are already settled in the complement-conducive way. Taken as an established situation, the set s corresponds broadly to the notion of a catalyst as proposed by Baglini and Francez (2016). Situation s need not be causally necessary but insufficient for $P(x)$ (as example 25 shows), but must at least be part of a (potential) complete causing situation for the implicative complement: minimally, augmenting s with the truth of $A(x)$ is sufficient for $P(x)$, and augmenting s with $\neg A(x)$ results in the falsity of $P(x)$.

way verbs like *pystya*. The potential for a unified approach to the two verb classes is nevertheless appealing—in particular, an approach on which one- and two-way verbs share some distinctive semantic core (*qua* implicatives), and on which the 'missing' positive entailment in (**??**) is explained by adding, subtracting, or otherwise modifying some isolatable semantic element from the lexical representation of a two-way verb. As I argue below, while it is possible to modify the catalyst proposal to account for one-way implicatives, this approach is subject to the same types of objections as were raised in Sections 4.1-4.2. Moreover, the modifications required to unify one- and two-way verbs on the catalyst perspective again serve to lampshade the existence of a(n unsettled) prerequisite, suggesting once again that the prerequisite perspective offers a more straightforward and indeed natural view of implicative meaning.

It seems uncontroversial that, on Baglini and Francez's (2016) catalyst approach, the distinguishing lexical semantic feature of an implicative verb is the concept of a (presupposed) familiar catalyst: i.e., the salience and truth of a partial, potentially efficacious cause for the implicative complement. Thus, any attempt to unify one- with two-way verbs on this analysis should preserve the catalyst concept. The discussion at the end of Section 4.1 showed that a *manage*-licensing catalyst need not be causally necessary for complement $P(x)$, leaving us with the revised definition of a catalyst as a situation comprising facts which are (a) causally relevant for $P(x)$ and (b) causally compatible (given dynamics $\mathcal{D}$) with the eventual truth of $P(x)$ as well as its eventual falsity. Combined with the assertion of *actual cause*, as given in Definition 13, the amended catalyst proposal derives the dual entailments of *manage*, since a familiar catalyst s can only actually cause $P(x)$ if $P(x)$ is (also) true in the evaluation world; likewise, actual cause fails (where s holds) just in case $P(x)$ is false.

In considering how to modify the revised catalyst proposal to derive the inference pattern in (29), we have two potential starting points: we can either modify the composition of a catalyst for one-way verbs, or make changes to asserted content (so that a one-way verb asserts something weaker than actual cause, which crucially does not force complement entailment in the positive direction). The first option can be ruled out fairly quickly. Since the revised catalyst is simply causally relevant for $P(x)$, there is no obvious way to weaken its composition without eliminating a causal connection to the implicative complement: this runs counter to the motivating intuition of a catalyst as a potential cause for $P(x)$. Second, and perhaps more consequentially, given the definition of actual cause, altering the composition of a presupposed catalyst can have no effect on the derived complement entailments: a causally irrelevant catalyst, just like a causally relevant or causally necessary one, can only *actually cause* a fact if both the catalyst and the fact hold in the evaluation world. No matter what the catalyst comprises, then, its presupposed familiarity, combined with an assertion of actual cause, will derive complement entailment for a positive implicative claim, counter to the empirical data in (29a).[16]

A catalyst-preserving approach to one-way implicatives thus must diverge from (a modified) Proposal (17) with respect to asserted content. In particular, we will need to replace the actual cause assertion in the one-way case with a relation that produces the negation of $P(x)$ under matrix negation, and which is compatible with $P(x)$ under positive polarity, but which crucially does not force a positive entailment. While it is in principle possible to define such a relation—call it *allows*—in the dynamics (SEM) framework, setting *allows* in place of *actual cause* as the asserted content of a one-way implicative ultimately suffers from the same conceptual shortcomings as actual cause in the two-way context.[17] In particular, since the catalyst is

[16]This observation—that a situation s can, per Definition 13, *actually cause* a fact for which s is causally irrelevant—highlights the counterintuitive aspect of *actual cause*. See also note 9.

[17]It is possible to define a relation between situations and facts that produces the desired results here, but it is not exactly straightforward. For instance, in parallel with the definition of actual cause, we would like s *allows* fact X in a world w to be true just in case s leaves available a causal pathway to $\langle X, 1\rangle$. However, since a world

presupposed to hold regardless of matrix polarity, it must be some catalyst-external condition which makes the difference between a positive, complement-compatible one-way claim, and a negative, complement-denying claim. Again, then, it is not the catalyst s which is actually instrumental in *allowing* (or *disallowing*) the complement's realization, but rather some external condition which represents a (potential) causal pathway from s to $P(x)$. In the positive case, the relevant condition must be valued in a way that is conducive to $P(x)$, but need not ensure its truth; under negation, the relevant condition must be determined in a way which entails the negation of $P(x)$. Taken as a prerequisite, then, the relevant catalyst-external condition is causally necessary but not (necessarily) sufficient for $P(x)$, given catalyst s. The prerequisite perspective thus offers a natural way of expressing the difference between one- and two-way implicatives: both types of verbs presuppose the relevance of a(n unresolved) condition which is, in context, causally necessary for the realization of their complements, but only two-way verbs presuppose that their prerequisites are also causally sufficient for $P(x)$.

Based on the preceding discussion, it seems to me that a prerequisite-focused approach to one-way verbs is both simpler and more perspicacious than the catalyst view, and should therefore be preferred. Section 4.2 argued that the prerequisite approach is necessary if we wish to account for the full inferential profile of lexically-specific two-way verbs, and in addition offers a means of unifying their analysis with that of *manage* (and *onnistua*). It turns out that the Finnish implicative paradigm contains a number of lexically-specific one-way implicatives which extend the argument for a prerequisite focused account from (lexically-specific) two-way verbs to the one-way cases as well.

(5) a. Sampo **jakso-i** noust-a.
Sampo have.strength-PST.3SG rise-INF
'Sampo had strength to rise.' ⇝ *Sampo rose.*
presumes: Rising required strength from Sampo.
indicates: Sampo had the required strength (and so it was possible to rise).

b. Sampo e-i **jaksa-nut** noust-a.
Sampo NEG-3SG have.strength-PP.SG rise-INF
'Sampo did not have strength to rise.' → *Sampo did not rise.*
presumes: Rising required strength from Sampo.
indicates: Sampo lacked the required strength (and so did not rise).

(30) a. Freija **mahtu-i** kulke-ma-an ove-sta.
Freija fit-PST.3SG go-INF-ILL door-ELA
'Freija fit through the door.' ⇝ *Freija went through the door.*
presumes: Going through the door required Freija to fit (be small enough).
indicates: Freija was small enough (and so it was possible to go through the door).

b. Freija e-i **mahtu-nut** kulke-ma-an ove-sta.
Freija NEG-3SG fit-PP.SG go-INF-ILL door-ELA
'Freija did not fit through the door.' → *Freija did not go through the door.*
presumes: Going through the door required Freija to fit (be small enough).
indicates: Freija was not small enough (and so did not go through the door).

w necessarily determines all of $\mathrm{Anc}(X)$, and thus, via $\tau_{\mathcal{D}}$, entails a determination for X itself, s *allows* fact X in world w is effectively indistinguishable from the relation of actual cause in Definition 13. The problem is not insurmountable: we can instead define *allows* in terms of the relationship between some consistent supersituation s' of s (where s' is true in w) and $\langle X, 1\rangle$, but it is not trivial to constrain this relationship so that it entails $\langle X, 0\rangle$ under negation, but falls short of requiring $\langle X, 1\rangle$ in the positive case. I leave the details of an appropriate *allows* relation as an exercise for the interested reader, since I do not pursue the catalyst approach further here.

Jaksaa ('have the strength'; 5) and *mahtua* ('be small enough, fit'; 30), like their two-way cousins in Section 4.2, project the relevance of a particular (lexicalized) property, and give rise to polar inferences about the status of this property. Apart from the particular prerequisite specified, the only difference between (26)-(28) and (10), on the one hand, and (5) and (30), on the other, is in the consequences of prerequisite satisfaction with respect to the implicative complement: satisfying the prerequisite is sufficient for $P(x)$ in the two-way cases from Section 4.2, but not in the case of the one-way verbs considered here. Thus, even if we set aside Finnish *pystya* (and its English counterpart *be able*; see Karttunen 1971, 2012) as a modal (or semi-modal) verb rather than an implicative, Finnish predicates like *jaksaa* and *mahtua* present a strong argument for treating one-way implicatives as close semantic relatives of lexically-specific two-way verbs like *dare* and *hennoa* ('have the heart').

The data, then, suggest a basic semantic unity between one- and two-way implicative verbs in terms of the notion of a prerequisite which is contextually necessary for the implicative complement, and which is potentially (but not necessarily) sufficient. While Baglini and Francez's catalyst proposal improves on the direct assertion proposal (8) as a treatment of *manage*, we have seen that it cannot, as formulated, account for lexically-specific verbs in either the one- or two-way classes. All of this argues for moving to a restructured analysis which preserves the important causal insights from Baglini and Francez, but centers the prerequisite notion which is key to the inferential profile of lexically-specific verbs. We have, more or less, outlined such an account over the course of Section 4; the next section spells out the proposal directly.

5 Causal necessity and sufficiency in implicative verbs

What we are now after is a semantic account of implicativity that preserves the causal component introduced by Baglini and Francez (2016), but which invokes an in-question, contextually-determinative prerequisite instead of a catalyst. This account should derive Facts A-C (see Section 2.1), with the caveat that one-way implicatives do not exhibit the positive $I(x, P) \rightarrow P(x)$ entailment. We saw in Section 4.3 that one-way implicatives parallel two-way implicatives in conveying that complement realization hinges on the (in-context) resolution of a particular prerequisite. This suggests that what is at issue remains consistent across the one- and two-way subclasses. Consequently, the one- and two-way entailment contrast should follow from a (minimal) difference in not at-issue content.

Karttunen (1971) anticipates the basic structure of a satisfactory account, in a passage whose significance has perhaps been obscured by the subsequent direct assertion proposal (Karttunen and Peters, 1979).

> "[. . .] let us ignore the individual differences among implicative verbs and try to state 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:"
>
> *Presupposition:* $v(S)$ is a necessary and sufficient condition for S
> *Proposition:* $v(S)$ (Karttunen, 1971, p.352)

To convert Karttunen's schema into a full analysis, we first need to identify the "central part of the proposition." Based on the discussion in Section 4, a natural candidate is the in-question,

causally-determinative prerequisite whose status is resolved by a positive or negative implicative assertion.

Building on Baglini and Francez, we can add the requirement that the connection between $v(S)$ and S (or rather, between $I(x, P)$ and $P(x)$) involves *causal* necessity and sufficiency. In addition to the evidence we have already seen, the importance of a causal component in implicativity is further emphasized by an example like (31).

(31) *Context.* In the United States, you must be (at least) 21 years old to legally drink 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 turned 21 yesterday.

a. ??Yesterday, Amira managed to drink a glass of wine.

Amira's age is salient in this context, as a necessary and sufficient condition for her to drink wine. Crucially, however, the relationship is one of *deontic* (rather than causal) necessity and sufficiency. The markedness of (31a) thus strongly suggests that a deontically necessary and sufficient prerequisite cannot license *manage*. Moreover, attempting to make sense of (31a) in this context readily invites conjecture about the relevance of non-legal conditions for Amira's drinking: for instance, we might infer that it was logistically difficult for Amira to obtain wine, or perhaps that she suffered a physical reaction which made it difficult for her to finish a full glass of wine. In other words, even though context provides a salient deontic prerequisite for the implicative complement, the use of *manage* encourages speculation about conditions which might act instead as *causal* prerequisites for Amira's wine-drinking—that is, conditions which, unlike legal regulations, concretely precipitate or preclude the complement event.

5.1 The proposal

Putting everything together, I propose the following precisification of Karttunen's (1971) semantic template:

(32) **The prerequisite account of implicatives.**
For a two-way implicative verb I, an agent x, a one-place predicate P, and a background situation c, the proposition $I(x, P)$:

i. *Presupposes:* The existence of a predicate A such that $A(x)$ is *causally necessary* for $P(x)$ in the utterance context. $A(x) \lhd_c P(x)$

ii. *Asserts:* $A(x)$

iii. *Presupposes:* $A(x)$ is the only unmet causally necessary condition for $P(x)$ in context (so $A(x)$ is *causally sufficient* for $P(x)$ relative to c) $A(x) \rhd_c P(x)$

On the prerequisite account, the presupposed condition $A(x)$ is crucially left unresolved in the discourse context (unlike the 'familiar' catalyst from Baglini and Francez 2016). As a result, implicative presuppositional content—per Proposal (32)—highlights that, given what the speaker knows about the causal ancestors of $P(x)$, $A(x)$ is not only causally decisive for $P(x)$ with respect to background situation c, but is also left undetermined by c.

The presuppositions in Proposal (32) do not explicitly encode that $A(x)$ is unresolved at utterance time. I suggest that this inference arises as an implicature: in particular, that it serves as justification of a speaker's choice to use the implicative construction $I(x, P)$ instead of a salient simpler alternative—the bare complement $P(x)$. This is the source of the 'obstacle' impression associated with implicatives, and how the prerequisite approach captures Fact A. We generally conceive of actions and events in the world as embedded in causal chains. Using an implicative (and especially a lexically-specific verb) draws attention to a particular segment of

this chain. It is hard to recover a reason for doing so if the status of the highlighted segment is settled in the discourse context. Consequently, we infer that it is not.[18] Since fulfillment of the prerequisite $A(x)$ is both (causally) necessary and sufficient for the realization of the implicative complement, Proposal 32 also captures Fact C.

Proposal (32) derives the characteristic entailments of implicative verbs (Fact B) in the joint contribution of presupposition and assertion, as desired. Taking the negative entailment first, the causal necessity presupposition (32)i establishes that if $A(x)$ is not realized, $P(x)$ cannot be actualized. According to (32)ii, the at-issue content of a negative implicative claim establishes that $A(x)$ is false, from which it follows that $P(x)$ is also false.

Consider a case where I = *uskaltaa* ('dare'):

(4b) Juno e-i **uskalta-nut** avat-a ove-a.
Juno NEG-3SG dare-SG.PP open-INF door-PART
'Juno did not dare to open the door.' → *Juno did not open the door.*

Here, A represents something like the (active) deployment of courage. All that (4b) asserts is that Juno did not deploy courage. Since doing so is causally necessary for her to open the door, she cannot have opened the door (thus, her failure to open the door is understood to be *because* of her lack of courage). The negated complement is not directly asserted by (4b), but instead is calculated as a causal consequence of the assertion (in any felicitous context for *uskaltaa*).

Turning to the positive entailment, $I(x, P)$ asserts that $A(x)$ holds. If the only thing that relates $A(x)$ and $P(x)$ is the necessity presupposition in (32)i, we cannot conclude anything about $P(x)$. This is exactly what we want for one-way predicates like *jaksaa* ('have the strength'; 5). Asserting the truth of $A(x)$ may defeasibly implicate $P(x)$, since it removes at least one potential barrier for the implicative complement, but in the absence of causal sufficiency, $A(x)$ does not entail $P(x)$.

On the other hand, if I is a two-way implicative, we have additional (not at-issue) information: the causal sufficiency presupposition in (32)iii. This presupposition is formulated so that positive assertion of a two-way implicative will convey that the only unresolved necessary condition for $P(x)$ was settled positively. Since, in this case, the negation of $A(x)$ is the only potential obstacle for $P(x)$, $A(x)$ will causally entail $P(x)$. The positive entailment is again calculated as a causal consequence of what is actually asserted, provided that the context satisfies presupposition (32)iii.

Given Proposal (32), the choice of one implicative verb over another involves choosing the appropriate constraints for A. Lexically-specific implicatives characterize A with some degree of precision: *jaksaa* ('have the strength'; 5) constrains A to involve the use of strength, while *dare*/*uskaltaa* restricts consideration to courageous actions. Implicatives vary between the extremely constrained, as for example with Finnish *mahtua* ('fit', 'be small enough'; 30) and the apparently unconstrained, such as *pystya* ('be able'; 29), which simply indicates the existence of some causally necessary precondition for the realization of its complement. Indeed, *pystya* appears to be the one-way counterpart of bleached verbs such as *manage*/*onnistua*, which convey only what is provided by Proposal (32).

5.1.1 Illustration: the modified Dreyfus scenario

To see how Proposal (32) works, let us consider a fictionalized version of the Dreyfus scenario (adapted from Baglini and Francez 2016). Suppose the following conditions hold:

[18] If the reasoning outlined is correct, the inference is question can be classified as an example of *Need-a-Reason* implicatures (Lauer, 2013, Ch.9).

(33) If Dreyfus intends (INT) to spy for the Germans (SPY), then:

a. he will collect secrets about the French (SEC) SEC := INT

b. if he has the nerve (NRV) as well as the intent to spy, he will send a radio message to make contact with the Germans MSG := INT ∧ NRV

c. if it happens that a German is listening on the correct frequency (LST), and the message is not garbled (BRK), Dreyfus will establish a private communications line (COM) COM: = MSG ∧ LST ∧ ¬BRK

d. he will use the line to pass information to the Germans, thus spying for them SPY: = SEC ∧ COM

Figure 3 provides the graph for the dynamics in (33). The background variables are INT (whether or not Dreyfus has the intention to spy), NRV (whether or not Dreyfus has the nerve to spy), LST (whether or not a German is listening), and BRK (whether or not the message is garbled).

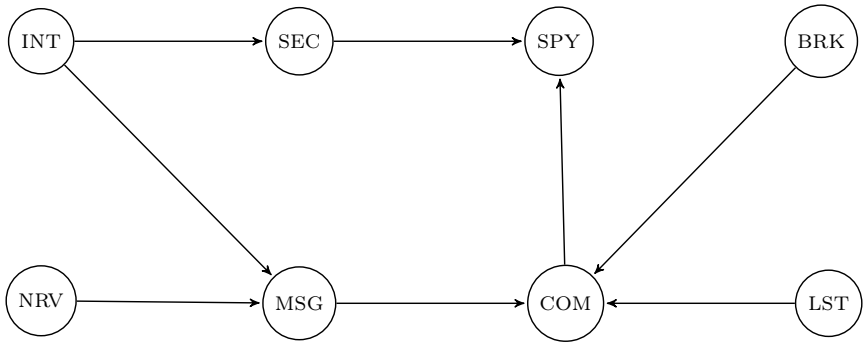

Figure 3: Graphical representation for the fictional Dreyfus scenario

Suppose that we are in a context which establishes that Dreyfus intends to spy, and has in fact already collected secrets. Then the relevant background situation s has $s(\text{INT}) = s(\text{SEC}) = 1$. Given s, we have the following intuitive judgements for (34a)-(34d).

(34) a. Dreyfus dared to send a message to the Germans.

b. Dreyfus did not dare to send a message to the Germans.

c. ?/#Dreyfus dared to establish communication with the Germans.

d. ?/#Dreyfus dared to spy for the Germans.

The felicity of (34a)-(34b) is predicted by Proposal (32). In situation s, NRV is the only undetermined condition for the truth of MSG: it is thus both causally necessary and sufficient for MSG ($\langle \text{NRV}, 1\rangle \triangleleft_s \langle \text{MSG}, 1\rangle, \langle \text{NRV}, 1\rangle \triangleright_s \langle \text{MSG}, 1\rangle$). The polarity of *dare* then sets the value of NRV in evaluation world w^*, allowing us to calculate $w^*(\text{MSG})$.

Proposal (32) also predicts *dare*'s infelicity in (34c)-(34d). For (34c), situation s leaves two relevant conditions for the implicative complement (COM) unresolved: BRK and LST. As a result, the truth of NRV is contextually necessary but not sufficient for COM ($\langle \text{NRV}, 1\rangle \triangleleft_s \langle \text{COM}, 1\rangle, \langle \text{NRV}, 1\rangle \not\triangleright_s \langle \text{COM}, 1\rangle$), and the felicity conditions for two-way *dare* are not satisfied. In (34d), the implicative complement SPY is itself causally dependent on COM, and the same problem arises: *dare* is infelicitous because $\langle \text{NRV}, 1\rangle$ is causally necessary but not sufficient for $\langle \text{SPY}, 1\rangle$, since BRK, LST, COM $\in$ Anc(SPY) are all undetermined in the discourse context.

The fictitious Dreyfus dynamics will also illustrate how a non-specific implicative like *manage* works. The examples in (35) are all judged to be felicitous.

(35) a. Dreyfus managed to send a message to the Germans.
inferred: $w^*(\text{NRV}) = 1$

b. Dreyfus did not manage to send a message to the Germans.
inferred: $w^*(\text{NRV}) = 0$

c. Dreyfus managed to establish communication with the Germans.
inferred: $w^*(\text{NRV}) = w^*(\text{MSG}) = w^*(\text{LST}) = 1, w^*(\text{BRK}) = 0$

d. Dreyfus managed to spy for the Germans.
inferred: $w^*(\text{NRV}) = w^*(\text{MSG}) = w^*(\text{LST}) = w^*(\text{COM}) = 1, w^*(\text{BRK}) = 0$

How is the contrast between (34c)-(34d) and (35c)-(35d) explained? On the current account, while *dare* requires that the only unresolved causal ancestor for its complement involves courageous action by Dreyfus, *manage* simply requires that the set of unresolved causal ancestors for its complement represent a causally necessary and sufficient condition. This view is supported by the fact that each statement in (35) licenses a particular set of inferences about the values of various relevant propositions in the Dreyfus situation. Crucially, for each claim in (35), the indicated set of inferred condition-value pairs represent a contextually necessary and sufficient (collective) condition for the implicative complement.[19]

Lastly, consider a scenario which is closer to the truth of the Dreyfus affair. Suppose Dreyfus is innocent, and has no intention to spy for the Germans; he is, however, known for showing courage in any and all situations. In this context, with a background situation s that fixes $s(\text{INT}) = 0$ and $s(\text{NRV}) = 1$, each of (34a)-(34d) is infelicitous, since $\langle \text{NRV}, 1 \rangle$ is not sufficient in context for $\langle \text{MSG}, 1 \rangle, \langle \text{COM}, 1 \rangle$ or $\langle \text{SPY}, 1 \rangle$. Notably, (35a)-(35b) also become infelicitous in the absence of Dreyfus's intent to spy, because no (set of) condition(s) can be causally sufficient for the truth of MSG, COM, or SPY relative to a background in which INT is false.

5.2 More evidence for the prerequisite account

Proposal (32) already has an analytical advantage over both the direct assertion and catalyst accounts, in that it not only derives Facts A-C, but also captures the differences between one- and two-way implicatives without assigning them divergent at-issue contributions. This section provides some additional empirical evidence which supports the prerequisite account over Baglini and Francez's catalyst proposal.

Proposal (32) makes two claims for a one-way implicative I. First, $I(x, P)$ asserts $A(x)$. Secondly, $A(x)$ is not enough to derive $P(x)$. This is illustrated by the felicity of (36), where a positive assertion of one-way *jaksaa* ('have the strength'; 5) is followed by the negation of its complement. Despite the absence of an inference from $I(x, P)$ to $P(x)$, (36) conveys that the requisite strength was available.[20]

[19] For (35a)-(35b), the contextually-determined prerequisite for $\langle \text{MSG}, 1 \rangle$ (given s) is the simple condition $\langle \text{NRV}, 1 \rangle$. (35c) and (35d) induce more complex prerequisites, expressible as the sentence $\text{NRV} \wedge \text{MSG} \wedge \text{LST} \wedge \neg\text{BRK}$ for (35c), and as $\text{NRV} \wedge \text{MSG} \wedge \text{LST} \wedge \neg\text{BRK} \wedge \text{COM}$ for (35d). See note 11.

[20] There is, however, an important difference between a positive assertion of a one-way verb like *jaksaa* ('have the strength') and that of a two-way verb like *dare*/*uskaltaa*. Although *jaksaa* asserts the availability of the required strength, it does not require that the subject took any action characterized by strength: (36) can be felicitous where strength is present but not deployed. Two-way implicatives do not distinguish between latency and action: an agent who *dares* to do $P(x)$ is not just capable of courage, but actually acts courageously.

This suggests that the locus of the difference between one- and two-way implicatives may lie in whether or not the specified prerequisite is inherently eventive. The idea is that verbs like *jaksaa* name conditions which, although inherently actionable, can be present in a latent state. The prerequisite conditions of two-way implicatives, on the other hand, are always understood to be eventive. If this hypothesis is borne out by a wider range of Finnish data (see, e.g., Flint 1980), it narrows the gap between one-way implicatives and variably-implicative *enough* and *too* constructions (e.g., *x be fast enough to P*), whose complement inferences are sensitive to overt aspectual marking (in, e.g., French and Portuguese; see Hacquard 2005; Marques 2012; Nadathur 2017, 2019).

(36) Sampo **jakso-i** tappelema-an, mutta päätt-i sitä
Sampo have.strength-PST.3SG fight-INF, but decide-PST.3SG he.PART
vastaan.
against.ILL
'Sampo had the strength to fight, but he decided not to.'

Baglini and Francez do not make predictions about this case, since the catalyst proposal simply does not cover one-way implicatives.

Since both prerequisite and catalyst proposals derive two-way implicative entailments, the most promising ground for adjudicating between them is in not at-issue content. Proposal (32) predicts the infelicity of two-way implicatives in contexts where the following holds: $P(x)$ causally depends on conditions which are (a) independent of the specified prerequisite $A(x)$ and (b) known to be unresolved in context (thus blocking the contextual sufficiency of $A(x)$ for $P(x)$). Setting aside for the moment the issue of lexical specificity (i.e., that the catalyst proposal offers no clear way of identifying the named prerequisite of lexically-specific implicatives), no such infelicity is predicted by Baglini and Francez, as long as the background verifies some causally necessary but insufficient situation for the implicative complement.

Example (37) constructs the relevant type of scenario for implicative *bother*:

(37) *Context.* Bala is apathetic about parties. However, he is also an opportunist, and will often show up if someone well-connected is coming. Mika planned a party to which she invited some newly-elected city councillors. She also invited Bala, who said he would think about whether he wanted to meet the councillors. He also said that he might be out of town on the day of the party, so he wasn't sure if he'd be able to attend in any case. Bala and Mika did not talk again before the party, and in the end he did not show up.

a. *Mika:* ?Bala didn't bother to come to my party.

Mika's invitation is causally necessary but insufficient for Bala's attendance at the party. The context in (37) thus satisfies the catalyst presupposition, and (37a) is, broadly speaking, predicted to be felicitous on the catalyst account. In addition to establishing uncertainty over whether or not Bala will overcome his apathy (another necessary condition for attendance), (37) establishes the potential for Bala to be out of town as an unresolved, apathy-independent causal condition which might prevent him from attending Mika's party. Since Bala's presence in town is both undetermined and causally necessary for him to attend the party, the prequisite approach in Proposal (32) predicts (37a) to be infelicitous.

Judgements of (37) were somewhat variable: however, where my informants accepted (37a), they described it as a 'meta'-comment on Bala's attitude (and his failure to RSVP), rather than as an accurate description of the core situation at hand. The consensus is that, since the reasons for Bala's absence are unknown, Mika's use of *bother* is at least marked. Markedness is even more pronounced for (38): since Mika does not know the actual reason for Bala's absence, a *because*-clause which constrains the target of Bala's (potential) apathy serves to highlight her inappropriate use of *bother*.

(38) *Mika:* #Bala didn't bother to come to my party because he decided the councillors weren't worth his time.

Judgements are sharper for Finnish two-way implicatives *ehtiä* ('have the time'; 39a) and *kehdata* ('be unembarrassed', 'act without shame'; 40a) in the contexts below. Informants were told to imagine a situation in which someone was telling them the story in (39) or (40), and

concluded with the two-way implicative claim in (39a) or (40a), respectively. In both cases, they reported that the implicative claim was marked or infelicitous as a resolution to the narrative.

(39) *Context.* A hunter in the forest had lost count of the number of times he had fired his gun and was not sure if he had used all the bullets or not. He decided to check after eating something, and put the gun down to get some food from his bag. While he had both hands in the bag, he spotted a bear coming towards him.

a. #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.' → *He shot the bear.*

(39) explicitly suspends a necessary and time-independent condition for shooting the bear—namely, whether or not the hunter had any bullets remaining. This makes (39a) infelicitous: one informant explained that she could not use *ehtiä* here because "if [the hunter] didn't have any bullets, he could not have shot the bear." She identified the same problem for negated *ehtiä* in the same context, even if the speaker's intention was to convey that the bear was not shot.

Similarly, *kehdata* ('be unembarrassed', 'act without shame'; 40a) was judged infelicitous as a conclusion to the narrative in (40). Again, the context establishes an unresolved condition which might prevent complement actualization, and which is causally independent of shame: here, it is possible that the consultant simply had the inoffensive version of the survey.

(40) *Context.* Two versions of a survey were prepared for a policy consultant to take door to door. One version had unusually detailed questions about sexual preferences which were not included on the other. The policy consultant was only given one version, but you are not sure which one.

a. #Hän **kehtas-i** kysy-ä niin henkilökohtais-i-a asio-i-ta.
he.NOM unashamed-PST.3SG ask-INF such personal-PL-PART thing-PL-PART
'He acted without shame in asking something so personal.'
→ *He asked the personal questions.*

Examples (37)-(40) support the prerequisite account over the catalyst proposal. In each case, two-way verbs are judged infelicitous when a causally necessary condition independent of the specified prerequisite is explicitly left unresolved in the discourse context. This is good evidence for the claim that implicative prerequisites are backgrounded as causally sufficient in addition to being causally necessary for complement realization.

There is, in addition, a predictable contrast between contexts like (37)-(40) and contexts where causally relevant and potentially unresolved conditions are left unmentioned. In such a context—for instance, if the background for (39a) establishes only that the hunter was reaching for food when he spotted the bear, and the issue of bullets is not made salient—the use of *ehtiä* is not only felicitous, but moreover licenses the inference that time was the only potential obstacle for shooting the bear. Positive resolution of the time condition—as asserted by (39a)—allows us to infer that the hunter shot the bear. Taken together with the evidence from (37)-(40), this suggests that an account of implicatives which includes a(n accomodatable) precondition of causal sufficiency is on the right track.

5.3 Circumscription, presupposition, and implicature

In Proposal (32), the difference between one- and two-way predicates is captured by the difference between a single presupposition of causal necessity and a dual presupposition, which adds causal sufficiency to causal necessity. The condition $A(x)$ invoked by a one-way verb is only taken to

be necessary for the realization of the implicative complement, whereas the condition invoked by a two-way implicative is taken to be sufficient as well.

The second presupposition, (32)iii, is formulated in a particular way: causal sufficiency of $A(x)$ for $P(x)$ is established by closing off the possibility that any necessary conditions other than $A(x)$ are left unresolved in context. This is a 'what you see is what you get' presupposition—or, to be more precise, a presupposition that 'what you see is all there is' (WYSIATI; Kahneman 2011). Essentially, we take it for granted that the causally necessary condition that has been brought to our attention (made salient by the causal necessity presupposition of an implicative) is the only relevant condition for determining the truth of the implicative complement.

This kind of reasoning—from the highlighting of a single condition to the conclusion that alternative conditions of the same type are not contextually relevant—is a very natural form of pragmatic reasoning. I want to suggest that it is precisely the WYSIATI inference, drawn at the pragmatic level in the case of one-way implicatives, which accounts for the observed tendency for positive assertions of one-way verbs to defeasibly implicate their complements. These implicatures are spelled out for *jaksaa* ('have the strength') and *mahtua* ('fit,', 'be small enough') in (5)-(30).

(5) a. Sampo **jakso-i** noust-a.
Sampo have.strength-PST.3SG rise-INF
'Sampo had the strength to rise.' ⇝ *Sampo rose.*

(30) a. Freija **mahtu-i** kulke-ma-an ove-sta.
Freija fit-PST.3SG go-INF-ILL door-ELA
'Freija was small enough to go through the door.' ⇝ *Freija went through the door.*

Bolstering this hypothesis, Karttunen (2012) draws a parallel between these implicatures and the well-known pragmatic phenomenon of **conditional perfection** (Geis and Zwicky, 1971). In cases of conditional perfection, a statement of the form *if R, (then) Q* is interpreted biconditionally, as *Q if and only if R.* (41) is an example of conditional perfection.

(41) You will get an A on the test if you study Chapter 5.
   a. *Implicature:* You will not get an A on the test if you do not study Chapter 5.
   b. *Perfected interpretation:* You will get an A on the test if and only if you study Chapter 5.

The two phenomena—conditional perfection and the complement implicatures of non-negated one-way implicatives—both involve WYSIATI inferences. In each case, the listener infers from the mention of a single condition (R or $A(x)$) that it is in fact the *only* contextually-relevant condition for the relevant conclusion (Q or $P(x)$). In cases of conditional perfection, we infer necessity (41a, above) from asserted sufficiency. For implicative implicatures, we infer causal sufficiency from presupposed causal necessity. Since the necessity-sufficiency direction is reversed in the implicative case, I will refer to these inferences as instances of **antiperfection**.

Implicative verbs are not the only evidence for the existence of causal perfection and antiperfection implicatures. Nadathur and Lauer (2020) analyze periphrastic causatives like *cause* and *make* in terms of causal dependency relations, focusing on the claim that *make* (as in "Gurung made the children dance") asserts that the bringing-about relationship between a cause and its effect is one of causal sufficiency. Empirically, however, there are many uses of *make* that seem to license inferences about (causal) necessity:

(42) *Context.* the speaker is on trial for participating in the blocking of a coal train in Spokane, Washington. The action was undertaken in an effort to protest global warming.

a. ?Climate change made me do it.
$\rightsquigarrow$ *I would not have done it, were it not for climate change.*

Nadathur and Lauer explain this phenomenon as one of **causal perfection**, an inference about the structure of a causal dynamics. Causal perfection proceeds from the stated availability of a single (sufficient) causal pathway for the realization of a particular effect, to the conclusion that no other causal pathway to this effect are consistently realizable in context. This makes the *make*-cause (climate change, in example 42) a necessary as well as sufficient condition. The analogy with conditional perfection is immediate.

Implicative antiperfection inferences also involves reasoning about the structure of a causal dynamics. **Causal antiperfection** might also be expected to arise in the interpretation of necessity causatives.[21] It remains to be seen whether the fourth permutation—*conditional antiperfection*—arises as a natural-language inference pattern.

The WYSIATI reasoning involved in (anti)perfection is also known as *(predicate) circumscription* (McCarthy, 1980, p.27, emphasis in original):

> "Circumscription is a rule of conjecture that can be used by a person or program for 'jumping to certain conclusions'. Namely, *the objects that can be shown to have a certain property P by reasoning from certain facts A are all the objects that satisfy P.*"

In the semantics/pragmatics literature, McCarthy's circumscription has been formalized as the (pragmatic) operation of *exhaustive interpretation*, introduced by Groenendijk and Stokhof (1984) and further developed in van Rooij and Schulz (2004); Schulz and van Rooij (2006); Spector (2007). The idea here is that one-way implicative implicatures—instances of causal antiperfection—arise through circumscription/exhaustive interpretation, as long as the utterance context does not preclude the results of the operation.[22]

We have seen that two-way implicatives are infelicitous when a condition independent of $A(x)$ is explicitly left unresolved. Moreover, they are accommodated when no other factors are mentioned. From use of a two-way implicative, listeners will infer a background in which all causal conditions for $P(x)$ other than $A(x)$ are met. This inference is distinguished from antiperfection implicatures, by not being at issue (and thus not defeasible) in the discourse context. Formulating the causal sufficiency presupposition of Proposal (32) as one of circumscription thus establishes a natural continuity between one- and two-way predicates.

On this view, two-way implicatives have lexicalized their antiperfection, resulting in two-way entailments. One-way implicatives leave antiperfection to the pragmatic dimension, where it arises easily in contexts where no alternative causal conditions for the implicative complement are salient. The lexicalization hypothesis remains speculative, but may find some support in Flint's (1980) taxonomy of Finnish verbs of possibility and sufficiency. Flint ranks implicatives with similar lexical content by the strength with which they invite the conclusion that their complements hold. On this view, the distinction between presupposed and implicated causal sufficiency is gradient rather than sharp (see also White, 2019). The degree of fluidity involved,

[21] Assuming, of course, that pure necessity causatives exist. Certain treatments of English *cause* suggest that it minimally indicates (causal) necessity, but the broad consensus goes against a view on which this is all that *cause* predicates.

[22] Franke (2009) and Nadathur (2013) offer accounts of conditional perfection in terms of pragmatic exhaustive interpretation. These accounts are to be distinguished from *exhaustification* accounts of conditional perfection, which rely on a proposed grammatical operator *exh* (Fox, 2007; Chierchia et al., 2012). Herburger (2015) offers an analysis of conditional perfection in the latter style.

which verbs are subject to it, and the potential relevance of any frequency or usage effects are left as matters for future investigation.[23]

5.4 Polarity-reversing implicatives

One more group of predicates deserves attention: polarity-reversing implicatives like *fail* and Finnish *laiminlyödä* ('neglect'; 44). As (43)-(44), show, asserting a two-way polarity-reversing implicative entails the negation of its complement; denying the implicative entails complement actualization.

(43) 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.*

(44) 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 the error.*
b. Hän e-i **laiminlyö-nyt** korjat-a virhe-ttä.
he.NOM NEG-3SG neglect-PP.SG repair-INF error-PART
'He did not neglect to repair the error.' → *He corrected the error.*

There are two straightforward ways to extend Proposal (32) to polarity-reversing implicatives, both involving a minor change to presuppositional content. The first possibility is that a polarity-reversing implicative backgrounds the highlighted condition $A(x)$ as causally necessary for $\neg P(x)$; this derives the negative entailments in (43b) and (44b) immediately, and the positive entailments in (43a) and (44a) as a result of circumscribing $A(x)$ as the only causally necessary condition in question. Alternatively, $\neg A(x)$ might be backgrounded as causally necessary for $P(x)$. If we choose the latter option, the entailments in (43a) and (44a) follow directly, and the negative entailments will be derived via circumscription. The data from two-way polarity-reversing implicatives alone do not provide a clear basis for preferring one option over the other.

One-way polarity-reversing implicatives resolve the issue. *Hesitate* and its Finnish equivalent *epäröidä* (46) entail complement actualization under matrix negation, but, like polarity-preserving one-way implicatives, do not entail in the positive case.

(45) a. Amira **hesitated** to drink a beer. ↛ *Amira did not drink a beer.*
b. Amira did not **hesitate** to drink a beer. → *Amira drank a beer.*

(46) a. Juno **epärö-i** otta-a osa-a kilpailu-un
Juno hesitate-PST.3SG take-INF part-PART race-ILL
'Juno hesitated to take part in the race.' ↛ *Juno did not take part in the race.*
b. Juno e-i **epäröi-nyt** otta-a osa-a kilpailu-un
Juno NEG-3SG hesitate-PP.SG take-INF part-PART race-ILL
'Juno did not hesitate to take part in the race.' → *Juno took part in the race.*

Since the positive entailments (from $A(x)$ to the negation of the implicative complement) are the ones that disappear in the one-way case, it seems as if the negative entailments should be taken as more basic. In particular, this favours an analysis on which the presupposition shared by one- and two-way polarity-reversing implicatives takes a condition $A(x)$ to be causally necessary

[23] This hypothesis has a non-trivial interaction with the type of condition (namely, actionable or inherently eventive) that is specified by an implicative verb. See note 20.

for the failure of the implicative complement. Then, as in the polarity-preserving cases, two-way polarity-reversers can be analyzed as having lexicalized the circumscriptive reasoning that produces the inferences in (43b) and (44b), while one-way polarity-reversers have not.

A final observation: where one-way polarity-preserving implicatives are strongly associated with antiperfection implicatures, as discussed above, the tendency towards these inferences is for some reason much weaker in the polarity-reversing case. More surprising still is the apparent potential for positive assertions of one-way polarity-reversing verbs to generate implicatures which follow a factive pattern (that is, which do not change with matrix polarity), as well as implicatures in the implicative pattern. Whether an implicative- or factive-type inference is drawn (if either is) depends heavily on context.

(47) Juri **hesitated** to ask for help.

a. *Implicative:* $\rightsquigarrow$ Juri didn't ask for help (because of her hesitance).

b. *Factive:* $\rightsquigarrow$ Juri asked for help (after some time had passed).

(48) Leo **ujostel-i** näyttä-ä kuva-{a/n} minu-lle.
Leo shy-PST.3SG show-INF picture-{PART/GEN} me-ILL
'Leo was shy to show me the picture.'[24]

a. *Implicative:* $\rightsquigarrow$ Leo did not show me the picture (due to shyness).

b. *Factive:* $\rightsquigarrow$ Leo showed me the picture (with reluctance).

The implicative-type inference in (47a) is likely to arise in a context in which (47) is offered as a (polite) explanation for the number of mistakes in Juri's homework, while (47b) might be a more natural interpretation in a context where (47) instead addresses the lateness of the assignment. Similarly, I might use (48) to implicate (48a) (i.e., to provide a negative answer) if someone asks me if I know what Leo's long-distance partner looks like. (48b) is a more reasonable inference to draw if I am explaining why it took me so long to come back from my visit to Leo with a description of the individual in question.

The availability of both types of inference opens up questions about the semantic relationship between implicative and factive verbs. If one-way polarity-reversing verbs like *hesitate* can, in fact, trend towards the factive pattern, this may shed some light on results from Karttunen et al. (2014) and Tonhauser et al. (2020), which indicate a certain fluidity in the use of implicative- or factive-type inferencing for phrasal, evaluative-adjective constructions like *be lucky to*. I leave an investigation of these connections for future work.

6 Conclusions and outlook

Building on Baglini and Francez's (2016) novel causal account of implicative *manage*, I have proposed a general semantics for the implicative verb class which (a) derives the characteristic implicative entailment pattern first described by Karttunen (1971), (b) avoids endorsing an undesirable functional equivalence between an implicative assertion and that of its bare (reconstructed) complement, and (c) captures projective inferences about the non-triviality of complement realization (Coleman, 1975; Karttunen and Peters, 1979, among others). The account draws on Schulz's (2011) causal **dynamics** (in turn based on Pearl 2000); I proposed that implicative verbs across the one- and two-way subtypes background the existence of a causally-necessary condition for their complements (specified to a greater or lesser degree depending on

[24] In Finnish, case marking within the embedded proposition seems to correlate with which implicature is preferred. In (48), partitive marking on *kuva* ('picture'), seems to privilege a factive inference, while the genitive/accusative marker privileges an implicative inference.

both language and verb), and assert that this condition was realized in the utterance context. To capture the bidirectional entailment pattern of two-way implicatives, I further proposed that these verbs encode a second, circumscriptive presupposition, to the effect that the lexically-invoked prerequisite is the only unresolved causal condition for the implicative complement.

Unlike previous treatments of implicative semantics, which focus almost exclusively on two-way *manage*, the account offered here provides a natural link between one- and two-way implicatives via the pragmatic prevalence of circumscriptive (exhaustive) reasoning (McCarthy, 1980; Groenendijk and Stokhof, 1984). In addition to considering lexically-specific English implicatives like *dare,* and *condescend*, I further support the proposal with data from the rich Finnish implicative paradigm, which includes not only a counterpart to semantically-bleached *manage* (*onnistua*; 2), but also a wealth of lexically-specific one- and two-way verbs of both the polarity-preserving and polarity-reversing types.

The success of a causal approach in capturing the class-level semantic behaviour of implicatives raises a number of questions which deserve closer scrutiny. One of these, which involves exploring potential gradience in the factive-implicative semantic boundary, is discussed in Section 5.4. Of particular interest going forward is a class of phrasal *enough* and *too* predicates, described by Karttunen as predicates which "must sometimes be understood in an implicative, sometimes in a non-implicative sense" (1971; 354).

(49) a. ?[Boehner] **was smart enough** to leave once he saw the direction his party was going.

$\rightsquigarrow$ *Boehner left [the party].*

b. ?When I played soccer as a chubby little ten-year-old, I **was too slow** to score any goals, so my dad (who was the coach) had me play defense.

$\rightsquigarrow$ *I did not score any goals.*

(50) a. ?Best part of this or any reunion was the cast feeling bad for Sean and swearing he **was smart enough** to be a neurosurgeon.

$\not\rightsquigarrow$ *[The cast believed that] Sean was a neurosurgeon.*

b. ?I had a friend who taught for a while who really **was too stupid** to be a teacher.

$\not\rightsquigarrow$ *My friend was not a teacher.*

Whether or not they invite implicative inferences, *enough/too* predicates link (some degree) of the matrix adjective to the potential for complement realization, and convey a relationship of sufficiency (*enough*) or excess (*too*) between the subject's allotment and the degree required for complement realization.

The distribution of implicative behaviour in *enough/too* constructions is important for (at least) two reasons. First, despite the general (requirement) link between the matrix property attribution and the realization of the *enough/too* complement, there is an intuitive difference between the conditions invoked by *enough/too* predicates and those invoked by two-way implicatives like *dare* (or Finnish *uskaltaa*; 4). In particular, *enough/too* property attributions are at base uniformly stative, and give rise to implicative inferences only where they describe characteristics that have actionable potential (*be fast enough, be too slow*; Nadathur 2017, 2019). A comparison between examples like (49a)-(49b) and one-way implicatives like Finnish *jaksaa* ('have strength'; 5), which often describe similarly latent (but actionable) capacities promises therefore to shed light on the nature of the lexical divide between one- and two-way semantic implicativity.

Secondly, Hacquard (2005) observes that the implicative inferences of French *enough/too* (*assez/trop*) constructions show sensitivity to grammatical aspect. Under perfective marking in (51a), *être assez rapide* ('be fast enough') entails the realization of its complement, while implicative behaviour remains at best defeasible in the imperfective case in (51b).

(51) French *enough/too* inferences:

a. *Khalil* ***a été assez rapide*** *pour s'enfuir, #mais il ne s'est pas enfui.*
'Khalil was-PFV fast enough to escape, #but he did not escape.'

b. *Khalil* ***était assez rapide*** *pour s'enfuir, mais il ne s'est pas enfui.*
'Khalil was-IMPF fast enough to escape, but he did not escape.'

These data strengthen the link between between implicativity and the longstanding puzzle of aspect-sensitive **actuality entailments** from ability modals, first observed (for aspect-marking Greek and Hindi) by Bhatt (1999); (52) replicates the phenomenon for French abilitative *pouvoir* ('can').

(52) French actuality entailments:

a. *Eman* ***a pu*** *soulever cette table, #mais elle ne l'a pas soulevée.*
'Eman could-PFV lift this table, #but she did not lift it.'

b. *Eman* ***pouvait*** *soulever cette table, mais elle ne l'a pas soulevée.*
'Eman could-IMPF lift this table, but she didn't lift it.'

Although actuality entailments seem to arise in the composition of circumstantial (abilitative) modality and perfective aspect, they have proven difficult to explain in terms of the received semantics for either component (see, among others, Hacquard 2009; Mari and Martin 2007; Piñón 2009; Mari 2016; Homer 2021, for accounts which re-examine facets of one or both elements). Bhatt's original proposal sidesteps the 'standard' compositional problem by assigning ability predicates (ABLE, subsuming English *be able* and ability modals in Greek, Hindi, and other aspect-marking languages) the two-way 'direct assertion' semantics of Karttunen and Peters's (1979) *manage*: this approach, however, fails to account for the contrast between lexical implicatives, which entail their complements under imperfective as well as perfective marking (see French *réussir* in 53), and the aspect sensitivity of actuality entailments, shown in (52).

(53) French implicative *réussir* ('succeed', 'manage'):

a. *Khalil* ***a réussi*** *à s'enfuir, #mais il ne s'est pas enfui.*
'Khalil managed-PFV to escape, #but he did not escape.'

b. *Khalil* ***réussissait*** *à s'enfuir, #mais il ne s'est pas enfui.*
'Khalil managed-IMPF to escape, #but he did not escape.'

The causal approach to implicative semantics offers a new perspective on the data in (52), and one which has the potential to make good on the intuition that actuality entailments are instances of implicative behaviour. Where Bhatt's original proposal attempts to establish equivalence at the lexical level (between ABLE and *manage*/*réussir*), the causal approach—and in particular its rapprochement between one- and two-way implicative verbs—suggests that the real equivalence may instead be analytical, so that the semantic components of implicativity (causal dependence, a necessary and sufficient prerequisite, and so on), which operate as a package deal for lexical implicatives, come together only at the compositional level (see also Nadathur, 2019, 2021). A starting point for such an account would be the one-way analysis of English *be able* (and its Finnish counterpart *pystya*; 29) anticipated by Karttunen (1971): however, a detailed investigation of the consequences of a causal analysis of ability for the standard premise semantics approach (Kratzer, 1981, 2012) and the composition of abilitative modality and grammatical aspect—and thus, ultimately the success of a causal implicative account of actualized ability—will have to be undertaken elsewhere.

Appendix: Sources for naturally-occurring examples

Below, example numbers refer to the number under which the example occurs in the main text.

(6a) Tempting fate, I dared to open an umbrella indoors.
kool1079.com/tempting-fate-i-dared-to-open-an-umbrella-indoors/
Last retrieved on: 2019-02-05

(6b) That is a technical explanation, and it does not throw light on precisely why Mr. Sinha condescended to meet the tainted persons in the first place.
www.dailypioneer.com/2014/columnists/director-in-deep-trouble.html
Last retrieved on: 2019-03-05

(14a) Without intending to, Ms. Streisand actually managed to synthesize the problem of diversity mania.
www.baltimoresun.com/news/opinion/oped/bs-ed-op-0814-goldberg-20170813-story.html
Last retrieved on: 2018-12-04

(14b) By 1998, four years after a federal ban on assault weapons took effect, gun manufacturers had easily managed to bypass the law by making small alterations to their weapons.
www.motherjones.com/politics/2008/07/semiautomatic-people/
Last retrieved on: 2019-01-05

(14c) The social democrats (Socialdemokratiet) managed to strengthen their position as Denmark's strongest political force as expected during local elections.
www.kas.de/nordische/en/
Last retrieved on: 2018-12-04

(42a) Climate change made me do it: activists press the 'Necessity Defense'.
www.forbes.com/sites/legalnewsline/2018/01/10/climate-change-made-me-do-it-activists-press-the-necessity-defense/#721ecb0553e0
Last retrieved on: 2018-01-25

(49a) [Boehner] was smart enough to leave once he saw the direction his party was going.
www.twitter.com/i/web/status/868633857926582273
Last retrieved on: 2018-04-03

(49b) When I played soccer as a chubby little ten-year-old, I was too slow to score any goals, so my dad (who was the coach) had me play defense.
www.theladders.com/career-advice/measure-the-process-not-the-results
Last retrieved on: 2019-04-09

(50a) Best part of this or any reunion was the cast feeling bad for Sean and swearing he was smart enough to be a neurosurgeon.
www.reddit.com/r/survivor/comments/jzixz9/would_you_do_what_richard_did_to_win/
Last retrieved on: 2022-01-09

(50b) I had a friend who taught for a while who really was too stupid to be a teacher.
www.proteacher.net/discussions/showthread.php?p=3540844
Last retrieved on: 2022-01-09

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