Causal semantics for implicative verbs

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Abstract

Implicative verbs (e.g., *manage, dare*) are characterized by complement inferences (Karttunen, 1971). English *manage* entails its complement; the entailment reverses polarity with matrix negation, and is accompanied by a projective inference to the complement's non-triviality (Coleman, 1975; Karttunen and Peters, 1979). I use data from Finnish and English to argue that the implicative inferential profile is derived from backgrounded relations of *causal necessity* and *causal sufficiency* (defined over 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 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 complement), we have the following relationships:

$$\text{(i)} \ \ I(x, P) \to P(x) \hspace{4cm} \text{(ii)} \ \ \neg I(x, P) \to \neg P(x)$$

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).

$$\text{(iii)} \ \ I(x, P) \equiv P(x)$$

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 a verb like *manage* is taken to piggyback on the assertion of its complement, and thus 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*. For Baglini and Francez (2016), *manage* presupposes the truth of a causally necessary but insufficient *catalyst* situation for its complement, and asserts that this catalyst was efficacious in the reference context (i.e., that it *actually caused* the complement to occur). While this approach improves on that of Karttunen and Peters, it cannot be satisfactorily extended to an account of the broader implicative class, which includes a range of 'specific' verbs such as *dare* and its Finnish counterpart *uskaltaa*: alongside the standard complement entailments, these verbs license polar inferences about particular actions of the sentential subject.

(3) a. Ana **dared** to enter the cave. $\hspace{2cm} \to$ *Ana entered the cave.*
 Licenses: Ana was daring (behaved courageously).

 b. Ana did not **dare** to enter the cave. $\hspace{1.5cm} \to$ *Ana did not enter the cave.*
 Licenses: Ana was not daring (did not behave courageously).

(4) a. Juno **uskals-i** avat-a ove-n.
 Juno dare-PST.3SG open-INF door-GEN/ACC
 'Juno dared to open the door.' $\hspace{2.2cm} \to$ *Juno opened the door.*
 Licenses: Juno was daring (behaved courageously).

 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.' $\hspace{1.2cm} \to$ *Juno did not open the door.*
 Licenses: Juno was not daring (did not behave courageously).

In (3)-(4), the presence or absence of courageous action—that is, action of a sort specified by the main verb—appears determinative (necessary and sufficient) for complement realization.

Since daring is present in (3a)/(4a) but lacking in (3b)/(4b), it cannot be part of an already-realized catalyst in the spirit of Baglini and Francez. Verbs like *dare* are typical of the English and Finnish implicative paradigms, thus privileging an approach on which implicative claims highlight and characterize an unsettled but determinative condition for their complements, rather than focusing attention on an established but non-determinative part of the causal chain.

Where prerequisite-specifying verbs resist analysis on the catalyst approach, *manage* and *onnistua* can be treated on the prerequisite account as underspecified instances of the implicative class: they too presuppose the relevance of a causally necessary and sufficient condition for their complements, but (unlike *dare/uskaltaa*) do not characterize this condition. The prerequisite approach also improves on prior analyses in offering a unified treatment of 'two-way' complement entailing verbs (examples 1-4) and a related class of 'one-way' implicatives (Karttunen, 1971, 2012) like Finnish *jaksaa* ('have the strength'; 5), which share the overall inferential structure of *dare/uskaltaa*, but weaken the positive complement inference to a defeasible implicature.

(5)   a. Sampo **jakso-i**   noust-a.
         Sampo have.strength-PST.3SG rise-INF

         'Sampo had strength to rise.' $\rightsquigarrow$ ($\not\rightarrow$) *Sampo rose.*
         Licenses: Sampo was strong.

      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.*
         Licenses: Sampo was not strong.

On the prerequisite approach, one-way verbs reduce the presupposed matrix-complement relationship to one of causal necessity alone, but are otherwise identical to their two-way cousins. Accounting for the one-way profile on either the Karttunen and Peters or Baglini and Francez approaches requires changes to both presupposition and assertion, conflicting with the robust intuition that verbs like *dare, uskaltaa*, and *jaksaa* share a semantic core.

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 implicative verbs 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 ingredients of an analysis

Karttunen (1971) suggests that the false equivalence between an implicative claim and its complement (relation (iii) in Section 1) is blocked by presuppositional material associated with the implicative verb. The idea is that an implicative restricts the contexts in which it is felicitously used to a subset of the contexts which license its bare (reconstructed) complement. As a result, implicative constructions license inferences which do not follow from the complement alone.

While this suggestion has been widely adopted in work on implicative *manage*, consensus on the precise presuppositional content has proven elusive. Karttunen and Peters (1979) argue that

manage introduces a projective inference of effort, as in (6a) (see also Bhatt 1999), but others (e.g., Givón, 1973; Coleman, 1975) have suggested that *manage* instead presupposes trying (6b), intention (6c), or even the unlikeliness of its complement (6d).

(6) Solomon managed / did not manage to build the temple.
   a. ⟩⟩ Building the temple was effortful for Solomon.
   b. ⟩⟩ Solomon tried to build the temple.
   c. ⟩⟩ Solomon intended to build the temple.
   d. ⟩⟩ It was unlikely that Solomon would build the temple.

Adjudicating between these proposals is complicated by the observation (Coleman, 1975; Baglini and Francez, 2016) that while each of (6a)-(6d) is individually plausible, *manage* can be felicitously used in contexts where any one of these inferences is denied.

(7) a. $^{\gamma}$By 1998, [. . .] gun manufacturers had **easily** managed to bypass the laws by making small alterations to their weapons.[1]
   b. $^{\gamma}$**Without even trying**, Trent Reznor and his musical colleague Atticus Ross managed to win a Country Music Association Award.
   c. $^{\gamma}$**Without intending to**, Ms. Streisand actually managed to synthesize the problem of diversity mania.
   d. $^{\gamma}$The social democrats (Socialdemokratiet) managed to strengthen their position as Denmark's strongest political force **as expected** during local elections.

The empirical picture becomes clearer if we look beyond *manage*. Alongside their characteristic complement entailments, each of the verbs in (8)-(11) invokes some condition or factor which is required (prerequisite) for complement realization. English *dare* in (8) indicates a need for courageous action, as does Finnish *uskaltaa* ('dare'; 4). *Condescend* in (9) suggests that attending the meeting required Sinha to suppress disdain; Finnish *viitsiä* ('bother'; 10) indicates a need to overcome apathy, while *malttaa* ('have patience'; 11) indicates a need to be patient (act patiently). Finnish is particularly rich in implicatives of this sort, with verbs invoking arrogance (*röyhjetä*), (lack of) shame (*kehdata*), hard-heartedness (*hennoa*), and so on.

(8) a. $^{\gamma}$I **dared** to open an umbrella indoors.   → *I opened the umbrella.*
   b. I did not **dare** to open an umbrella indoors.   → *I did not open the umbrella.*
   (8a), (8b) ⟩⟩ Opening an umbrella indoors required me to be daring.

(9) a. $^{\gamma}$Mr. Sinha **condescended** to meet the tainted persons.
                                     → *Sinha met the tainted persons.*
   b. Mr. Sinha did not **condescend** to meet the tainted persons.
                            → *Sinha did not meet the tainted persons.*
   (9a), (9b) ⟩⟩ Meeting the tainted persons required Sinha to suppress disdain.

(10) a. Hän   **viits-i**   vastat-a.
       he.NOM bother-PST.3SG answer-INF
       'He **bothered** to answer.'   → *He answered.*
   b. Hän   e-i   **viitsi-nyt**   vastat-a.
       he.NOM NEG-3SG bother-PP.SG answer-INF
       'He didn't **bother** to answer.'   → *He did not answer.*
   (10a), (10b) ⟩⟩ Answering required him to take an interest.

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

(11)   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.*
        (11a), (11b) ⟩⟩ Waiting required Marja to be patient.

Each of the 'requirement' inferences projects through negation, supporting a presuppositional diagnosis (Chierchia and McConnell-Ginet 1990). Extrapolating from these data, I take it to be uncontroversial that implicatives indicate that some prerequisite condition must be satisfied in order for their complements to be realized. Moreover, as shown for *dare/uskaltaa* in (3)/(4), and for *malttaa* ('have patience') below, positive implicative claims license the inference that their prerequisite was satisfied, while negative claims indicate that it was not. Consequently, (non)satisfaction of the prerequisite correlates with (non)realization of the implicative complement, suggesting a relationship of sufficiency as well as of necessity between the two.

(11)   a. Marja **maltto-i** odotta-a.
           'Marja had the patience to wait.'
           Indicates: Marja was patient (and so she waited).

       b. Marja e-i **maltta-nut** odotta-a.
           'Marja did not have the patience to wait.'
           Indicates: Marja was not patient (and so she did not wait).

I suggest, then, that verbs in the implicative class background the existence of a *potential obstacle* (see also Karttunen 2014): overcoming this obstacle, by means of some prerequisite action, is both necessary and sufficient for complement realization.[2]

From this perspective, the chief dimension of semantic variation between implicative verbs lies in what they lexicalize about the nature of the implicative obstacle—or rather, about the sort of activity that is needed to overcome it. The verbs in (8)-(11) are all specific in their characterization of this activity: *manage* and *onnistua* ('succeed', 'manage'; 2) are not. As I will suggest later, non-specificity may well explain the apparent variability of *manage*'s presuppositions: presumptions of effort, intention, unlikeliness, and so on are contextual enrichments of a presupposition which indicates the existence of a potential obstacle, but is not informative about either the nature of this 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) $\neg P(x)$[3]

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[2]The notion of an obstacle captures an important aspect of the prerequisite-complement relationship which is not always apparent from a verb's paraphrase or gloss. The prerequisites referenced by implicatives verbs involve *action* that bridges a gap between established facts and complement realization. The relevant action may be characterized by an individual-level property (e.g., patience in 11), or by the nature of the 'gap', as with the Finnish verb *ehtiä* ('find/make time'), which indicates that the time available for effecting the complement is short. In this case, the prerequisite involves fitting any necessary preparation into the available temporal space. See Flint (1980) for more detailed discussion of the types of obstacles invoked by Finnish implicatives.

[3]A reviewer questions whether implicative verbs necessarily entail their complements, noting that (1)—in which Bo does not realize a *complete* (culminated) instance of the complement—seems non-contradictory.

(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; accordingly, it follows from $I(x, P)$ that the obstacle was overcome, and from $\neg I(x, P)$ that it was not

As (8)-(11) show, the conditioning relationship in Fact A belongs to the projective (*not at-issue*) content of an implicative. Since both complement and prerequisite/obstacle inferences (Facts B-C) are sensitive to matrix polarity, they are best classified as entailments. It is not yet clear whether these entailments should be captured as asserted (at-issue) contributions, or as consequences of what is at-issue in an implicative claim. The analytical task is thus to determine a division of semantic labour which will capture Facts A-C across the full range of verbs.

When the facts are laid out as above, a schema for implicative semantics suggests itself immediately: implicatives presuppose the existence of a necessary and sufficient prerequisite for their complements, and establish the satisfaction of this prerequisite (thus realizing the complement) by means of asserted content (cf. Karttunen 1971). Indeed, *modulo* the introduction of a causal element, this is what I will propose. I suspect that the reason that such an account has not so far been prevalent is due to the literature's singular focus on implicative *manage*, which obscures the key role of a prerequisite due to its non-specificity.

The two accounts to be considered in opposition to the prerequisite analysis are due to Karttunen and Peters (1979) and Baglini and Francez (2016). The Karttunen and Peters proposal, on which *manage* introduces only presuppositional material, succeeds to some extent in capturing Facts A-B, but cannot explain the prerequisite inferences in Fact C; it also cannot account for certain empirical contrasts between the interpretation of adverbially-modified implicative claims and their identically-modified complements. Baglini and Francez use this shortcoming to motivate treating *manage*'s asserted content as non-trivial. On their catalyst proposal, *manage* presupposes the truth and salience of a (causally) necessary but insufficient situation for complement realization, and asserts that this situation *actually caused* the complement, so that a positive *manage* claim establishes that a causal chain between catalyst and complement was completed, and a negative claim establishes that it was not. Again, this is enough to capture Facts A-B, but, as we will see, it forces implicative prerequisites to be external to the referenced causal background, creating problems for an account of Fact C in the general case.

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(1) Bo dared to run a marathon (but did not finish it).

I agree with this judgement, but believe the culprit is the availability of a non-culminated reading for the complement accomplishment, rather than a non-entailing semantics for *dare*. In support of this view, 'non-entailing' readings are ruled out for activity or achievement complements (*write fiction, summit Kilimanjaro*; implicatives are marginal with statives), whereas accomplishments like *run a marathon* are independently observed to license both 'participation' (process-only) and 'completion' readings in certain contexts. Setting aside cases where *dare* has prosodic emphasis (thus introducing metalinguistic effects), the main claim in (1) minimally entails the initiation of its complement. If accomplishment predicates can describe both culminated and non-culminated eventualities (see, e.g., Parsons 1990; Koenig and Muansuwan 2000; Szabó 2008; Nadathur and Filip 2021), then the required non-initiation reading in (1) is in fact predicted by a complement-entailing *dare* (together with a principle of pragmatic cooperativity which pushes interpreters to disambiguate in favour of non-contradictory meanings).

Adjudicating between different treatments of accomplishments is beyond the scope of this paper. However, it is worth noting that a theory on which accomplishment predicates denote only culminated eventualities privileges a causal account of implicativity (Baglini and Francez 2016 or this paper's proposal) over the received Karttunen and Peters (1979) approach. Implicative assertions are equivalent to complement assertions for Karttunen and Peters: thus, if $\sqrt{}$*Bo run a marathon* picks out only complete marathon-runnings, the same is true of $\sqrt{}$*Bo manage to run a marathon*. Both causal approaches instead take implicative assertions to instantiate (parts of) a causal chain for the complement. This is compatible with situations where the (durative) complement is initiated but then interrupted (as in *imperfective paradox* effects; Dowty 1979), as long as we specify that causal precipitation of an eventuality requires completing a causal chain that leads up to the start time of the result eventuality in question.

The remainder of the paper is structured as follows. Section 3 examines the received Karttunen and Peters account of *manage*, motivating Baglini and Francez's introduction of a causal semantic component. Section 4 introduces the technical tools for defining causal dependencies. With this machinery in hand, Section 5 assesses Baglini and Francez's catalyst proposal with respect to Facts A-C, as well as against additional data from one-way implicatives (see, e.g., 5), using this discussion to motivate and argue for the prerequisite perspective. Section 6 formalizes the prerequisite proposal, and provides some additional supporting arguments. Section 7 summarizes the main claims of the paper and offers some directions for further investigation.

3   The division of labour in implicative semantics

3.1   Direct assertion and its discontents

Taking ostensible justification from Karttunen's (1971; pp.349–350) observation that "all that takes place when John *manages to do* something is that he does it", Karttunen and Peters (1979) propose that *manage*'s asserted content is identical to that of its (bare) complement, adding only the presupposition that complement realization was effortful for the implicative subject.[4]

(12)   **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 $(P(x) = 1)$

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

Where it arises, the effort inference as formulated in (12)ii projects through negation (see 6a). The results of embedding a *manage* claim under *discover* also appear to support the direct assertion analysis: as a presupposition 'hole', *discover* is expected to embed any ordinary entailments of its prejacent, but to project the prejacent's presuppositions (Karttunen, 1973). This is exactly what we see: (13) commits a speaker to the embedded claim (13a) and the unembedded presupposition (13b), but crucially not to the embedded effort inference in (13c).

(13)   I just discovered that Solomon **managed** to build the temple.
   a.   *Entails:* I just discovered that Solomon built the temple.
   b.   *Licenses:* Building the temple was effortful for Solomon.
   c.   *Does not license:* I just discovered that building the temple was effortful for Solomon.

Since Karttunen and Peters's *manage* asserts its complement, it is immediately obvious that (12) captures Fact B. Insofar as any attempt to overcome a potential obstacle for complement realization requires action (thus, effort) from the *manage*-subject, the direct assertion approach is also compatible with Fact A, broadly construed. Despite these apparent successes, however, several challenges remain, calling into question not only the content of (12)ii, but also the semantic division of asserted and presuppositional content proposed in (12). These issues ultimately motivate turning to an alternative approach.

First, while the effort-demanding nature of a *manage*-complement can reasonably be construed as a potential obstacle to its realization, judgements about the presence or absence of effort do not match judgements about the prerequisites of lexically-specific implicatives (Fact

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[4]Karttunen and Peters classify (12)ii as *conventional implicature*, the label under which they aim to unify projective phenomena. I do not adjudicate between this and a presupposition classification here, but take the view that an implicative's projective content seems less aligned with current theories of conventional implicature (Potts, 2005) than with the admittedly heterogeneous behavior of presuppositions (see Tonhauser et al., 2013).

C). Where the presence of courageous action and patience is governed by matrix polarity in (3) and (11), respectively, effort is typically assumed to be present regardless of the polarity of a *manage* claim, as shown in (14).

(3) a. Ana **dared** to enter the cave.
      Licenses: Ana was daring (and so she entered the cave).

 b. Ana did not **dare** to enter the cave.
      Licenses: Ana was not daring (and so she did not enter the cave).

(11) a. Marja **maltto-i** odotta-a.
      'Marja had the patience to wait.'
      Licenses: Marja was patient (and so she waited).

 b. Marja e-i **maltta-nut** odotta-a.
      'Marja did not have the patience to wait.'
      Licenses: Marja was not patient (and so she did not wait).

(14) a. Solomon **managed** to build the temple.

 b. Solomon did not **manage** to build the temple.

 (14a), (14b) *license:* Solomon worked toward/put effort into building the temple.

This suggests that the subject's output of effort is itself presupposed (taken for granted), rather than entailed (as per Fact C); if effort is indeed what *manage* presupposes, it cannot be identified with the necessary and sufficient prerequisites introduced by more specific verbs.

However, inferences about effort (and/or *trying*; Givón 1973) do not seem to capture the full range of projective content associated with *manage*. Coleman (1975) points out that *manage* can be felicitous in contexts which deny not only the need for effort, but even that the sentential subject intends for the complement to be realized. (15a) explicitly denies that Harry attempted to insult Ursula—and, accordingly, suggests that doing so was not effortful. (15b) is acceptable whether or not the dog intends to wake Harry, and (15c) neither requires that the neighbors meant to cause problems for the speaker, nor that it was difficult to do so.

(15) 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.

To explain these data, Coleman suggests that the 'vanishing' inferences are in each case supplanted by a weaker presupposition, so that the not at-issue contribution of *manage* varies systematically between the three options in (16): trying, difficulty, and unlikeliness.

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

 a. Solomon tried to build the temple.

 b. It was difficult for Solomon to build the temple.

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

On Coleman's view, variation is governed by a strength-based ordering: *trying* indicates intention and difficulty, *difficulty* indicates volition (effort) and unlikeliness, and unlikeliness is the minimal felicity requirement for *manage*. In any given context, the strongest tenable presupposition is expected to hold (see also Fillmore 1975; Dalrymple et al. 1998). Thus, if context rules out intention, as in (15a), we retain a presupposition of difficulty; if effort is also contextually

denied, complement unlikeliness must still be supported.[5] Coleman therefore predicts *manage* to be infelicitous if—and only if—unlikeliness (the weakest presupposition) fails.

As Baglini and Francez (2016) point out, natural examples of the sort in (7) (repeated below) do not support Coleman's hierarchy, because they fail to license intention, effort, and/or unlikeliness inferences in the predicted relationships. Crucially, *manage* can be felicitous where unlikeliness fails, independently of contextual support for intention and/or effort.

(7)   a. $^\gamma$By 1998, [. . .] gun manufacturers had easily managed to bypass the laws by making small alterations to their weapons.
     $\rightsquigarrow$ *intent,* ? $\rightsquigarrow$ *effort,* $\not\rightsquigarrow$ *unlikeliness*

     b. $^\gamma$Without even trying, Trent Reznor and his musical colleague Atticus Ross managed to win a Country Music Association Award.
     $\not\rightsquigarrow$ *intent,* ? $\rightsquigarrow$ *effort,* ? $\rightsquigarrow$ *unlikeliness*

     c. $^\gamma$Without intending to, Ms. Streisand actually managed to synthesize the problem of diversity mania.
     $\not\rightsquigarrow$ *intent,* $\not\rightsquigarrow$ *effort,* $\rightsquigarrow$ *unlikeliness*

     d. $^\gamma$The social democrats . . . managed to strengthen their position as Denmark's strongest political force as expected during local elections.
     $\rightsquigarrow$ *intent,* ? $\rightsquigarrow$ *effort,* $\not\rightsquigarrow$ *unlikeliness*

While it is clear that *manage* places (not at-issue) constraints on its utterance context, it is evidently difficult to offer a precise characterization of these constraints. One way around the problem—suggested by Baglini and Francez (2016) and taken up in the next section—is to treat *manage*'s presuppositional contribution as fairly abstract: that is, to distill the presupposition down to some general semantic core which is compatible with inferences of intention, effort, and/or unlikeliness as (locally-driven) contextual enrichments.

A second, perhaps more fundamental problem for the direct assertion proposal in (12) has to do with the structure of asserted content. According to Karttunen and Peters, *manage* itself contributes nothing to the at-issue dimension, simply co-opting the assertion of its complement. This evidently predicts the observed two-way complement entailment pattern (Fact B), but cannot account for the interpretation of *manage* claims under modification by *because*.

As shown in (17), temporal and locative modifiers are straightforwardly 'inherited' by the complement of an implicative claim (Karttunen, 1971). This is consistent with the direct assertion proposal, insofar as any at-issue modification of the *manage* claim should apply directly to its at-issue content (i.e., the complement proposition).

(17)   Yesterday, in class, Mika **managed** to solve the riddle.
     $\rightarrow$ *Yesterday, in class, Mika solved the riddle.*

The pattern fails, however, when *manage* is modified by a *because*-adverbial. (18a) does not license an inference to its modified complement in (18b):

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

     b.   Juno opened the safe because it was unlocked.

The modifier in (18a) is explanatory, indicating how or why Juno succeeded in opening the safe (i.e., providing information about how a potential obstacle was overcome). In (18b), however,

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[5]Coleman (1975) focuses on *manage*, but argues that implicatives like *happen* and polarity-reversing *fail* (see Section 6.4) also invoke strength-ordered presuppositional content; her suggestion is thus that ranked presuppositions (along with complement entailments) are a distinguishing feature of the implicative class.

the same clause addresses Juno's motivation—suggesting, for instance, that she was guided by idle curiosity. These two interpretations are largely complementary: the explanatory reading is at best marginal for (18b), and the motivational reading is ruled out for (18a).

This difference 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 any process that modifies asserted content. The simplest explanation for the contrast in (18) is that the proposed assertion (12)i of the direct assertion account is incorrect: i.e., that either the implicative or its (bare) complement asserts something that the other does not.

3.2 An alternative approach

Baglini and Francez (2016) offer a new approach to implicative *manage* which aims to address the problems with Proposal (12). Although I will argue that their proposal must also be revised, the semantics I ultimately propose builds on its key innovations. It is therefore worth setting out the analysis in some detail. I begin here with a brief and informal overview.

The first major innovation of Baglini and Francez's 'catalyst' approach is in its treatment of implicative assertions. Baglini and Francez argue that the *because*-clause contrast illustrated in (18) is evidence of a non-trivial difference between the at-issue contribution of a *manage* claim and that of its bare 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 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 6 differs from Proposal (19) 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.

Alongside 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 (7) and (15) are explained by generalizing the not at-issue contribution of *manage*. Since what *manage* projects varies with contextual cues, Baglini and Francez it in fact presupposes something rather abstract, formulated in a manner that lends itself to context-driven pragmatic enrichment.

The central insight of Proposal (19) is that implicative presuppositions operate by imposing causal constraints on the relationship between the utterance context and the realization of a particular complement proposition. The catalyst proposal achieves this by backgrounding a relationship of *causal necessity* and *causal insufficiency* between (a set of) established facts and the *manage*-complement. The causal link is completed via the assertion in (19)ii, which conveys 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). Negating *manage* denies efficacy (resulting in non-realization of the complement).

(19) **The catalyst account of *manage*.**   (Baglini and Francez, 2016)
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** $P(x)$

The catalyst proposal in (19) 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 complement entailment

pattern. Moreover, since (19)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), (19) appears to offer an intuitive pragmatic account of the enrichments to projective content observed in (7) and (15).

The real test of Proposal (19) rests in the precise formulation of its key causal dependence relations: *causal necessity, causal (in)sufficiency,* and *actual cause.* The next section introduces Schulz's (2011) **causal dynamics** framework as a basis for the relevant definitions. Section 5 examines the catalyst proposal in detail: I argue that, while Baglini and Francez improve substantially on the direct assertion approach, the account remains incomplete. More importantly, although the catalyst concept does (at least at first) appear to capture the 'non-specificity' of *manage*, as compared to verbs like *dare* (3) and *malttaa* ('have the patience'; 11), Proposal (19) as formulated does not naturally extend to more specific verbs, and thus to a class-level semantics for implicatives. Consequently, the proposed causal relationships (between background information, assertion, and the implicative complement) must be revised.

4 Modeling causal dependencies

This section introduces the notion of a **causal model**. My aim 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 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 on the use of SEM, and the types of models built within this framework are not the only ones that support an approach on which linguistic causation subsumes multiple distinct causal dependency relations.[6] 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).

4.1 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 their typical consequences. Reasoning about causal expectations relies on three things: a starting context (or set of facts), 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:

(20) **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.

(20a) describes a relevant set of causal laws, and (20b) provides a specific starting context. Taking (20a) and (20b) together leads us naturally to certain conclusions: we expect that the

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[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).

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 (20a) to work out the normal causal consequences of the situation in (20b).

A structural equation causal model is one way of formalizing this type of reasoning. 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 links between propositional variables, in which the existence of a particular arrow indicates 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 (20) involves three propositional variables. The opening of the door is 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 (20a), the value of O depends on the values of B and S; B and S do not depend on any other variables. Figure 1a provides the corresponding graphical representation.

$$f_O = \begin{array}{cc|c} B & S & O \\ \hline 0 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \\ 1 & 1 & 1 \end{array}$$

(a) (b)
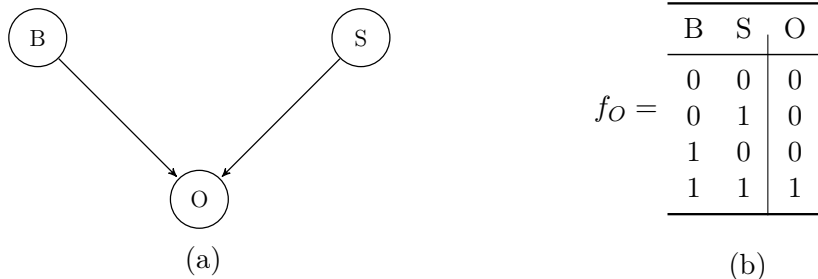
Figure 1: Graphical model for the automated door scenario

Figure 1a does not capture all of the information in (20a), 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*, one for each dependent variable, 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 $O := B \land S$, or as the equivalent truth table in Figure 1b. Since (20) involves only one causally dependent variable (the state of the door), the appropriate causal model includes only one structural equation.

The situation s described by (20b) assigns the value 0 to B and 1 to S. This corresponds to the second line of the truth table in Figure 1b; thus, assuming that the evaluation world is causally normal, we conclude that, as a consequence of s, the train door is not 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.

4.2 Dynamics for causal entailment

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

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

  F is rooted *in β.*

A *dynamics* encodes the causal structure of a closed system. *Background* (or *exogenous*) 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) a 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) a function f_X which encodes the nature of the relevant dependencies (i.e., the structural equation for X). The requirement that F is *rooted* in β precludes circular chains of causation, by ensuring that 'walking backwards' 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 (Pearl, 2000).

Definition 2 (Rootedness). *Let $\beta \subseteq \Sigma$ be a set of proposition letters, and F a function mapping elements X 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 and equation in Figure 1 constitute a dynamics $\mathcal{D}_d = \langle \Sigma_d, \beta_d, F_d \rangle$ for the automated door scenario in (20). $\Sigma_d = \{B, S, O\}$, with $\beta_d = \{B, S\}$ the set of background variables and $\xi_d = \{O\}$ the set of causally-dependent inner variables. Function F_d associates O with the set $Z_O = \{B, S\}$ and the function f_O, represented as a truth table in Figure 1b.

Schulz works with a trivalent logic, 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]

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[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 $\phi, \psi \in \mathcal{L}_\Sigma$. $\mathcal{L}_\Sigma$ is interpreted in the strong Kleene logic, 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 $\mathcal{L}_\Sigma^\gg$. Since my purpose here is to introduce specific causal dependence relations within the SEM framework, I do not discuss $\mathcal{L}_\Sigma^\gg$, 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); $\langle X, 0 \rangle$ is the proposition that X is false, $\langle X, 1 \rangle$ is the proposition that X is true, and so on.

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 can use the causal laws in $\mathcal{D}$ to check for causal consequences. Schulz defines an operator $\mathcal{T}_{\mathcal{D}}$ which extends s to a larger situation by adding its immediate consequences, in effect running the dynamics on s for a single step. If s determines the full set of parents of any undetermined inner variable X, $\mathcal{T}_{\mathcal{D}}$ uses f_X (Definition 1) to calculate the causally-appropriate value for X, and adds this to s in the output. Note that $\mathcal{T}_{\mathcal{D}}$ can only update undetermined inner variables; it cannot assign values to undetermined background variables, or change the values of inner variables which are already determined by s.

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 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 $\langle X, x \rangle$ just in case computing all of the causal consequences of s (its maximal normal causal development) leaves us with a situation in which X has the value x.

Applying $\mathcal{T}_{\mathcal{D}_d}$ formalizes the reasoning we used in situation (20b) (where the train is stopped but Ria has not pressed the button) to work out that the train door is shut. A single application of $\mathcal{T}_{\mathcal{D}_d}$ to the background situation $s = \{\langle B, 0 \rangle, \langle S, 1 \rangle, \langle O, u \rangle\}$ involves checking the value of O in the second line of the truth table in Figure 1b, 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 B, S, and O are the only relevant variables ($\Sigma_d = \{B, S, O\}$), no further updates are possible, and $\mathcal{T}_{\mathcal{D}_d}(s) = s^*$, the fixed point of $\mathcal{T}_{\mathcal{D}_d}$ on s. Since O is valued at 0 in s^*, we have $s \models_{\mathcal{D}_d} \langle O, 0 \rangle$: given the dynamics D_d (Figure 1), situation s in (20b) causally entails that the door is shut.

4.3 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. Intuitively, 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*

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

Definition 8 (Supersituation, subsituation). *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 $s'(X) = s(X)$. Situation s is a **subsituation** of s' iff s' is a supersituation of s.*

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.

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:* $\langle X, x \rangle \rhd_s \langle Y, y \rangle$

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

    i. $s[X \mapsto x]$ *has a consistent supersituation s' 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: $\langle X, x \rangle \lhd_s \langle Y, y \rangle$.

These definitions capture intuitive ideas about (fact-based) necessity and sufficiency.[8] 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 $\langle X, x \rangle$: $\langle X, x \rangle$ completes a causal pathway for the effect $\langle Y, y \rangle$, thereby guaranteeing $\langle Y, y \rangle$. 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 $\langle X, x \rangle$: $\langle X, x \rangle$ 'opens up' the possibility of $\langle Y, y \rangle$ by making available one or more consistent pathways to $\langle Y, y \rangle$ (which were unavailable in the absence of $\langle X, x \rangle$).

I return to the automated door scenario to illustrate Definitions 10a-b. Instead of the situation in (20b), however, 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 (determining $\langle B, 1 \rangle$) is both causally necessary and sufficient for opening the door ($\langle O, 1 \rangle$).

(21) **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 Figure 1b, where O takes value 1. Since the resulting situation $\mathcal{T}_{\mathcal{D}_d}(s'_S) = \{\langle B, 1 \rangle, \langle S, 1 \rangle, \langle O, 1 \rangle\}$ determines all of Σ_d, we have $\mathcal{T}_{\mathcal{D}_d}(s'_S) = s^*_S$, the 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 (21a), 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 (20b); 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_S are satisfied, and $\langle B, 1 \rangle \triangleleft_{s_S} \langle O, 1 \rangle$. □

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[8]Definitions 10a-b are necessarily 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 cause is sufficient for the effect). Consequently, any fact in a cause-entailing background situation would be 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 s to entail either cause or effect means that s itself makes available a consistent causal pathway to $\langle Y, y \rangle$, obviating the causal role of $\langle X, x \rangle$.

4.4 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 be put to work in the central proposal of this paper, formalized in Section 6. However, the definitions in 10 are not precisely the same as those needed to cash out the catalyst proposal in (19): 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* between situations and facts in a given world. I provide these definitions below, before turning to a discussion of the catalyst proposal.[9]

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 $\mathrm{Anc}(X) = \big\{ Y \in \Sigma \mid R_F^T(X, Y) \big\}$, 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 $s \triangleright \langle X, x \rangle$.*

(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 $s \triangleleft \langle X, x \rangle$.

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 12b 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 (22) illustrates Definitions 12a-b using the automated door example.

(22) **Situation-based causal dependence in the automated door scenario.** Let s_S be a situation for the door in (20a) 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 $s_S = \{\langle B, u \rangle, \langle S, 1 \rangle, \langle O, u \rangle\}$, $s_S \not\triangleright \langle O, 1 \rangle$. Situation s_S is causally complete (s_S is its own 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 $s_S \not\triangleright \langle O, 1 \rangle$ by Definition 12a. $\qquad\square$

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

    1. We need to consider alternative situations s' which differ from s_S on some determination from 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 Figure 1b, $\mathcal{T}_{\mathcal{D}_d}(s_B) = \{\langle B, 1 \rangle, \langle S, 0 \rangle, \langle O, 0 \rangle\}$; therefore, $s_B \models_{\mathcal{D}_d} \langle O, 0 \rangle$.

        (c) By Figure 1b, $\mathcal{T}_{\mathcal{D}_d}(s_{\neg\neg}) = \{\langle B, 0 \rangle, \langle S, 0 \rangle, \langle O, 0 \rangle\}$; 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 $s_S \vartriangleleft \langle O, 1 \rangle$.   □

Lastly, per Definition 13, the relation of *actual cause* holds between a situation and a fact in a world which makes both true (Baglini and Francez, p.554).[10]

Definition 13 (Actual cause). *Given a dynamics $\mathcal{D}$, a world w, and a variable $X \in \xi = \Sigma - \beta$, situation s* **actually causes** $\langle X, x \rangle$ *iff $s(X) = u$, $w(X) = x$, and w is a supersituation of s.*

As a final illustration, 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; this is proved in (22). Per Definition 13, 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 5, 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*).

5   *Manage* and other implicatives

5.1   A closer look at the catalyst proposal

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

(19)   **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** $P(x)$

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[10]A reviewer rightly observes that Definition 13 is puzzlingly weak, as it does not require that the caused fact is causally dependent on dom(s) (nor even that w is consistent with s). Consequently, a situation s_{ir} can *actually cause* an independent fact $\langle X, x \rangle$ (where $X \in \Sigma - \beta$, Anc(X)$\cap$dom(s_{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 (19) 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 intuitive notion of actual cause is a topic of some interest in the causal modeling literature; see, e.g., Pearl (2000), Halpern and Pearl (2005), Halpern (2015) (and references therein) for more detailed discussion and alternative definitions.

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, (19)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 (19)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 (19) 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 (19)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 facts set out in Section 2 for implicative 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; accordingly, it follows from $I(x, P)$ that the obstacle was overcome, and from $\neg I(x, P)$ that it was not

The catalyst proposal (19) evidently captures Fact B. It also appears to capture (albeit indirectly) the notion of an *obstacle*, central to Facts A and C. By (19)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 Nadathur 2019, pp.296–298), asserting that catalyst s actually caused $P(x)$ tells us that its insufficiency was overcome: that is, that s was appropriately supplemented, thus precipitating $P(x)$. A negative assertion conveys that supplementation did not occur, resulting in the failure of $P(x)$.

The final automated door context from Section 4.4 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 opening button: the u-valuation of B thus presents a potential obstacle for $\langle O, 1 \rangle$ (see $\mathcal{D}_d$; Figure 1). A positive claim (*Ria managed to open the door*) informs us not only that the door opened, but also—assuming that the evaluation world is causally normal—licenses the inference that Ria pressed the door-opening button, setting $\langle B, 1 \rangle$ and so overcoming the obstacle. A negative claim (*Ria did not manage to open the door*) establishes that the door did not open, and licenses the inference that Ria did not press the button ($\langle B, 0 \rangle$): indeed, suggesting that the catalyst failed to actually cause $\langle O, 1 \rangle$ *because* Ria did not supplement it in the appropriate, obstacle-overcoming way.

This scenario also illustrates how Fact C is handled by the catalyst proposal. Once catalyst s_S is fixed, the truth value of complement O is fully predicted by whether or not Ria presses the

button: $\langle B, 1\rangle$ is both causally necessary and sufficient for $\langle O, 1\rangle$ relative to s_S (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.[11]

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 (19). The backgrounded relationship between a familiar catalyst s and $P(x)$, together with *actual cause*, requires the existence of a condition which is determinative for $P(x)$ relative to s: realizing this condition precipitates $P(x)$, while its failure (implied by negated *manage*) produces $\neg P(x)$ as a causal consequence.[12] Since s is, by construction, compatible with both $P(x)$ and its negation, it must further be the case that the prerequisite is causally relevant for $P(x)$ in $\mathcal{D}$, and that neither its truth nor falsity is entailed by s alone. In other words, the catalyst proposal indirectly mandates the existence of a catalyst-indepedent, causally-relevant condition for $P(x)$ whose truth value is decisive for $P(x)$ relative to s.[13] The existence of such a condition means that Proposal (19) does in a sense capture Fact C. However, the prerequisite's causal role calls into question the intuition behind *actual cause*; I discuss the problem at the end of this section. Moreover, as Section 5.2 will show, the fact that the (implicit) prerequisite is not directly referenced by either (19)i or (19)ii is a problem for the analysis of lexically specific implicatives.

Insofar as the catalyst proposal captures Facts A-C (indirectly or otherwise), it improves on 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 supplies a natural explanation for the context-sensitivity of *manage*'s projective content (cf. Coleman 1975). Since a dynamics is carried as a discourse parameter, and *manage* does not identify specific propositions comprising a familiar catalyst (or the associated prerequisite), what is known or uncovered in a specific context can support a key role for effort, intention, complement unlikeliness, or other factors. Example (23) illustrates; the accompanying dynamics is in Figure 2).

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[11]While Proposal (19) is compatible with the notion of an obstacle, nothing ensures that the subject x plays an active role in overcoming the obstacle, as per Fact A. The causal condition needed to supplement catalyst s_S in the door context (the Fact C prerequisite) does involve action by Ria, but this is a contextual artefact, and does not follow from (19). Given $\mathcal{D}_d$, we can describe an alternative catalyst $s_B = \{\langle B, 1\rangle, \langle S, u\rangle, \langle O, u\rangle\}$ such that the supplementary (prerequisite) condition—$\langle S, 1\rangle$—is not influenced by Ria. Per (19), backgrounding s_B should make *manage* felicitous, even though Ria cannot act to overcome the obstacle (and so make s_B efficacious).

A reviewer finds this problematic for (19), 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*. Proposal (19) should ideally be revised, then, to require x's involvement in either the catalyst or some (implicit) supplementary cause for $P(x)$.

It seems to me that felicity in contexts like s_B, where x is only active in the utterance background, is specific to *manage*. For more specific verbs, x must be actively involved in the realization of an obstacle-overcoming prerequisite, independently of involvement in a catalytic background. This is reflected in Proposal (32).

[12]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 under $\wedge, \vee, \neg$). The requirement that α be 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 $\neg P(x)$.

[13]Given a dynamics $\mathcal{D}$ for Σ, a situation s, 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 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 s iff any variable Z which occurs in α is causally independent of s.

(23) **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.

$$\text{ATT} := \text{ASK}$$
$$\text{STO} := \text{ATT} \wedge (\neg\text{DLO} \vee \neg\text{HRS} \vee \text{ALC})$$
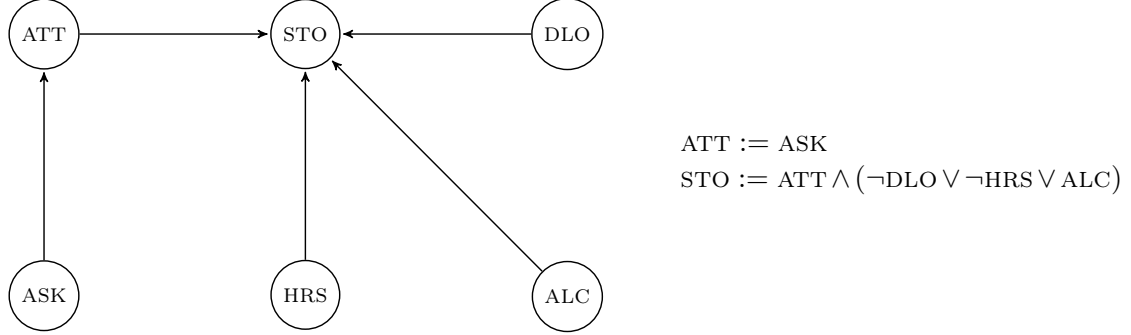
Figure 2: Dynamics $\mathcal{D}_o$ for the opera scenario

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

According to Proposal (19), (23a) is licensed when s_{ASK} is salient and true. Given s_{ASK}, (23a) tells us that Maya succeeded in sitting through the opera, leading to the inference that $(\neg\text{DLO} \vee \neg\text{HRS} \vee \text{ALC})$ also held—i.e., that either Maya enjoyed the opera $(\langle\text{DLO}, 0\rangle)$, it took less than two hours $(\langle\text{HRS}, 0\rangle)$, or she had a drink at intermission $(\langle\text{ALC}, 1\rangle)$. Without more information, we cannot draw any conclusions as to which of these possibilities precipitated $\langle\text{STO}, 1\rangle$: 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 unlikely.

It is easy to see, however, that learning something further about the situation can 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_{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.

On the catalyst proposal, then, specific inferences of effort, intent, unlikeliness, and so on (Coleman's 'vanishing' presuppositions) follow from how from particular contexts sort causal ancestors of $P(x)$ 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 (19) also offers an account of the *because*-clause contrast in (18), repeated below. Baglini and Francez argue that distinguishing the at-issue contribution of

$manage(x, P)$ from that of $P(x)$ explains why a *because*-clause receives different interpretations in (18a) and (18b). On Proposal (19), *because* in (18a) modifies the *actual cause* assertion, thus explaining why the catalyst was in fact efficacious for $P(x)$ (despite its insufficiency). In (18b), 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.

(18) 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, (18a) 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. If we take some action by Juno—say, pulling on the safe's handle—to be the familiar catalyst, an unmodified assertion of (18a) indicates that this action was efficacious, licensing the inference that some un(der)specified potential obstacle was circumvented. With the *because*-clause, 18a additionally indicates that Juno's catalyst succeeded due to the safe's being unlocked (identifying the possibility that it was locked as the relevant potential obstacle). By proxy, then, the state of the lock was contextually decisive for the *manage*-complement: it stands in for the catalyst-external prerequisite whose existence can be inferred from the catalyst proposal.

While I concur with Baglini and Francez that the contrast in (18) 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 (19)ii's predication of *actual cause* between an established catalyst and the implicative complement in the general case. If positive *manage* establishes that some familiar situation was implicated in bringing the *manage*-complement about, but was crucially insufficient on its own, then *manage* plausibly conveys that the determinative condition for complement realization rested with the catalyst-external prerequisite, and not the catalyst at all.[14] What I want to suggest, then, is that—by mandating the existence of a determinative condition which stands between the catalyst and its efficacy for $P(x)$—the catalyst proposal is at least compatible with a conception of the catalyst-external prerequisite as the proximate cause of *manage*'s complement. This runs counter to the intuition behind identifying a familiar catalyst as the *actual cause* of $P(x)$.

Before moving to lexically specific implicatives, I note one last puzzle 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 scenario suggested by 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.

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[14]For instance, in the final automated door context, where the train being stopped acts as a catalyst, and Ria's action is the catalyst-external prerequisite, it seems more accurate to describe Ria's action as *actually causing* the door to open than to apply this description to the catalyst. As noted, the definition of *actual cause* is quite weak, so this objection is perhaps more terminological than formal: I find it counterintuitive to label a familiar catalyst as 'actual cause' when complement realization may have a more proximate cause. The literature on *causal selection* is too extensive to discuss here, but it is worth noting that a 'final' (precipitating) causal influence is more likely to be labeled *a* (or *the*) *cause* of a given effect than a 'familiar' but contextually non-decisive set of facts (see, e.g., Halpern and Hitchcock, 2015; Icard et al., 2017; Hitchcock, 2020; Henne et al., 2021).

In context, (25a) is a felicitous way to convey that Kayvan got to school by bus or car, while (25b) is appropriate if neither option worked out. However, since either biking or walking would individually be enough to get Kayvan to school, the joint failure of these options 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. For instance, I find (25b) to be a reasonable description of a situation in which the first thing Kayvan hears on Friday morning is a radio announcement that the roads are closed due to snow, and consequently neither forms the intention nor makes any concrete attempt to travel. I see no obvious way of constructing a dynamics for (25a) which gets around the problem of necessity.[15]

Proposal (19) can make sense of data like (25) if we redefine a catalyst as a situation comprising facts that are causally relevant and collectively insufficient for the complement $P(x)$, dropping the necessity requirement. Together with the assertion in (19)ii, however, this makes (25a) amount to the claim 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 disjunctive cause scenarios, the proposed *actual cause* assertion remains suspect. Even under the weaker catalyst conception suggested above, Proposal (19) mandates the existence of a catalyst-external, causally determinative condition (in 25, the complex proposition that Kayvan traveled by bus or car), which I take to motivate an account which focuses more explicitly on an unsettled, obstacle-overcoming prerequisite. As Section 5.2 shows, the case for such an account—that is, one which maintains a causal semantics in the spirit of Baglini and Francez, thus preserving many of their improvements over 'direct assertion', but which eschews the problematic *catalyst* and *actual cause* elements—is only strengthened by considering lexically specific verbs.

5.2 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 (19) can be extended to more paradigmatic verbs, such as *dare* (26) and Finnish *hennoa* ('have the heart'; 27). Like the lexically specific verbs in Section 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. $\rightarrow$ *He killed the cat.*
          Licenses: He was daring (and so he killed the cat).

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[15]A similar problem arises for the opera dynamics $\mathcal{D}_o$ (Figure 2) in a context s_{AD} which establishes both that 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 (23a) 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 (19)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.

b. He didn't **dare** to kill the cat.   → *He didn't kill the cat.*
    Licenses: He was not daring (and so he did not kill the cat).
  (26a), (26b) ⟩⟩ Daring was required for him to 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.*
      Licenses: 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

      'He didn't have the heart to kill the cat.'   → *He didn't kill the cat.*
      Licenses: He was not hard-hearted (and so he did not kill the cat).
  (27a), (27b) ⟩⟩ Hard-heartedness was required for him to 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, 11 in Section 3.1). These inferences are spelled out in (26) and (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 subject needs to 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 (19), extending the catalyst approach to (26)-(27) would mean specifying daring/hard-heartedness as part of a 'familiar' catalyst: this is evidently incompatible with the role played by these prerequisites. By (19)i, a familiar catalyst is 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/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 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 10) and Finnish *malttaa* ('have the patience'; 11). In (28), Juri's engagement (active 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 (11a) indicates that Marja waited as a result of being patient, while (11b) 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.*

(11)   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.*

To reiterate points made in Section 2, lexically specific implicative verbs presuppose the existence of a specific prerequisite whose resolution is determinative for their complements. This is the basis of Fact C. I take the prerequisite to be *causally* determinative (i.e., causally necessary and sufficient) for complement realization; further support for this assumption is given in Section 6. Section 5.1 showed that the existence of just such a determinative condition is mandated by the catalyst proposal for *manage*: this section argues that, since lexically specific verbs name their prerequisites, these verbs directly reference determinative conditions for their complements, instead of indicating their existence as indirect consequences of a catalyst's familiarity.

The not at-issue contribution of lexically specific verbs cannot be incorporated into a catalyst. However, it is fairly straightforward to reconcile causal *manage* with the prerequisite perspective. Where *dare* or *hennoa* lexicalizes a particular prerequisite $A(x)$ (the realization by x of some condition A) as causally determinative for complement $P(x)$, *manage* leaves A underspecified, and thus subject to contextual enrichment. This effectively inverts the intuition behind a catalyst. From the prerequisite perspective, the not at-issue contribution of *manage* establishes the existence of a causally-determinative condition for its complement. Just as the existence of such a condition follows from the familiarity of a catalyst, the prior satisfaction of some situation s which is causally relevant for (and conducive to) the truth of $P(x)$ follows from the presupposed relevance of a causally-determinative prerequisite.[16]

From this perspective, *manage* and its Finnish counterpart *onnistua* are generalized alternatives to more specific verbs. An implicative-licensing context may or may not contain information about the nature of a causal prerequisite for 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 might select *dare* (or Finnish *uskaltaa*) as the matrix verb, while *manage* (or *onnistua*) are available if the speaker is unable or unwilling to characterize the prerequisite for $P(x)$. Focusing on a prerequisite's contextual causal relevance, rather than on the settled causal background (as per Proposal 19) 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 and the *because*-clause contrast in 18.

5.3 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 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 positive (29a) only licenses an implicature to complement realization.

(29) a. Maarit **pysty-i**   tappelema-an.
          Maarit able-PST.3SG fight-INF

          'Maarit was able to fight.' $\not\to$ ($\rightsquigarrow$) *Maarit fought.*

      b. Maarit e-i   **pysty-nyt** tappelema-an.
          Maarit NEG-3SG able-SG.PP fight-INF

          'Maarit was not able to fight.' $\to$ *Maarit did not fight.*

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[16]More precisely, if a particular condition $A(x)$ is the only thing standing in the way of complement $P(x)$, any causal ancestors of $P(x)$ outside of A must already by settled in the complement-conducive way. Taken as an established situation, the set s roughly corresponds to Baglini and Francez's catalyst. Situation s need not be causally necessary for $P(x)$ (as example 25 shows), but must be part of a complete causing situation for $P(x)$: minimally, augmenting s with $A(x)$ is sufficient for $P(x)$, and augmenting s with $\neg A(x)$ results in $\neg P(x)$.

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-way verbs. The potential for a unified approach is nevertheless appealing—in particular, an approach on which one- and two-way verbs share some distinctive semantic core (*qua* implicatives), with the 'missing' positive entailment in (29a) explained by adding, subtracting, or otherwise modifying some isolatable semantic element from the representation of a two-way verb. While it is in principle possible to modify the catalyst proposal to account for one-way implicatives, this approach is subject to objections of the sort raised in Sections 5.1-5.2. Moreover, the modifications required to unify one- and two-way verbs on the catalyst perspective again lampshade the existence of a determinative prerequisite, reinforcing the idea that the prerequisite perspective offers a more straightforward and indeed natural view of implicative meaning.

On Baglini and Francez's approach, the distinguishing lexical semantic feature of an implicative 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, it seems reasonable that any attempt to unify one-way implicatives with two-way verbs on this analysis should preserve the catalyst concept. The discussion at the end of Section 5.1 showed that a *manage*-licensing background situation need not be causally necessary for complement $P(x)$, leaving us with a revised definition of a catalyst as comprising facts which are (a) causally relevant for $P(x)$ and (b) causally compatible (given dynamics $\mathcal{D}$) with both $P(x)$ and $\neg P(x)$. Combined with the assertion of *actual cause* (as per 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 more consequentially, the definition of actual cause means that altering the composition of a presupposed catalyst will not affect 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 a complement entailment from a positive implicative claim, counter to the empirical data in (29a).[17]

A catalyst-preserving approach to one-way verbs must therefore diverge from (a modified) Proposal (19) 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 (but crucially does not entail) $P(x)$ under positive polarity. While it is possible to define such a relation—call it *allows*—in the dynamics framework, replacing *actual cause* with *allows* as the asserted content of a one-way implicative ultimately suffers from the same conceptual shortcomings as actual cause in the two-way context.[18] In

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[17]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 note 10).

[18]Defining an appropriate *allows* relation is not straightforward. For instance, in parallel with the definition of actual cause, we would like s *allows* $\langle X, 1\rangle$ in a world w to be true just in case s leaves open a causal pathway to $\langle X, 1\rangle$. However, since a world w necessarily determines all of Anc(X), and thus entails a determination for X itself, s *allows* $\langle X, 1\rangle$ in world w is effectively indistinguishable from actual cause in Definition 13 as long as w is assumed to be causally normal. The problem is not insurmountable: we can instead define *allows* in terms

particular, since the catalyst is 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 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 in the one-way context is causally necessary but need not be 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 condition which is causally necessary for the realization of their complements, but only two-way verbs presuppose that this condition also sufficient.

Based on the preceding discussion, it seems to me that a prerequisite-focused approach to one-way verbs is simpler and more perspicacious than the catalyst view, and should therefore be preferred. Section 5.2 argued that the prerequisite approach is needed 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.[19]

(5) a. Sampo **jakso-i** noust-a.
Sampo have.strength-PST.3SG rise-INF

'Sampo had strength to rise.' $\rightsquigarrow$ *Sampo rose.*
Licenses: 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.' $\rightarrow$ *Sampo did not rise.*
Licenses: Sampo lacked the required strength (and so did not rise).

(29a), (29b) $\rangle\rangle$ Rising required strength from Sampo.

(30) a. Freija **mahtu-i** kulke-ma-an ove-sta.
Freija fit-PST.3SG go-INF-ILL door-ELA

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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 further details of an appropriate *allows* relation as an exercise for the interested reader.

[19]The most fluent English gloss ('have strength' or 'have the strength') does not fully capture the interpretation of *jaksaa* (5); in the same way that *mahtua* ('fit') in (30) describes an action that is in some sense characterized by being (sufficiently) small, *jaksaa* indicates not the latent possession of strength, but instead action characterized by this property. One empirical consequence of the difference is that while it is possible (albeit marginal) to 'get around' a lack of strength for English *have the strength*, a similar continuation is contradictory with *jaksaa* (1b).

(1) a. Sampo did not have the strength to get up, but he somehow did it anyway.

b. Sampo e-i jaksa-nut noust-a, #mutta jotenkin hän nous-i kuitenkin.
Sampo NEG-3SG have.strength-PP.SG rise-INF, #but somehow he.NOM rise-PST.3SG however.

'Sampo did not have strength to rise, #but he somehow rose anyway.'

The availability of (1a) is an interesting puzzle in its own right. There is an intuitive connection between complex predicates like *have the strength* and simplex (lexical) implicatives, but (1a) shows that their implicative properties (and thus their underlying semantics) are not identical. I deal only with the simplex cases in this paper, leaving the exploration of complex predicates as a topic for other work.

        'Freija fit through the door.' $\rightsquigarrow$ *Freija went through the door.*
        Licenses: Freija fit/was small enough (and so it was possible to go through).

  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.' $\rightarrow$ *Freija did not go through the door.*
      Licenses: Freija did not fit/was not small enough (and so did not go through).

     (30a), (30b) $\rangle\rangle$ Going through the door required Freija to fit (be small enough).

Jaksaa ('have the strength'; 5) and *mahtua* ('be small enough, fit'; 30), like their two-way cousins in Section 5.2, project the relevance of a particular prerequisite, and license polar inferences about its status. Thus, even if we set aside Finnish *pystya* (and its counterpart *be able*; see Karttunen 1971, 2012) as a 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 two-way verbs like *dare* and *hennoa* ('have the heart'). Apart from the particular prerequisite specified, the only difference between *dare, hennoa, bother* and *malttaa* (26-28; 11), on the one hand, and *jaksaa* (5) and *mahtua* (30), on the other, is in the consequences that prerequisite satisfaction has for the implicative complement: satisfying the prerequisite guarantees $P(x)$ in the two-way cases, but not for the one-way verbs considered here.

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. Baglini and Francez's catalyst proposal 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. I have outlined such an account over the course of Section 5; the next section spells it out directly.

6 Causal necessity and sufficiency in implicative verbs

I am pursuing an account of implicativity that preserves the causal component introduced by Baglini and Francez (2016), but which invokes a contextually-determinative prerequisite instead of a catalyst. This account should derive Facts A-C (see Section 2), with the caveat that one-way implicatives do not exhibit the positive entailment $(I(x, P) \rightarrow P(x))$. We saw in Section 5.3 that one-way implicatives parallel two-way verbs in conveying that complement realization hinges on the resolution of a particular prerequisite. This suggests that what is at-issue remains consistent across the one- and two-way classes. Consequently, the contrast between one- and two-way verbs should follow from a minimal difference in not at-issue content.

Karttunen (1971, p.352) 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: $v(S)$*

To convert Karttunen's schema into a full analysis, we need to identify the "central part of the proposition." Based on the preceding discussion, a natural candidate is the causally-determinative prerequisite whose status is resolved by the polarity of an implicative claim.

I propose to 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 (including, in particular, the interpretation of *because*-clauses; see Section 5.1), the importance of a causal component is further emphasized by examples 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 *deontic*, rather than causal. The markedness of (31a) thus strongly suggests that a deontically necessary and sufficient prerequisite cannot license *manage*. Moreover, attempting to make sense of (31a) invites conjecture about the relevance of non-legal conditions for Amira's drinking: we might infer that it was logistically difficult for Amira to obtain wine, or that she suffered a physical reaction which made it difficult for her to finish a full glass. In other words, even though the context supplies a salient deontic prerequisite for the implicative complement, the use of *manage* encourages speculation about conditions which act instead as *causal* prerequisites for Amira's wine-drinking—that is, conditions which, unlike legal regulations, concretely precipitate or preclude the complement event.

6.1   The proposal

Putting everything together, I propose the following semantic template for two-way implicatives. (As discussed below, one-way verbs are subject only to 32i and 32ii.)

(32)   **The prerequisite account of implicatives.**
For a two-way implicative 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(n eventive) one-place predicate A such that $A(x)$ is *causally necessary* for $P(x)$ in the utterance context. $A(x) \triangleleft_c P(x)$

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

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

The condition $A(x)$ is crucially left unresolved by the background situation c (unlike Baglini and Francez's familiar catalyst).[20] As a result, the presuppositional content of a two-way implicative highlights that, given what a speaker knows about (a) the set of causal ancestors of $P(x)$ and (b) what the discourse context establishes about their truth values, the valuation of $A(x)$ is causally determinative for $P(x)$ (that is, acts as its proximate cause). The indeterminacy of $A(x)$ relative to c is the source of the 'obstacle' impression associated with implicatives (Fact A); since the

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[20]Indeed, since c is the situation relative to which the necessity and sufficiency of $A(x)$ for $P(x)$ is evaluated, it necessarily does not settle truth values for either $A(x)$ or $P(x)$ (see Definition 10.

truth of $A(x)$ is necessary and sufficient for $P(x)$, and is settled by the at-issue contribution in (32)ii, Proposal (32) also captures the polar prequisite inferences associated with Fact C.

Requiring that $A(x)$ is unsettled with respect to c is not the same thing as requiring that $A(x)$ is unresolved in the broader discourse context (the common ground). Since the use of an implicative assigns a truth value to $A(x)$, it is reasonable to assume that the common ground often will not already do so (although the speaker's own information must; this is no different from any other declarative). However, insofar as an implicative claim stands in pragmatic competition with its (syntactically) simpler complement, the implicative may also be used in contexts where the value of $A(x)$ is known, in order to focus attention on its relationship to $P(x)$ in a causal chain: that is, to inform an interlocutor about the value of $P(x)$ by indicating the crucial role of $A(x)$. In such uses, a speaker conveys that the context up to resolution of $A(x)$ (implicitly, the evaluation background c) satisfies the licensing conditions for $I(x, P)$—that $A(x)$ was not a (causally) foregone conclusion, and that its resolution was determinative for $P(x)$.

It should also be clear from the preceding comments that Proposal (32) derives the characteristic entailments of implicative verbs (Fact B) in the joint contribution of presupposition and assertion. The causal necessity of $A(x)$ for $P(x)$ establishes that if $A(x)$ is not satisfied, $P(x)$ cannot be realized. According to (32)ii, a negative implicative claim asserts that $A(x)$ is false.

(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, I = *uskaltaa* ('dare'), and A represents some action characterized by courage or daring. (4b) asserts that Juno did not perform this action. Since doing so was causally necessary for her to open the door, she cannot have opened the door. The negated complement is not part of what (4b) asserts, but is calculated as a causal consequence of (negative) assertion in any appropriate context for *uskaltaa*.

In the positive case, $I(x, P)$ asserts that $A(x)$ holds. If $A(x)$ and $P(x)$ are only related by 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 $A(x)$ may defeasibly implicate $P(x)$, since it removes a potential barrier for the implicative complement, but $A(x)$ does not entail $P(x)$ in the absence of the sufficiency presupposition in (32)iii.

If I is a two-way implicative, however, we do presuppose causal sufficiency. This means that adding the truth of $A(x)$ to the evaluation background c will guarantee (causally entail) the truth of $P(x)$, and the positive complement entailment is again calculated as a causal consequence of what is asserted, provided that the context satisfies presupposition (32)iii.

The choice of one implicative verb over another comes down to the choice of an appropriate characterization for A. Lexically specific implicatives characterize A with some precision: *jaksaa* ('have the strength'; 5) constrains A to involve the use of strength, while *dare/uskaltaa* restricts consideration to courageous action. Implicatives range from the highly constrained (e.g., *mahtua*; 30) to the apparently unconstrained: *pystya* ('be able'; 29), for instance, appears to be the one-way, necessity-only counterpart of bleached verbs like *manage* and *onnistua*, which convey only that there is some causally necessary and sufficient prerequisite for their complements, but are uninformative about the nature of this event.

6.1.1   Illustration: the modified Dreyfus scenario

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

(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   MSG := INT ∧ NRV
        to spy, he will send a radio message to make
        contact with the Germans

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

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

The graph for (33) is in Figure 3. 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).
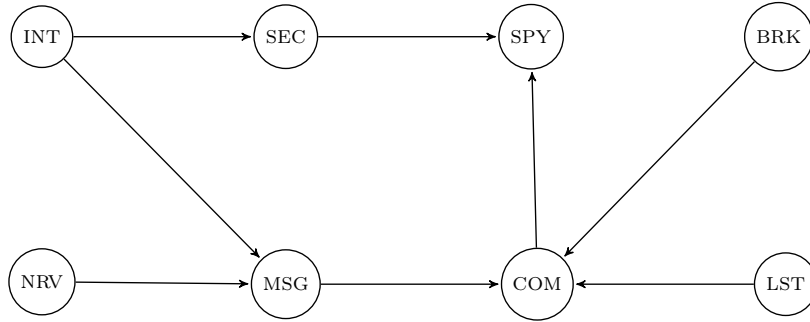

Figure 3: Graphical representation for the fictional Dreyfus scenario

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 ($\langle \text{NRV}, 1 \rangle \lhd_s \langle \text{MSG}, 1 \rangle$, $\langle \text{NRV}, 1 \rangle \rhd_s \langle \text{MSG}, 1 \rangle$). 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 ($\langle \text{NRV}, 1 \rangle \lhd_s \langle \text{COM}, 1 \rangle$, $\langle \text{NRV}, 1 \rangle \not\rhd_s \langle \text{COM}, 1 \rangle$), 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 $\in \text{Anc}(\text{SPY})$ 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.[21]

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.

6.2   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, $A(x)$ does not derive $P(x)$. This is illustrated by the felicity of (36), where a positive assertion of one-way *jaksaa* ('have the strength'; 5) does not mandate complement realization. Despite the absence of an inference from $I(x, P)$ to $P(x)$, (36) conveys that Sampo was strong.

(36) Sampo **jakso-i**   tappelema-an, mutta vastustaja   paken-i.
      Sampo have.strength-PST.3SG fight-INF,   but   opponent.NOM flee-PST.3SG
      'Sampo had the strength to fight, but his opponent fled.'

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 complement entailments, the most promising ground for adjudication 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

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[21]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 a more complex prerequisite, expressible as the sentence $\alpha = \text{NRV} \wedge \text{LST} \wedge \neg\text{BRK}$ for (35c). The inferred values of MSG in (35c) and MNG and COM in (35d) follow from the truth of α in each case and so need not be explicitly included in α. See note 12.

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 specificity discussed in Section 5.2 (i.e., that the catalyst proposal offers no clear way of identifying the named prerequisites of lexically specific implicatives), no such infelicity is predicted by a catalyst-focused analysis, 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 come.

   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/or 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* ('make/find 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, the implicative claim was judged to be 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 make.time-PST.3SG shoot-INF bear-GEN/ACC
   'He had 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 predictions of the prerequisite account. 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. To the extent that each of the contexts supplies a potential catalyst (Mika's invitation in 37, the hunter's sighting of the bear in 39, the consultant's receipt of a survey in 40), a catalyst-style account does not predict the observed infelicity. These examples thus provide empirical support for the prerequisite account to implicative semantics over the catalyst approach.

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.

6.3   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 suggest that it is precisely the WYSIATI inference, in this case pragmatically drawn, 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') below.

(5) a. Sampo **jakso-i** noust-a.
Sampo have.strength-PST.3SG rise-INF
'Sampo had the strength to rise.' $\rightsquigarrow$ *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.' $\rightsquigarrow$ *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 hard.
   a. *Implicature:* You will not get an A on the test if you do not study hard.
   b. *Perfected interpretation:* You will get an A on the test if and only if you study hard.

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, necessity (41a, above) is inferred from asserted sufficiency. In the one-way implicative case, 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. $^\gamma$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 (here, climate change) a necessary as well as sufficient condition. The analogy with conditional perfection is immediate.

Implicative antiperfection similarly involves reasoning about the structure of a causal dynamics (and might also be expected to arise in the interpretation of necessity-predicating causative verbs). The WYSIATI reasoning involved in both perfection and antiperfection can be cashed out in terms of *predicate circumscription* (McCarthy, 1980, p.27, emphasis in original):

35

> "Circumscription is a rule of conjecture that can be used [...] 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, circumscription has been formalized as the pragmatically-triggered operation of *exhaustive interpretation* (Groenendijk and Stokhof, 1984; 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, so that it arises 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, which verbs are subject to it, and the potential relevance of any frequency or usage effects are left as matters for future investigation.

6.4 Polarity-reversing implicatives

One last group of implicatives deserves mention: polarity-reversing verbs 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

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

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. $\nrightarrow$ *Amira did not drink a beer.*

     b. Amira did not **hesitate** to drink a beer. $\rightarrow$ *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.' $\nrightarrow$ *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.' $\rightarrow$ *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 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 (43a) and (44a), 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.'[23]

     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

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[23]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.

assignment. Similarly, a speaker might use (48) to implicate (48a) (i.e., to provide a negative answer) if asked if they know what Leo's long-distance partner looks like. (48b) is a more reasonable inference to draw if the speaker is explaining why it took them so long to come back from a conversation with Leo with a description of the individual in question.

The availability of both types of inference raises 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 empirical results from Karttunen et al. (2014) and Tonhauser et al. (2020), which indicate a certain fluidity between implicative- or factive-type inferencing for phrasal, evaluative-adjective constructions like *be lucky to*. I leave an investigation of these connections for future work.

7 Conclusions and outlook

Building on Baglini and Francez's (2016) causal analysis of *manage*, I have proposed a general semantics for the implicative verb class which (a) derives the characteristic complement entailment pattern first described by Karttunen (1971), (b) avoids endorsing an intuitively incorrect equivalence between an implicative claim and that of its bare complement, and (c) captures projective inferences about the non-triviality of complement realization (Coleman, 1975; Karttunen and Peters, 1979, among others). Drawing on Schulz's (2011) causal **dynamics** (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 by different verbs), and assert that this prerequisite was realized in the reference 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 relevant prerequisite is also causally sufficient for complement realization.

Unlike previous accounts of implicativity, which have focused almost exclusively on two-way *manage*, the account offered here extends to the full implicative class, including lexically specific two-way verbs, one-way verbs, and even polarity-reversers like *fail, neglect/laiminlyödä*, and *hesitate/epäröidä*. The tendency for one-way verbs to license defeasible implicatures in the positive (sufficiency-driven) direction is explained in terms of an independently-observed pragmatic tendency towards circumscriptive reasoning (McCarthy, 1980; Groenendijk and Stokhof, 1984).

The success of a causal approach in treating the class-level semantics of implicative verbs opens up several avenues for continued investigation. One of these involves the distribution and variation of (defeasible) complement inferences associated with phrasal *enough* and *too* constructions (which "must sometimes be understood in an implicative, sometimes in a non-implicative sense"; Karttunen 1971, p.354):

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

b. *γ*When I played soccer as a [...] ten-year-old, I **was too slow** to score any goals [...]　　　　　　　　　　　　　　　　　↝ *I did not score any goals.*

(50) a. *γ*Best part [...] was the cast feeling bad for Sean and swearing he **was smart enough** to be a neurosurgeon.　　↝̸ *[The cast believed] Sean was a neurosurgeon.*

b. *γ*I had a friend who taught for a while who really **was too stupid** to be a teacher.　　　　　　　　　　　　　　　　　↝̸ *My friend was not a teacher.*

Regardless of their implicativity, *enough/too* predicates evidently share semantic structure with lexical implicatives. Intuitively, they indicate that there is some degree of a particular property (above, intelligence or speed) which is required for the realization of their complements (see,

e.g., Meier, 2003; von Stechow et al., 2004; Hacquard, 2005); by comparing this degree to the subject's allotment, they also establish whether or not the subject has the relevant property to a sufficient (*enough*) or excessive (*too*) degree for the complement.

An important contrast between lexical implicatives and *enough/too* predicates, and one which may be recruited to explain differences in the distribution and strength of their complement inferences, has to do with what is conveyed about the sentential subject. Lexical implicatives, as we have seen, assert that their subject realized (acted on) a prerequisite for their complements; thus, *dare* establishes that its subject took courageous action. The assertion of an *enough/too* construction is weaker than that of a related implicative: a positive use of *be brave enough*, for instance, need only establish that its subject was *capable* of courageous action. Assuming a shared background on which courageous action is necessary and sufficient for complement realization, then, *be brave enough* is strictly weaker than *dare*: since the former need not assert prerequisite realization, we do not predict complement entailment.

With shared causal structure in place, the contrast between a lexical implicative and an *enough/too* claim can be understood in terms of aspectual class: the lexical implicative makes an eventive claim, while the weaker *enough* predicate is compatible with a (related) stative assertion. This way of conceptualizing the difference may, in turn, offer a way to explain for the aspect-sensitivity of implicativity in *enough/too* claims (noted for French by Hacquard 2005). Under perfective marking (independently argued to select for eventive predicates; Moens and Steedman 1988; de Swart 1998, among others), *être assez rapide* ('be fast enough') entails the realization of its complement, while imperfective (51b) does not. Notably, (51a) indicates that Khalil actually ran (or moved) quickly, while (51b) only suggests that this action was possible for him (see Nadathur, 2017, 2019).

(51) 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.'   (French)

The aspect-sensitivity of implicative *enough/too* constructions strengthens a link between implicativity and the longstanding puzzle of aspect-sensitive **actuality entailments** from ability modals (here, French *pouvoir*), first observed by Bhatt (1999).

(52) 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.'   (French)

Although actuality entailments appear to arise in the composition of modality and aspect, they resist explication on received analyses for circumstantial possibility and perfective marking (but see Hacquard 2006; Mari and Martin 2007; Mari 2016; Homer 2021, among others, for accounts which re-examine one or both semantic components). Bhatt's original proposal sidesteps the 'standard' compositional problem by treating ability modals as distinct from circumstantial possibility, and assigning them instead the two-way 'direct assertion' semantics of Karttunen and Peters's (1979) *manage*. While this approach certainly derives actuality entailments in the perfective contexts where they do arise, it struggles to explain their absence under imperfective marking; more generally, it does not account for the difference between lexical implicatives' entailments, which obtain regardless of aspectual marking (see French *réussir*; 'succeed', 'manage' in 53), and aspect-sensitive actuality entailments, as in (52).

(53) 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.'   (French)

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 genuine instances of implicativity. Where Bhatt's original proposal aims to establish equivalence at the lexical level (between ability modals and *manage/réussir*), the causal approach—and in particular the contrast between eventive lexical implicatives and aspect-sensitive, at-base stative *enough/too* predicates—suggests instead an analytical equivalence, on which the semantic components of implicativity (a causally necessary/sufficient prerequisite, its asserted satisfaction, and so on), which operate as a package deal in the lexical case, come together only in the composition of a (potentially stative) ability claim with an eventive-selecting perfective aspect (Nadathur, 2019, 2021). A starting point for such an account would be the one-way (i.e., necessity-presupposing) analysis of *be able* anticipated by Karttunen (1971): however, a detailed investigation of the consequences of a complex, prerequisite-invoking 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

(8)   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

(9)   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

(7a)   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

(7b)   Without even trying, Trent Reznor and his musical colleague Atticus Ross managed to win a Country Music Association Award.
`https://www.revolvermag.com/music/nine-inch-nails-trent-reznor-atticus-ross-win-country-music-award-old-town-road`
Last retrieved on: 2023-04-17

(7c)   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

(7d)   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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