TOWARDS A THEORY OF MODAL-TEMPORAL INTERACTION

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A compositional analysis is provided of temporal perspective and orientation (Condoravdi 2002) of modals in Dutch, English, Gitksan (Tsimshianic), and St'át'imcets (Lillooet Salish). Modals interact freely with the tense-aspect architecture in each language. Temporal perspective is determined by an operator scoping over the modal, usually tense, while temporal orientation is determined by aspectual operators below it (and further restricted by the diversity condition). In contrast to much of the literature, it is argued that epistemic modals can scope under past tense. Modal-temporal interactions behave in predictable ways in Dutch, Gitksan, and St'át'imcets, whereas the English system is more idiosyncratic and partly lexicalized.*

Keywords: modals, tense, aspect, epistemic, Gitksan, St'át'imcets, Dutch

'The study of the interaction between modality and temporality has always been informed by the insight that these two dimensions are not independent.' (Laca 2008:1)

1. INTRODUCTION.

1.1. STATEMENT OF THE PROBLEM. In the investigation of natural language modality, a perennial issue is the extent to which the interpretation of a modal is restricted by temporal factors. The basic problem is illustrated by the different readings of English *might have*, as discussed by Condoravdi (2002; see also Huddleston & Pullum 2002:203–4, Ippolito 2003). On one reading, *might have* expresses present epistemic uncertainty about a past event.

(1) John **might have** won the game (but I'm not sure if he did).

The sentence in 1 asserts that it is consistent with the present epistemic state of the speaker (or some other salient agent) that John won the game at some time preceding the utterance time. A second reading of *might have*, exemplified in 2, says that at some past time it was metaphysically possible for the world to develop in such a way that John would win the game. The sentence is about the different ways in which history could have unfolded after some past time.

(2) John **might have** won the game (if he hadn't been feeling sick that day).

These two readings of *might have* differ in both their modal flavor (epistemic vs. metaphysical) and their temporal profiles. Importantly, the available interpretations of the *might have* sentences represent a small subset of the logically possible combinations

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of modal flavor and temporal properties. We summarize the two attested combinations in Table 1, which also introduces some necessary terminology. The MODAL BASE is a conversational background in the sense of Kratzer 1981, 1991, a function that narrows down the set of worlds a modal quantifies over. The modal base, together with a second conversational background, the ORDERING SOURCE (also due to Kratzer), determines the modal flavor. Again following Kratzer's early work, we adopt a broad distinction between two types of modal bases: epistemic and circumstantial. All nonepistemic flavors of modality involve a circumstantial modal base; this includes what Condoravdi calls metaphysical modality, as well as—in the terminology of Portner (2009)—'priority' modality (such as deontic) and 'dynamic' modality (such as ability). The TEMPORAL PERSPECTIVE (henceforth TP) of a modal is the time at which its conversational background is evaluated (Condoravdi 2002). In 1, this is the utterance time/present, while in 2, the TP is some time in the past. A modal's TEMPORAL ORIENTATION (henceforth TO; Condoravdi 2002) is the relation between its TP and the time of the prejacent event. In 1, the TO is past, because John's potential winning precedes the utterance time. In 2, the TO is future, because John's potential winning follows the past time at which it was still possible for him to win.

MODAL BASE	TEMPORAL PERSPECTIVE	TEMPORAL ORIENTATION
epistemic	present	past
circumstantial	past	future

TABLE 1. Two readings of *might have* (based on Condoravdi 2002).

The restricted set of modal-temporal combinations in Table 1 raises the question of what constrains interactions between TP, TO, and modal flavor. The answer to one part of the puzzle—the apparent restriction of the epistemic interpretation to present TP—has been argued by Condoravdi and others to follow from a general stipulation that epistemic modals cannot scope under either past tense or the perfect auxiliary. This is often argued to follow from a syntactic hierarchy whereby epistemic modals scope higher than nonepistemic ones (Brennan 1993, Cinque 1999, among many others).

In this article, we propose a compositional theory of the interaction between modals and tense and aspect, which builds on previous analyses (in particular Condoravdi's) but differs from them in a number of respects. As far as TP is concerned, we argue that it depends only on temporal operators scoping above the modal (in particular, tense) and that there are no restrictions of a grammatical nature on the possible combinations of TP and modal flavor. In particular we provide extensive empirical evidence for the existence of epistemic modals with past TP, which we analyze as involving a past tense. We also discuss pragmatic and discourse-based factors that may limit or enhance the availability of past-TP readings. As for TO, we propose an analysis in which it is determined by aspectual operators scoping under the modal, in combination with the lexical aspect of the predicate and a general condition on the interpretation of modals that we adapt from Condoravdi (the DIVERSITY CONDITION). The aspectual operators we propose have general meanings that are motivated for independent reasons. Particular languages may differ from each other in whether these operators are overt or covert (phonologically null).

Crucially, in our analysis the modal itself is essentially atemporal. The temporal interpretation of the modal is derived from the way it interacts in a compositional fashion with independently motivated temporal operators. In our view, this represents the null hypothesis. Our analysis is thus both simpler and more general than previous ones. And whereas other accounts have often focused only on English, the present article presents evidence from three additional languages, including two non-Indo-European ones;

see also Chen et al. 2017 for a discussion of a broader sample of languages from the same perspective.

1.2. MAIN CLAIMS OF THE ARTICLE. Our discussion is based on data from four languages from three families: English, Dutch, Gitksan (Tsimshianic), and St'át'imcets (Salish). We make two proposals about the relation between conversational backgrounds and temporal properties. Our first and primary proposal is that a modal's flavor does not depend on its TP. In contrast to a large body of literature (discussed below), we propose that all modals, including epistemic ones, scope under tense and therefore receive past TP if and only if the tense provides a past reference time. The relevant data include examples like 3.

(3) [Context: Yesterday, my friend John was playing a game. At the time, I didn't know if he won, but I bought a bottle of champagne just in case. I found out when I got home that John had lost. My spouse asked me why I had bought the champagne. I replied:]
Because John **might have** won the game.

Here the speaker is talking about a past epistemic state: at the utterance time she knows that John did not win the game, but at some point in the past she had considered it possible that he had won. The modal base is epistemic, but the TP is past. We argue, in line with a minority of authors including von Fintel and Gillies (2008), that the modal is simply scoping under past tense here. There is therefore no need to appeal to special pragmatic mechanisms to derive the attested interpretation.

Our proposal that there are no grammatical restrictions on the possible combinations of modal flavor and TP is supported by Dutch, which overtly encodes TP on modals (via tense marking), and in which TP is predictably determined by the tense morphology, regardless of modal flavor. It is also supported by Gitksan and St'át'imcets, which overtly encode modal flavor (via lexically distinct epistemic vs. circumstantial modals; Rullmann et al. 2008, Peterson 2010, Matthewson 2013). In the appropriate contexts, all flavors of modals in these languages allow for past TPs.

Our second proposal has to do with correlations between modal flavor and TO. Here, we provide crosslinguistic empirical support for a well-known correlation between a circumstantial modal base and future TO (Condoravdi 2002, Werner 2003, among others). We show that this correlation holds in all four languages we investigate. While modals with a circumstantial modal base are restricted to future TO, epistemic modals are free to have any TO (past, present, or future). We provide a compositional analysis of TO, according to which it is uniformly provided by aspectual operators located below the modal.

These proposals lead us to predict the set of possible modal base/TP/TO combinations in Table 2, as the null hypothesis for all languages.

	PAST TP	PRESENT TP
PAST TO	epistemic	epistemic
PRESENT TO	epistemic	epistemic
FUTURE TO	epistemic, circumstantial	epistemic, circumstantial

TABLE 2. Predicted modal base/TP/TO combinations.

This contrasts with Condoravdi's (2002) more restricted set of predicted possible combinations summarized in Table 1 above, according to which epistemic modals do not allow past TPs, and therefore, for example, 'there are no modals with a past perspective and a past [or present] orientation' (Condoravdi 2002:63).

In terms of how TP and TO are compositionally derived, we argue for a potentially universal basic architecture, in which TP is provided by temporal operators above the modal, and TO by operators scoping below it. We assume that typically tense scopes above the modal and aspectual operators below it; but see Chen et al. 2017 for discussion of languages in which (at least some) epistemic modals, which appear to be adverbials syntactically, can scope above tense (SENĆOŦEN (Salish), Hul'q'umi'num' (Salish), Atayal (Formosan), and Blackfoot (Algonquian)). It should also be noted that, in English, perfect aspect can scope over semi-modals (as opposed to modal auxiliaries), as in *He has been able to dance*, and similarly for modal verbs in Dutch.[1] However, we leave such cases outside of the discussion; in the rest of the article we make the simplifying assumption that tense always scopes above the modal and aspect below it.

The article is structured as follows. In the remainder of the introduction we provide background on the languages we discuss and our methodology (§1.3) and theoretical background (§1.4). In §2 we argue that a modal's TP is provided by a higher tense. We show that this is the case for any flavor of modal; our core empirical argument for this is that epistemic modals with past TP exist in Dutch, Gitksan and St'át'imcets, and English. Section 3 provides evidence that lower temporal operators, typically aspects, restrict TO. Again we show that our architecture and semantic proposals are supported in the four languages. In §4 we show how our formal analysis applies to a representative range of data from Dutch, Gitksan, and St'át'imcets, and we then address the lexical complexities of the English modal auxiliary system in §5, including the differing behavior of individual modals in sequence-of-tense and free indirect-discourse environments. Finally, we compare our analysis to previous ones in §6, and §7 summarizes and outlines avenues for future research.

1.3. LANGUAGES DISCUSSED AND METHODOLOGY. In addition to English and Dutch, we discuss two lesser-known languages, Gitksan and St'át'imcets. Gitksan is an Interior Tsimshianic language that is spoken along the upper drainage of the Skeena River in northwestern interior British Columbia, Canada. It comprises a chain of dialects and is very closely related to neighboring Nisga'a, spoken in the Nass River Valley. Gitksan currently has fewer than 400 speakers (First Peoples' Cultural Council 2014). Our data come from three speakers of different dialects: Barbara Sennott, from Ansbayaxw (Kispiox); Vincent Gogag, from Git-anyaaw (Kitwancool); and Hector Hill, from Gijigyukwhla (Gitsegukla).

St'át'imcets (a.k.a. Lillooet) is a Northern Interior Salish language spoken in the southwest interior of British Columbia. The 2014 report of the First Peoples' Cultural Council says that the language has just over 100 first-language speakers, but that number is now smaller. Data come from speakers of both the Upper St'át'imcets dialect (Carl Alexander, the late Beverley Frank, the late Gertrude Ned, and the late Rose Agnes Whitley) and the Lower St'át'imcets dialect (Laura Thevarge).

For Gitksan and St'át'imcets, our data and generalizations are based on fieldwork. Fieldwork methodologies used include: translation tasks (both to and from the contact language, English), acceptability-judgment tasks (in which the consultant evaluates a target-language utterance in a particular discourse context), and storyboard tasks (in which targeted contexts are provided to the consultant by a series of pictures, in response to which the consultant tells a story). See Matthewson 2004, Burton & Matthewson 2015, and Tonhauser & Matthewson 2016 for further details.

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[1] See n. 24 for an example.

For English and Dutch, our data sources are introspective native-speaker judgments by the authors, examples reported in the linguistic literature, attested examples gathered through informal corpus searches and encountered in general reading, and small informal questionnaire studies involving nonlinguist native speakers.

1.4. Theoretical background. We adopt the general framework of generative linguistics and compositional semantics (as outlined in Heim & Kratzer 1998, for instance), but beyond that, we stay as theoretically neutral as possible. As far as morphosyntax is concerned, we assume that tense is located in a head T that scopes over the clausal core consisting of the verb and its arguments, which for the sake of concreteness we call the VP, assuming the VP-internal subject hypothesis (abstracting away from the mechanism by which the subject ends up in its surface position).

Crucially, in our analysis tense also scopes over modals. In languages like Dutch, modal verbs behave in the same way as regular (main) verbs in that they inflect for tense, and this is true for English semi-modals, like *have to*, as well. That in such cases the tense scopes over the modal is obvious when it comes to nonepistemic interpretations. For instance, on the deontic reading of 4 and its English translation, the sentence clearly expresses a past obligation.[2]

(4) [Context (deontic): Jan wanted to go see a movie last night, but he couldn't because he had to wait for the delivery of an important package.]
    Jan **moest**   thuis   blijv-en.
    Jan nec.pst.3sg at.home stay-inf
       'Jan **had to** stay at home.'   (Dutch)

A large part of this article is devoted to arguing that this is true for epistemic modals as well. Thus, the sentence in 4 also has an epistemic reading, expressing a past epistemic state: it asserts that Jan was at home in every world compatible with some agent's epistemic state at a time before the utterance time. This is illustrated by the example in 5; the particle *wel* often helps to bring out the epistemic reading but is not required.

(5) [Context (epistemic): I was looking for Jan last night. I had searched all his usual haunts except his house and hadn't found him yet.]
    Jan **moest**   (wel) thuis   zijn.
    Jan nec.pst.3sg (ptcl) at.home be.inf
       'Jan **had to** be at home.'   (Dutch)

Thus, one of our main claims is that, in general, past TP results from the modal being in the immediate scope of a past-tense morpheme, irrespective of the flavor of the modal.

In English, however, modal auxiliaries do not seem to be inflected for tense. Chomsky (1957) treated modal auxiliaries and tense as being in complementary distribution. But in §2.4 we argue that English modals can have past TP, again irrespective of whether they are epistemic. In §5, we propose (based among other things on sequence-of-tense behavior) that English modal auxiliaries include tense information as part of their lexical entry.

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[2] We follow the conventions outlined in the Leipzig glossing rules (https://www.eva.mpg.de/lingua /resources/glossing-rules.php). Abbreviations not included in the Leipzig glossing rules are the following: i/ii/iii: series i/ii/iii pronoun, aut: autonomous intransitivizer, ccnj: clausal conjunction, circ: circumstantial modal, cn: common noun connective, counter: counter to expectations, deon: deontic modal, dir: directive transitivizer, dm: determinate marker, epis: epistemic modal, exis: assertion of existence, incep: inceptive, nec: necessity modal, pn: proper noun connective, pos: possibility modal, prosp: prospective, ptcl: particle, redup: reduplication, spt: spatiotemporal.

As for aspect, we argue that aspectual heads, such as perfect and (im)perfective, scope UNDER modals, determining the modal's TO. Thus, we assume the basic syntactic hierarchy in 6 as a null hypothesis; this is inherited from Condoravdi (2002), among others, and is expanded below.

(6) tense > modal > aspect > VP   (to be revised)

The semantics is built on this structure in a compositional fashion. The basic types we assume are e (entities), t (truth values), s (possible worlds), i (times, i.e. temporal intervals), and l (events). As is standard, propositions are sets of possible worlds, or more technically, functions from worlds to truth values, and are therefore of type $\langle s,t \rangle$ (abbreviated as st when inside a more complex type). Following Kratzer (1998), we assume that VPs denote properties of events, of type $\langle l,st \rangle$, and that aspect maps these onto properties of times (type $\langle i,st \rangle$). Modals denote functions from type $\langle i,st \rangle$ to $\langle i,st \rangle$. Finally, properties over times (of type $\langle i,st \rangle$) are turned into propositions (type $\langle s,t \rangle$) by applying them to tense. Adopting a referential analysis of tense analogous to pronouns (Partee 1973, Heim 1994, Abusch 1997, Kratzer 1998), in a recent implementation by Bochnak (2016), we assume that reference times are provided by (covert) temporal variables (located in T), which bear indices and receive their values from the assignment function. Morphological tenses contribute features that place presuppositions on the potential values of the reference time but that otherwise denote the identity function.

We now provide sample denotations of the basic functional morphemes we use here. Tense features for English and Dutch are given in 7 and 8, and for Gitksan and St'át'imcets in 9.[3] See §2.3 for discussion of the Gitksan/St'át'imcets nonfuture tense. Throughout the article, denotations are relativized to a variable assignment (g), time of utterance (t_0), and world of utterance (w_0). There also are two additional parameters of interpretation, namely the conversational backgrounds for modals argued for by Kratzer (1981, 1991): modal base (f), and ordering source (h). These will become relevant in a moment.

(7) $[\![\text{PAST}]\!]^{g,t_0,w_0,f,h}$ $= \lambda t : t < t_0 . t$
(8) $[\![\text{PRESENT}]\!]^{g,t_0,w_0,f,h}$ $= \lambda t : t = t_0 . t$
(9) $[\![\text{NONFUTURE}]\!]^{g,t_0,w_0,f,h} = \lambda t : t \leq t_0 . t$

In 10 we give language-neutral lexical entries for possibility and necessity modals. POS and NEC are 'pure' modals, abstracting away from additional tense or aspect features that are encoded in specific modals in certain languages, which we discuss below. The interpretation of modals depends on the modal base f and ordering source h, which are functions from an evaluation world w and an evaluation time t to sets of propositions.[4] The modal takes as its argument a prejacent tenseless proposition P of type $\langle i,st \rangle$ and yields a function of the same type, relativized to the time and world of evaluation (t and w) on which the conversational backgrounds also depend. The modal proposition asserts that the prejacent is true in some/all of the most highly ranked worlds in the intersection of the propositions provided by the modal base, as evaluated at w and t. The value of t is constrained by tense higher up in the tree.[5]

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[3] The ordering relation $t_1 \leq t_2$ means that no part of t_1 is later than any part of t_2. See Heim & Kratzer 1998 for the use of the 'colon' notation in the lambda-terms to represent presuppositions.

[4] For the sake of simplicity, in this article we treat f and h as contextual parameters of interpretation, rather than as covert variables in the object language, but nothing crucial hinges on this decision.

[5] The BEST operator picks out the most highly ranked worlds. For a definition, see Portner 2009:67, von Fintel & Heim 2011:61; see Kratzer 1991 for an alternative treatment that does not make use of the limit assumption.

As far as the types are concerned it is possible to stack modals; this happens in Dutch and with English semi-modals. The fact that English modal auxiliaries cannot stack (in most dialects) is presumably due to morphosyntactic constraints.

(10) a. $[\![\text{POS}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\exists w'\, [w' \in \text{BEST}_{h(w,t)}(\cap f(w,t))\ \&\ P(t)(w')]$
b. $[\![\text{NEC}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\forall w'\, [w' \in \text{BEST}_{h(w,t)}(\cap f(w,t)) \rightarrow P(t)(w')]$

The viewpoint aspects that apply below the modal include first perfective and imperfective. Simple standard denotations for these aspects are given in 11–12 (adapted from Kratzer 1998).

(11) $[\![\text{PFV}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle l,st\rangle}\, \lambda t\, \lambda w$. $\exists e\, [P(e)(w)\ \&\ \tau(e) \subseteq t]$
(12) $[\![\text{IPFV}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle l,st\rangle}\, \lambda t\, \lambda w$. $\exists e\, [P(e)(w)\ \&\ t \subseteq \tau(e)]$

In the perfective the event time $\tau(e)$ is included in the reference time t, whereas in the imperfective t is included in $\tau(e)$ (Klein 1994, Kratzer 1998). Languages may differ in whether the perfective and imperfective heads are overt; see §2 and §3 for further discussion of individual languages.

In addition to perfective/imperfective (which we refer to as INCLUSION ASPECT or Asp_{Inc}), we assume that there is a second kind of viewpoint aspect, which encodes an ordering relation between $\tau(e)$ and t. The core cases of ORDERING ASPECT (Asp_{Ord}) are perfect and prospective. These aspectual operators cooccur with (im)perfective, with the perfect/prospective head being higher than the (im)perfective head; witness constructions like *He might **have been** wait**ing** for you* (Chomsky 1957, Pancheva 2003, Liao 2005, Toews 2015). We therefore assume the expanded hierarchy in 13. The null hypothesis is that this hierarchical order of the two viewpoint aspects is universal, although of course this may be falsified by empirical testing in other languages.

(13) tense > modal > ordering aspect > inclusion aspect > VP

Ordering aspects cannot have the same semantic type as inclusion aspects, but must denote functions from properties of times to properties of times (type $\langle\langle i,st\rangle,\langle i,st\rangle\rangle$). For reasons that will become clear below, we adopt slightly different ordering aspects for English and Dutch on the one hand, and Gitksan and St'át'imcets on the other. The denotations of the ordering aspects are given in 14–17. In each language, one of these is overt and one is covert. The perfect is the overt member of the pair in English and Dutch, and the prospective is the overt member in Gitksan and St'át'imcets.[6] In both pairs of languages the nonovert aspect covers a timespan that includes the reference time and that is the complement of the timespan covered by its overt counterpart. This means that the aspect that is morphologically marked is also semantically marked in the sense of having the more specific meaning, whereas the morphologically unmarked aspect represents the 'elsewhere' case.

(14) $[\![\text{PERF}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\exists t'\, [t' < t\ \&\ P(t')(w)]$ (English, Dutch)
(15) $[\![\text{NONPERF}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\exists t'\, [t \leq t'\ \&\ P(t')(w)]$ (English, Dutch)
(16) $[\![\text{PROSP}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\exists t'\, [t < t'\ \&\ P(t')(w)]$ (Gitksan, St'át'imcets)
(17) $[\![\text{NONPROSP}]\!]^{g,t_0,w_0,f,h}$ $= \lambda P_{\langle i,st\rangle}\, \lambda t\, \lambda w$. $\exists t'\, [t' \leq t\ \&\ P(t')(w)]$ (Gitksan, St'át'imcets)

We follow Condoravdi (2002) in assuming that the perfect plays a role in contributing TO; we extend this to the claim that all ordering aspects perform this function.

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[6] We are adopting a simplified analysis of the English/Dutch perfect, according to which it only introduces anteriority. It has been pointed out that many of the properties typically attributed to the perfect are really properties of the PRESENT perfect, which are absent (or not obligatory) in other uses of the perfect, such as the pluperfect, the future perfect, and the infinitival perfect (Portner 2011, Bohnemeyer 2014, among others). This is also true for the perfect appearing in the complement of a modal. So, for instance, while in English the present perfect cannot be combined with a definite time adverbial, this restriction does not hold for the modal perfect.

(i) *Mary has arrived yesterday.
(ii) Mary must have arrived yesterday.

The overall type structure we are adopting is summarized in 18. Syntactic node labels are included merely for illustrative purposes; we call the projection headed by tense 'TenseP' instead of 'TP' to avoid confusion with temporal perspective.

(18)

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                          TenseP
                          ⟨s,t⟩
                  ╱                  ╲
               T′                      ModP
               i                       ⟨i,st⟩
          ╱        ╲              ╱            ╲
    [FEATURE]       T₁         Mod            Asp_OrdP
     ⟨i,i⟩          i      ⟨⟨i,st⟩,⟨i,st⟩⟩     ⟨i,st⟩
                                        ╱            ╲
                                   Asp_Ord          Asp_IncP
                               ⟨⟨i,st⟩,⟨i,st⟩⟩        ⟨i,st⟩
                                             ╱              ╲
                                         Asp_Inc             VP
                                    ⟨⟨l,st⟩,⟨i,st⟩⟩          ⟨l,st⟩
```
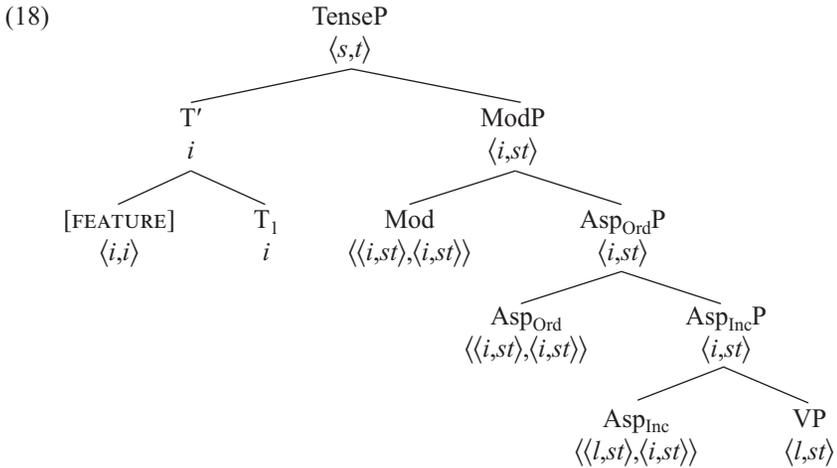
A simple denotation to illustrate the basics of our system is provided in 19. Supporting argumentation is provided throughout §2 and §3, and in §4 we work through some examples in more detail.

(19) John had to be in his office.   (past TP, present TO)
   $[[\text{NEC}(\text{NONPERF}(\text{PFV}(\textit{John be in his office})))](\text{PAST}(t_i))]^{g,t_0,w_0,f,h} =$
   $\lambda w . \forall w' [w' \in \text{BEST}_{h(w,g(i))}(\cap f(w,g(i))) \rightarrow \exists t' [g(i) \leq t' \& \exists e [\text{John.be.in.his.}$
      $\text{office}(e)(w') \& \tau(e) \subseteq t']]]$ (where $g(i) < t_0$)

Clauses (TensePs) like 19 denote propositions (i.e. functions from possible worlds to truth values); if the TenseP is a root clause that is uttered assertively by the speaker, this proposition is applied to the actual world w_0 to yield a truth value. Note that in the semantics T′ (consisting of the head T plus a tense feature) is treated as an argument of the modal, even though syntactically T′ scopes over (i.e. c-commands) Mod. This is simply a consequence of our decision to treat tense as representing a variable of type i rather than as a function of a more complex type. For the sake of clarity we continue to speak informally of tense as having scope over the modal, in accordance with the hierarchy in 13. If we wanted to bring our formal semantics in line with this, it would be trivial to do so by type-raising T′ to type $⟨⟨i,st⟩,st⟩$ (analogous to the standard raising of proper names from type e to $⟨⟨e,t⟩,t⟩$).

2. MODALS WITH ANY CONVERSATIONAL BACKGROUND CAN HAVE ANY TEMPORAL PERSPECTIVE. In this section we argue that, in principle, modals with any type of conversational background can have either past or present TP. Since the most controversial aspect of this claim concerns epistemic modals, we devote the section mainly to demonstrating that epistemic modals with past TP (henceforth PAST EPISTEMICS) exist. Our findings weaken the main argument behind the claim that epistemic modals always scope over tense (Hacquard 2011, among others). We begin with a brief overview of the debate about past epistemic modality. We then present evidence from Dutch, Gitksan, and St'át'imcets for past epistemic readings, and finally we turn to English, whose lexical and morphological idiosyncrasies make it possibly the least ideal language in which to study the question (see e.g. Stowell 2004 for a summary of some of these idio-

syncrasies). We conclude the section with some speculation about why the past epistemic readings, while possible, are dispreferred.

2.1. The debate about epistemic modals with past temporal perspective. The existence of past epistemic readings has been a subject of lively debate. The question is whether sentences like 20a–c can make an assertion about what was epistemically possible or necessary at some past time.

(20) a. Jack's wife **couldn't** be rich.   (Stowell 2004:625)
      b. There **had to** be a hundred people there.   (Stowell 2004:626)
      c. There **might have** been ice cream in the freezer. (von Fintel & Gillies 2008:87)

The existence of past epistemic readings has frequently been denied in the literature, for a variety of languages (Groenendijk & Stokhof 1975, Cinque 1999, Drubig 2001, Condoravdi 2002, Stowell 2004, Hacquard 2006, 2011, Borgonovo & Cummins 2007, Demirdache & Uribe-Etxebarria 2008b, Laca 2008, among others). At least some authors frame the issue in terms of the relative scope of modals and tense: the claim is that (in English or universally) epistemic modals must scope over tense (Cinque 1999, Stowell 2004, Hacquard 2006, 2011). This is often accompanied by the observation that nonepistemic modals can scope under tense, something that we take to be uncontroversial.

Although the view that epistemic modals always scope over tense is widespread, some scholars have argued against it. Von Fintel and Gillies (2008:87) give the example in 21, noting that '[i]t is possible for [the speaker] to have said something true, even though at the time of utterance she knows … there is no ice cream in the freezer' (see also Portner 2009, Abusch 2012 for discussion).

(21) [Context: Sophie is looking for some ice cream and checks the freezer. There is none in there. Asked why she opened the freezer, she replies:]
      There might have been ice cream in the freezer.

Other authors have argued for past epistemic readings on the basis of data from languages other than English, including Eide (2003, 2005) for Norwegian, and Homer (2010) and Martin (2011) for French.

2.2. Dutch. Since Dutch modals are just like any other verbs in that they inflect for tense, we assume that tense scopes over the modal. We therefore predict that the modal's TP will be determined by its tense marking, which is exactly what we find. Just as in English, Dutch modals can have a range of different flavors, but here we focus on epistemic readings. Our examples involve the universal modal *moeten* 'must, have to' and the existential modal *kunnen* 'can, could, may, might', both of which readily accept epistemic interpretations, as well as nonepistemic ones. (See Foolen & de Hoop 2009 for discussion of various factors determining the modal flavor of *moeten* and *kunnen*.)

When an epistemic modal is in the simple present tense, as in 22, the TP is present as well.

(22) De sleutel **moet**   / **kan**   (wel) (eens) in de la   ligg-en.
      the key   NEC.PRS.3SG / POS.PRS.3SG (PTCL) (PTCL) in the drawer lie-INF
        'The key must/might be in the drawer.'   (present TP, present TO)

In 22, the *moet* version contains the optional discourse particle *wel*, and the *kan* version contains *wel eens*; these particles often accompany epistemic modals in Dutch. They disambiguate the modal toward an epistemic interpretation and tend to make a sentence more colloquial, but an epistemic interpretation is also possible without them. The sentence in 22 asserts that at the speech time it is epistemically necessary/possible that the

keys are in the drawer at that time. The TP is present because the modal is inflected for present tense. (For discussion of TO, see §3.)

In addition to the simple modal verb *kan* as in 22, epistemic possibility with present TP can also be expressed by means of the double modal form *zou kunnen*, as in 23.[7]

(23) De sleutel **zou**   in de la   **kunn-en** ligg-en.
     the key   **shall.PST.3SG** in the drawer **POS-INF** lie-INF
       'The key may/might be in the drawer.'   (present TP, present TO)

Zou kunnen contains the past-tense form of the modal verb *zullen* 'shall, will' plus the infinitival form of *kunnen*. Semantically, it is a 'weakened' form of *kunnen*, analogous to the use of subjunctive modals in other Indo-European languages (cf. von Fintel & Iatridou 2008). We assume that *zou kunnen* can be treated as a single lexicalized present subjunctive form of *kunnen*, but we refrain from analyzing this further in this article.

Now let us turn to epistemic modals with PAST TP. The past-tense counterparts of 22 are given in 24.[8]

(24) De sleutel **moest**   / **kon**   (wel) (eens) in de la   ligg-en.
     the key   **NEC.PST.3SG** / **POS.PST.3SG** (PTCL) (PTCL) in the drawer lie-INF
       'The key {had to be}/{might have been} in the drawer.' (past TP, present TO)

As pointed out by Boogaart (2007), *moest* and *kon* can have an epistemic interpretation, reflecting the epistemic state of some agent—most likely (but not necessarily) the speaker—at a past time.[9] On this reading, the sentence asserts that at some (salient) time t preceding the utterance time, it was epistemically necessary or possible that the key was in the drawer. This past epistemic reading is brought out by contexts such as the following.

(25) Discourse context for a past epistemic reading of 24 with *moest*
     'Yesterday, when I wanted to go to work, I couldn't find my key anywhere. I tried to remember where I might have left it the previous night. I felt in the pocket of my pants, looked in my nightstand, and even searched the waste basket, but all in vain. Suddenly I knew. **It had to be in the kitchen drawer**.'

(26) Discourse context for a past epistemic reading of 24 with *kon*
     'When I arrived at work yesterday, I discovered that I didn't have my key on me. I called my wife and asked if I had left it somewhere at home by any chance. She asked me where she should look. I tried to remember where I might have left it the previous evening. **It might have been in the kitchen drawer**, so I asked her to look there.'

In addition to the simple past form *kon*, Dutch has another way of expressing past epistemic possibility, namely with the pluperfect form *had kunnen*, as in 27.

(27) De sleutel **had**   in de la   **kunn-en** ligg-en.
     the key   **have.PST.3SG** in the drawer **can-INF** lie-INF
       'The key might have been in the drawer.'

---

[7] For unknown reasons, the analogous form *zou moeten* can only express weak deontic necessity, and cannot be epistemic.

[8] It should be pointed out that the simple past form *kon* can also have a weak-possibility interpretation with PRESENT TP, equivalent to the 'subjunctive' double modal *zou kunnen* in 23. Here the past-tense morphology is not a semantic tense but expresses 'modal remoteness' (Huddleston & Pullum 2002:148–51) or 'nonreality' (Geerts et al. 1984:466–72). We do not attempt to analyze this present-TP use of morphologically past modals in this article. The possibility of having a present-TP, weak epistemic-possibility reading may make it harder to detect the past-TP reading of *kon* outside of a context like 26.

[9] Boogaart (2007) claims that this is restricted to free indirect discourse; see §6 for discussion.

As van Gerrevink and de Hoop (2011) point out, in Dutch the pluperfect form of a modal (of any flavor) implies the falsity of its prejacent. Thus, 27 implies that the key was not actually in the drawer. This is not a coincidence. In Dutch, much as in English, the pluperfect serves a dual function: in addition to its purely temporal interpretation as the past tense of a perfect, it is used for expressing past counterfactuality, for example in conditionals (cf. Iatridou 2000, Ippolito 2003). In the latter role it has the same function that in some other Indo-European languages is fulfilled by the past subjunctive. What is important for our purposes is that a 'past subjunctive' possibility modal like in 27 does not have to be circumstantial, but can also be epistemic. On the latter reading, the pluperfect *had kunnen* is very close in meaning to the simple past *kon* (cf. 24). The only difference is that with the pluperfect, the event is viewed in hindsight; at the utterance time, the speaker knows that the prejacent was false (i.e. the key was not in the drawer). It is probably for this reason that in a context like that of von Fintel and Gillies's 'ice cream' example 21, the pluperfect form *had kunnen* is strongly preferred over the simple past form *kon*, whereas a context like 26 requires *kon*. These complexities are not part of our formal analysis. Our main goal here is simply to show that past epistemic readings are possible in Dutch.

In this section we have seen that, in accordance with one of the main empirical claims of this article, Dutch modals can have past epistemic interpretations. Past TP is morphologically marked either by past tense on the modal or by the counterfactual pluperfect form.

2.3. Gitksan. We now turn to Gitksan, the first of two languages that provide a different kind of evidence for modals with past epistemic readings. The language has lexically dedicated epistemic modals, so there can be no doubt that the relevant examples are epistemic. However, Gitksan does not have explicit marking for tense, so we have to rely on context to make sure the TP is past.

We begin with some background on the Gitksan temporal system. Neither past nor present tense is overtly marked. Temporally unmarked predicates are compatible with events that are either fully in the past or ongoing at the utterance time, depending on discourse context (Jóhannsdóttir & Matthewson 2007). This is illustrated for eventive and stative predicates in 28 and 29, respectively. Note that these examples are in the perfective aspect (indicated by the absence of the overt imperfective marker *yukw*).

(28) Ba<u>x</u>=t   Yoko.
     run=DM Yoko
        'Yoko ran.'/'Yoko is running.'   (Jóhannsdóttir & Matthewson 2007)
(29) Siipxw=t James (k'yoots).
     sick=DM James (yesterday)
        'James was sick (yesterday).'/'James is sick.'   (Matthewson 2013:357)

Future time reference is obligatorily marked by the marker *dim*, as illustrated in 30–31 (see Jóhannsdóttir & Matthewson 2007, Matthewson 2013).

(30) *(**Dim**) limx=t   James t'aahlakw.
     *(**PROSP**) sing=DM James tomorrow
        'James will sing tomorrow.'   (Matthewson 2013:357)
(31) *(**Dim**) siipxw=t James t'aahlakw.
     *(**PROSP**) sick=DM James tomorrow
        'James will be sick tomorrow.'   (Matthewson 2013:357)

Following Jóhannsdóttir and Matthewson (2007), we assume that all finite clauses contain a phonologically null, nonfuture tense. In the formal implementation of Bochnak

(2016), the nonfuture restriction is modeled as a tense feature, whose denotation is given in 32 (repeated from 9).

(32) $\llbracket \text{NONFUTURE} \rrbracket^{g,t_0,w_0,f,h} = \lambda t : t \leq t_0 . t$

We analyze *dim* as a prospective aspect; its denotation is repeated in 33 (from 16).

(33) $\llbracket \text{PROSP} \rrbracket^{g,t_0,w_0,f,h} = \lambda P_{\langle i,st \rangle} \lambda t \lambda w . \exists t' [t < t' \& P(t')(w)]$

Just like Abusch's (1985) WOLL morpheme, the Gitksan prospective cooccurs with tense. This analysis correctly predicts that if the time interval picked out by T is in the past, so-called 'past future' readings obtain, as shown in 34.

(34) Gilbil=hl ganuutxw=hl hli=daa=t   mahl-i=s Diana **dim** wil   yee=t
      two=CN week=CN   PTCL=SPT=3.I tell-TR=PN Diana **PROSP** COMP go=3.I
          goo=hl Winnipeg ji hlaa   (am) k'i'y=hl ganuutxw.
          LOC=CN Winnipeg IRR INCEP (only) one=CN week
        'Diana said two weeks ago that she would go to Winnipeg after one week.'
                                                    (adapted from Jóhannsdóttir & Matthewson 2007)

We also postulate a phonologically covert nonprospective ordering aspect, given in 35 (repeated from 17), which is always present when prospective *dim* is absent. In the absence of any modal, the nonprospective aspect would be essentially vacuous (replicating the nonfuturity of the event time already captured by the nonfuture tense). When a modal is present, however, the nonprospective has detectable effects on TO (see §3.3 below).

(35) $\llbracket \text{NONPROSP} \rrbracket^{g,t_0,w_0,f,h} = \lambda P_{\langle i,st \rangle} \lambda t \lambda w . \exists t' [t' \leq t \& P(t')(w)]$

An interesting and correct prediction of the temporal system proposed here is that due to the absence in the language of an instantaneous present-tense morpheme, both eventive and stative perfective predicates can pick out eventualities that are ongoing at the utterance time, without the need for imperfective marking (see Bennett & Partee 1978 on the consequences of an instantaneous present tense). For example, 28–29 assert that there is an eventuality of running/sleeping within some nonfuture time interval. If that nonfuture time interval includes the utterance time, then the running/sleeping can be ongoing at the utterance time. It will, of course, likely continue for at least some moments into the future (cf. Altshuler & Schwarzschild 2013). But since running and sleeping are cumulative (Krifka 1998), there can still be an event of the right type contained within the nonfuture time interval.[10]

Gitksan lexically distinguishes epistemic from circumstantial modals (Peterson 2010, Matthewson 2013). An epistemic example with present TP is shown in 36, and circumstantial modals with present TP are given in 37–38.

(36) Limx=**imaa**=t Bob.
      sing=EPIS=DM Bob
        'Bob might be singing.'   (Matthewson 2013:359)
(37) **Da'a<u>k</u>hlxw**-i=hl maa'y dim   lim<u>x</u>s-t.
      CIRC.POS-TR=CN berries PROSP grow.PL-3.II
        'Berries could grow here.'   (Matthewson 2013:370)

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[10] This contrasts with the situation in a language like English, which has a present tense denoting an instantaneous moment (Bennett & Partee 1978). We assume that eventive predicates like *run*, although they are cumulative, lack the subinterval property (Dowty 1986). This means that not every instantaneous subpart of a running event counts as a running event. Present perfectives are therefore unable to assert the existence of a running event inside the present moment (Bennett & Partee 1978). See §3.2 for further discussion. We thank an anonymous referee for asking us to clarify these points.

(38) **Sgi**   dim   (ap)   ha'w=s   Lisa.
     CIRC.NEC PROSP (VERUM) go.home=PN Lisa
        'Lisa should/must go home.'   (adapted from Matthewson 2013:380)

The three modals in 36–38 have different syntactic properties. Epistemic =*imaa* (also pronounced =*ima'*, depending on dialect) is a second-position clitic. *Da'akhlxw* (also pronounced *da'akxw*) is a regular verb, and *sgi* is a predicative particle that introduces a dependent clause. For our argument that epistemic =*imaa* allows past TPs to go through, it is important to show that this modal does not induce a biclausal structure.[11] The monoclausal status of =*imaa* sentences is supported by the fact that they contain only a single set of agreement marking (e.g. the determinate marker =*t* in 36). Moreover, in Gitksan all subordinate clauses contain dependent marking (Rigsby 1986:Ch. 4), and =*imaa* fails to induce dependent marking on the prejacent predicate.[12]

 With this background in place, we can now establish that both epistemic and circumstantial modals can be interpreted with past TP in Gitksan. Due to the absence of past-tense marking, we do this by using discourse contexts to narrow down temporal reference possibilities. The possibility of past TP is demonstrated for epistemic modality in 39–40.[13]

(39) [Context: Stacey bought food to feed Pat's pet, but she didn't know what kind of pet he had, so she bought all the wrong kinds of food. Later she finds out Pat's pet is a snake. Pat asks, 'Why did you buy a carrot?' Stacey replies:]
     Yugw=**imaa**=hl gax-t.
     IPFV=**EPIS=CN**   rabbit-3.II
        'He might have been a rabbit.'
                                   ('Feeding Fluffy'; http://www.totemfieldstoryboards.org/)

(40) [Context: When you looked out your window earlier today, water was falling, so it looked like it was raining. But you found out later it was the gutters leaking.]
     Yugw=**imaa**=hl wis da'awhl.
     IPFV=**EPIS=CN**   rain then
        'It might have been raining earlier.'   (Matthewson 2013:363)

Given the contexts, both examples are clear cases of epistemic modality with past TP. The TO in these cases happens to be present—the time of the prejacent event overlaps with the TP. We will see examples in §3.3 with different TOs.

 Circumstantial modals with past TPs are illustrated in 41–42.

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[11] Thanks to an anonymous referee for pointing this out.

[12] For example, in (i) the third-person agreement marker ('*nit*) comes from series III, signaling that the clause is independent. A dependent-clause third person would be marked with series II -*t*, as shown in the minimally different (ii), where the aspectual auxiliary *yukw* induces dependent marking.

  (i) Siipxw=**imaa** '**nit** k'yoots.
      sick=**EPIS**   **3.III** yesterday
         'S/he might have been sick yesterday.'

  (ii) **Yugw**=imaa=hl siipxw-**t** k'yoots.
      IPFV=**EPIS=CN** sick-**3.II** yesterday
         'S/he might have been sick yesterday.'

[13] The use of imperfective *yukw* with epistemic modals in 39–40 is not obligatory, and its presence vs. absence does not affect TP. For reasons that have yet to be explained, speakers prefer the presence of *yukw* in epistemic modal statements (regardless of whether the TP is present or past).

(41) [Context: You are talking about some land you used to have. I ask you, 'What was the soil like? Could berries have grown there?']

Da'aḵhlxw-i=hl maa'y=hl dim limx̲s-t.
CIRC.POS-TR=CN berries=CN PROSP grow.PL-3.II
  'Berries could have grown.'   (Matthewson 2013:375)

(42) [Context: Lisa's son was all alone/he needed to see her.]

Sgi   dim=t sga-'wa=s   Lisa=hl hlguuhlxwim gat-t.
CIRC.NEC PROSP=3.I across-get.to=PN Lisa=CN child   man-3.II
  'Lisa should have met her son.'   (Matthewson 2013:380)

These data show that all types of Gitksan modals allow both past and present TPs. This supports our proposal that past TP is not restricted to modals with certain flavors. On the basis of these data, we propose that the hierarchy of functional elements is the same in Gitksan as it is in Dutch. In both languages, a modal's TP is determined by a higher tense morpheme. The only difference is that in Gitksan, there is no past/present tense distinction and the TP of a modal is restricted to whichever nonfuture reference time the phonologically covert tense picks out. We provide some worked-out examples in §4.2 below.

2.4. ST'ÁT'IMCETS. Just like Gitksan, St'át'imcets does not overtly encode a past/present tense distinction; see van Eijk 1997, Matthewson 2006, Davis 2010 for data. Following Matthewson 2006, we adopt for this language the same single, nonfuture tense feature as for Gitksan (see 32 above). Also just like Gitksan, St'át'imcets has overt prospective-aspect marking, primarily either the aspectual auxiliary *cuz'* 'be going to' or the modal clitic *kelh* 'might, will'. Sample data are given in 43. (On the differences between *cuz'* and *kelh*, which go beyond our concerns here, see Glougie 2007, Davis 2010, Matthewson & Davis 2016.)

(43) a. Sáy'sez'=lhkan.
        play=1SG.SBJ
          'I played/am playing.'   (Matthewson 2006:676)
     b. **Cúz'**=lhkan   sáy'sez'.
        PROSP=1SG.SBJ play
          'I'm going to play.'
     c. Say'sez'=lhkán=**kelh**.
        play=1SG.SBJ=PROSP
          'I might/will play.'   (Matthewson 2006:678)

The prospective aspects, which have the same denotation as was given in 33 for Gitksan, cooccur with the nonfuture tense, giving rise to possible 'past-future' readings, as illustrated in 44–45.

(44) **Cuz'** séna7   ka-tékw-a   ti=sk'úk'wmi7t=a, t'u7
     PROSP COUNTER CIRC-get.quiet-CIRC DET=child=EXIS   but
          wenacw-ts-mín-em   múta7 ti=skícza7-s=a.
          true-mouth-REL-PASS again DET=mother-3SG.POSS=EXIS
       'The child was going to stop crying, but her mother was talking loudly
        to her.'

(45) [Context: Mike Leech is currently chief of T'ít'q'et. His (deceased) mother was called Julianne.]
     Zwát-en-as   s=Julianne   [k=wa=s   kúkwpi7=**kelh**
     know-DIR-3.ERG NMLZ=Julianne [DET=IPFV-3.POSS chief=PROSP

       ta=skúza7-s=a]   i=kwís=as
       DET=child-3.POSS=EXIS] when.PST=fall=3.SBJV

     'Julianne knew when he was born that her child would become chief.'

<div align="right">(Matthewson 2006:689)</div>

We postulate that St'át'imcets has the same phonologically covert nonprospective aspect as in Gitksan (see 35 above), which is present whenever prospective *cuz'* or *kelh* is absent.

    Turning to modals, St'át'imcets lexically distinguishes epistemic from circumstantial modality (Matthewson et al. 2007, Rullmann et al. 2008, Davis et al. 2009). Epistemic and circumstantial modals with present TPs are illustrated in 46–47.

(46) Wá7=**k'a** qelh-n-ás   nilh kw=s=ts'áqw-an'-em
       IPFV=**EPIS** put.away-DIR-3.ERG FOC DET=NMLZ=eat-DIR-1PL.ERG
         lh=kalál=as.
         COMP=soon=3.SBJV
      'Maybe she put it away and we ate it later.'   (Matthewson 2005:58)

(47) Lán=lhkacw=**ka**   áts'x-en ti=kwtámts-sw=a.
       already=2SG.SBJ=**CIRC** see-DIR DET=husband-2SG.POSS=EXIS
        'You must/can/may see your husband now.'   (Rullmann et al. 2008:328)

Examples 48–49 show that both epistemic and circumstantial modals allow past TP. In 48, it is not compatible with the speaker's epistemic state at the utterance time that the Canucks were winning.

(48) [Context: The Canucks were playing last night. You weren't watching the game, but you heard your son sounding excited from the other room, where he was watching. You thought the Canucks were winning, and you called up your friend and said: 'Good sports news!' But after the game, you found out that the Canucks had actually lost, and your son was excited about something his friend was telling him on his cellphone. Today, your friend asks you why you had told him there was good sports news when the Canucks had actually lost. You say:]
     Wá7=**k'a** t'cum i=Canucks=a.
     IPFV=**EPIS** win   DET.PL=Canucks=EXIS
      'The Canucks might have been winning.'   (Chen et al. 2017:250)

(49) [Context: I don't remember if we ate the rabbits or not …]
     T'u7 wá7=**ka**   n-scwákwekw=a   ts'áqw-an'-em   nilh
     just   IPFV=**CIRC** 1SG.POSS-heart=EXIS eat-DIR-1PL.ERG FOC
       s=pápt=s=a   wa7 tecw-ecw=wít   lhas
       NMLZ=always=3.POSS=EXIS IPFV increase-REDUP=3PL COMP.IPFV.3.SBJV
       kwís-alt i=sqweyíts=a.
       fall-child DET.PL=rabbit=EXIS
      'But I think we had to eat the rabbits because they were always having babies.'   (Matthewson 2005:98–99)

    The data in this and the previous subsection show that epistemic (as well as circumstantial) modals can have past TPs in Gitksan and St'át'imcets, languages in which epistemic modality is lexically distinct from other types of modality. Similar facts obtain in a range of other languages, including Blackfoot, Atayal, and Mandarin; see Chen et al. 2017 for further discussion.

    2.5. ENGLISH. English is a language where modal auxiliaries carry only residual, lexically idiosyncratic inflectional morphology. The semi-modals (*have to*, *be allowed to*,

or *be able to*), however, inflect for tense in a fully productive way, and their TP is determined by their overt tense inflection, just as in Dutch. Among the semi-modals, we focus here on *have to*, which can have an epistemic interpretation (unlike *be allowed to* or *be able to*).

Stowell (2004) claims that the simple past tense of *have to* cannot have an epistemic reading in 50 (repeated from 20b).

(50) There **had to** be a hundred people there.   (Stowell 2004:626)

We disagree with this judgment;[14] we think 50 can have a reading where it describes a past epistemic state. To back up our claim, we collected cases of past epistemic *had to* from the Corpus of Contemporary American English (Davies 2008–2015). Representative examples are given in 51–54. In each case, the TP of the epistemic modal seems to be clearly located at the past narrative reference time.[15]

(51) And here in the bathroom off the hall they found Clorox bottles. Looked like someone tried to wash away evidence. This **had to** be more than just an injured dog.   (COCA 2011; 'The man who talked to dogs', *Dateline NBC*)

(52) Petra went to the left through the crowd, her eyes searching for any signs of trouble. They were so close. This **had to** be it. Here they would uncover the information they needed. She was sure of it.
                      (COCA 2011; *The silenced: A novel*, by Brett Battles; New York: Dell)

(53) A dim chemical light flickered on as we entered, revealing metal boxes of C-6 stacked to the ceiling. There **had to** be over a tonne of the stuff.
                      (COCA 2010; 'Teaching the pig to sing', by David D. Levine;
                      Analog Science Fiction & Fact 130(5).71–80)

(54) KEITH-MORRISON: His AR-15 Bushmaster. He fired a warning shot.
CHAD-WALLIN-REED: And then I just remember seeing some guy running away. …
KEITH-MORRISON: But would the warning be enough? These **had to** be the same men who came the night before. Now here they were a second time. These guys were bad news.
                      (COCA 2015; *Unidentified man*, NBC)

Let us now consider *might have*. The data in 55–60 show attested past epistemic readings of *might have*.

(55) I wasn't worried about the guards. They knew we were neighbors. I mean, we **might have** been borrowing a cup of sugar, right?   (COCA 2010;
                      'The robots' girl', by Brenda Cooper; *Analog Science Fiction & Fact* 130(4).90–103)

(56) I stood near the entrance. The bar was so crowded, people were literally bursting out the doors onto the street. Music **might have** been playing, but you couldn't hear it; it was completely drowned out by a huge human noise like a hive of bees, … .   (*While England sleeps*, by David Leavitt, p. 188)

(57) 'I have a brain tumour?' asked Petunia. She saw a tiny flicker in the man which showed that he did in fact think it possible that was what she had; it **might** even **have** been the thing he thought likeliest.
                      (*Capital*, by John Lanchester, Ch. 19)

(58) He turned and left the room. There **might have** been people in the corridor; he didn't notice and he didn't care.   (*Capital*, by John Lanchester, Ch. 22)

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[14] Stowell (p.c., 2014) has also since changed his opinion of this and similar examples.

[15] It might be argued that these examples are somehow special because they represent free indirect discourse. For our rebuttal, see §6.

(59) Aidid exchanged a sharp look with the Cobra. The two powerful men had been disgraced in public, rendered helpless in mere seconds, and that rough handling **might have** planted seeds of doubt among some of their fighters, who either had seen or would hear about the episode. Such a disgrace could not be tolerated.
(COCA 2015; *Night of the cobra*, by Jack Coughlin; New York: St. Martin's Press)

(60) She could make out the miners climbing up to the Buckbush and the Tiger for the morning shift. She saw a prospector with his burro make his way across the mountain, headed for somewhere along the Tenmile Range. He **might have** been Daniel, but Gracy knew he wasn't. Daniel would be gone a week or two, maybe more, and he'd said the night before when she had been rousted from bed that he wouldn't go until she returned.
(COCA 2015; *The last midwife*, by Sandra Dallas; New York: St. Martin's Press)

Many cases of past-TP *might have* in COCA involve not only a shift to a past TP, but also a shift in the agent whose epistemic state is being accessed to someone other than the speaker. This is the case, for example, in 55. The tendency for the TP and the agent whose epistemic state is relevant to shift in tandem is quite common in narratives, but as we have seen above (e.g. in the ice cream example in 21), the shift to another agent's epistemic state is not obligatory.[16]

To supplement our attested data we also elicited judgments on some constructed examples, in an informal questionnaire study with eleven (nonlinguist) native-speaker participants. The following are examples of past epistemic readings that received very high acceptability ratings.[17]

(61) This morning I opened my phone bill and was shocked when I saw that I owed $10,000. This **had to** be a mistake! Unfortunately, it turned out to be correct. My husband had used my phone on his latest trip to Papua New Guinea, forgetting about the roaming charges.

(62) [Context: Mary is a school principal and at her school there is a policy that if there is even a possibility that a teacher has abused a student, the teacher will be fired. Five years ago, Mary fired one of her teachers because he was accused of abusing a student. This morning, the accuser recanted the accusation and conclusive proof was brought forward that the accuser had lied and the teacher was innocent. Mary is now being interviewed by a reporter.]

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[16] Some cases of past-TP epistemic *might have* have a further twist, in that they shift the epistemic agent to a hypothetical other observer who does not know what the main protagonists know. The example in (i) is a case in point.

(i) 'What do you think?' asked Dumbledore. He **might have** been asking Harry's opinion on whether it was a good site for a picnic. (*Harry Potter and the half-blood prince*, by J. K. Rowling, p. 519)

As pointed out by an anonymous referee, (i) might be paraphrased as 'It was *as if* he was asking Harry's opinion', rather than 'Harry (genuinely) thought that it was possible that Dumbledore was asking his opinion'. We leave analysis of these cases for future research.

[17] Participants judged acceptability on a three-point scale, with '1' the best and '3' the worst. Control items were included, of straightforwardly acceptable or unacceptable modal claims. Examples 61 and 63 were judged as '1' by ten and eight participants, respectively. While we were preparing the final revisions for this article, we happened to come across an attested example that is almost identical to 61.

(i) [Context: A Canadian has to go to the hospital during a visit to the US, and upon return to Canada is confronted with a large hospital bill. Later it turns out that the bill is actually correct.]
A month later, I got a bill for (drum roll, please) $14,000. It came with a whack of paperwork to back it up. I almost laughed out loud (it was either that or cry). It **had to** be a mistake.
(*Globe & Mail*, April 20, 2017)

> Reporter: How do you feel about the news today that the teacher you fired
>   was in fact innocent?
> Mary: Very upset. It is most unfortunate.
> Reporter: So why did you fire him at the time, when you did not have con-
>   clusive proof that he was guilty?
> Mary: Because he **might have** been guilty.

The example from Stowell in 50 above received a relatively high average score[18] when embedded in the discourse context in 63.

> (63) When Susan arrived at Bob's house, she saw that the place was packed.
>   There **had to** be at least a hundred people there. But she found out later that
>   actually, there were only 60.

This questionnaire study suggests that epistemic modals with past TP, while perhaps not as readily accessible as those with present TP, are far from ruled out and are often judged as essentially perfect by native speakers.[19]

2.6. WHY ARE PAST EPISTEMIC READINGS OFTEN DISPREFERRED? One possible objection to what we have proposed so far is that, for English modal auxiliaries, past-TP epistemic readings often seem more difficult to get out of context than present-TP epistemic readings. If, as we argue, epistemic modals scope under tense, wouldn't we expect past-TP readings of modals to be just as easily available as present-TP readings? We believe that several factors explain why this is not always the case.

First of all, arguably, the default epistemic perspective of any sentence is that of the speaker at the time of utterance, if only because this is the perspective that is always freely available and is not in need of any special contextual support. In order to shift to a past epistemic perspective (either that of the speaker at a past time, or that of some other agent in the past), the context needs to make another TP sufficiently salient. As we have seen in the naturally occurring examples given in §2.5, when the context supports the presence of a salient past epistemic perspective, the past-TP readings are unproblematic. In narrative prose, this is especially the case in so-called FREE INDIRECT DISCOURSE (FID; see Eckardt 2015 for a thorough recent study and analysis), where discourse is explicitly presented as representing the thoughts or speech of a protagonist of the story. FID is the kind of discourse in which a past epistemic perspective is maximally salient; hence it pragmatically supports past-TP readings that might be difficult to obtain out of context.[20] This explains why many (but not all!) examples of past-TP epistemics discussed in this article occur in FID or FID-like narrative contexts.

In support of this idea, an interesting contrast (pointed out by a referee) arises between epistemic modal auxiliaries, on the one hand, and main verbs and adjectives that express similar epistemic meanings, on the other. The latter are much more free in allowing past TP, even in the absence of contextual support. This is illustrated by the contrast in the data in 64. Past TP is easy—in fact, obligatory—in 64a,b, but the reading is not immediately obvious out of the blue in 64c.

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[18] 1.5 on the scale between 1 and 3.

[19] As suggested by Portner (2009:227), the cases with stative predicates were generally judged as better by our participants than those with eventive verbs (not shown here). This effect may relate to claims by Sbardolini (2016) about the correlation between epistemic interpretations and atelicity, but further investigation is required.

[20] See §6 for arguments against analyzing FID in terms of syntactic processes that reduce it to embedding under an elided matrix propositional attitude verb.

(64) a. It **seemed** that Mary was the murderer.
    b. We **knew** that Mary was the murderer.
    c. Mary **might have** been the murderer.

This contrast arises for three reasons. First, the matrix verbs in 64a,b are overtly inflected for past tense, thereby unambiguously forcing a shift to a past perspective. This contrasts with the string *might have* in 64c, which is ambiguous and has a competing present-TP reading. This reason for the dispreferred status of past epistemic readings is specific to English modal auxiliaries, which are not overtly marked for tense. Modals like *might*, *could*, and *must* can be either present or past (see §5 for more discussion and examples). This means that English modal auxiliaries are in need of contextual support to bring out the nondefault, past-TP epistemic interpretation. This particular problem does not arise for English semi-modals or for languages like Dutch, where modal verbs are freely inflected for tense.[21]

Second, for the main verbs the relevant epistemic perspective is that of a grammatical argument of the verb (the subject of *knew* in 64b and the implicit goal argument of *seem* in 64a). Plausibly the presence of this grammatical argument facilitates the processing of the interpretation in which the relevant past epistemic perspective is the one belonging to this argument rather than the speaker.

Third and most importantly, with an epistemic modal, the conversational backgrounds that encode the agent's epistemic perspective are part of the backgrounded, not-at-issue content of the sentence (after all, they are called conversational BACKGROUNDS for a reason!). By contrast, propositional attitude verbs contribute to the at-issue content. So for instance, if someone says *I believe that John is the murderer*, it is possible to object by saying *No, that's false—you don't believe that at all!*, but such a response would be infelicitous to an utterance with an epistemic modal like *John must be the murderer*. In our formal analysis, the not-at-issue status of the conversational backgrounds is implemented by treating them as contextual parameters of interpretation. Because of their not-at-issue status, it is very difficult to switch conversational backgrounds without signaling this explicitly by means of overt, at-issue material, such as a propositional attitude verb with a grammatically represented attitude holder.[22]

Our explanation for why epistemic past-TP readings are often dispreferred for English modal auxiliaries raises a question about semi-modals like *have to*, which do inflect for tense and therefore are not subject to the first of the three arguments just given. An anonymous referee claims in this regard that past-tense inflection fails to force past

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[21] One striking example of this difference is the opening sentence of Kafka's *The trial*. In the German original (i) as well as its Dutch equivalent (ii), the past-inflected modal can only have past TP and as such represents the epistemic state of the protagonist, Josef K. This has the effect of narrating the story from his point of view right from the start. In the English translation in (iii) this is much less clear, as *must have* is ambiguous between representing Josef K.'s point of view (past TP) or the narrator's (present TP), with the latter interpretation probably being the default one.

  (i) Jemand **muss-te** Josef K. verleumd-et **hab-en.**
  (ii) Iemand **moest** Josef K. belaster-d **hebb-en.**
      someone must-PST.3SG Josef K. slander-PTCP have-INF

            (Dutch translation by Alice van Nahuys, Querido, 1977)

  (iii) Someone **must have** slandered Josef K.

          (English translation by Breon Mitchell, Schocken Books, 1998)

[22] If we had chosen to represent the modal base and ordering source as pronoun-like implicit variables in the object language, essentially the same point would apply. Unstressed pronouns (especially null ones) refer to contextually salient entities or discourse topics; it is very difficult to use them to pick out a nonsalient entity or to switch to a different topic.

TP for epistemic *had to*, as it does for *seem* or *know*, and even for *had to* itself when it is interpreted deontically. If it is correct that *had to* allows present TP, this fact is not predicted by our analysis and must be addressed in future research. However, we are not convinced that *had to* allows present TP. Consider 65. The discourse context here makes a present TP unambiguous. For six out of seven native speakers we consulted, *had to* is infelicitous or marginal in 65b. We return to the issue of present TP for epistemic *had to* in §7.

> (65) [Context: A mother is wondering what her son got up to at a party last night. He emerges from his room holding his head and looking green. She says:]
>   a.   You **must have** {been drunk}/{drunk too much} last night.
>   b.   #You **had to** {be drunk}/{drink too much}/{have drunk too much} last night.

2.7. Summary so far. So far we have seen that in Dutch, Gitksan, St'át'imcets, and English, epistemic modals can have past TPs. This evidence supports our core proposal that a modal's TP is independent of the flavor of its conversational background. TP is provided by a higher-scoping temporal element, typically tense, which may freely provide either a present or past time interval, regardless of modal flavor.

3. Temporal orientation and aspect. We turn now to the less empirically controversial of our two main claims: that TO is restricted both by modal flavor and by aspect (viewpoint and lexical). In this section we show that in each of the four languages investigated here, the predictions inherited from the literature are upheld. We begin by introducing the expected TO/flavor correlations, and then we present the relevant data.

3.1. TO and conversational background: the diversity condition. As pointed out in §1.2, there is a correlation between nonfuture TO and epistemic interpretations. For example, 66 and 67 can only be understood epistemically.

> (66) She must have left.   (past TO)
> (67) He might be in his office right now.   (present TO)

Condoravdi captured the interaction between TO and modal flavor via her diversity condition (see also Werner 2003, 2006, Kaufmann 2005, Copley 2006, Laca 2008, Portner 2009, Giannakidou & Mari 2016, among others). This condition is based on a branching-futures model of time, in which the past and the present are 'settled': up until the TP, the same facts hold in all metaphysically accessible worlds. After the TP, the accessible worlds diverge, so the future is metaphysically unsettled. We give our adaptation of Condoravdi's diversity condition in 68; it requires that for any (occurrence of a) modal, there be at least one world in the modal base in which the prejacent is true, and one in which it is false.[23]

> (68) The diversity condition: (adapted from Condoravdi 2002:83)
> For any modal Mod, prejacent P of type $\langle i,st \rangle$, and world w and time t,
> $[\![\text{Mod}(P)(t)(w)]\!]^{g,t_0,w_0,f,h}$ is defined only if
> $\exists w',w'' [w',w'' \in \cap f(w,t) \,\&\, P(t)(w') \,\&\, \neg P(t)(w'')]$

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[23] As Chris Kennedy (p.c.) points out, this is really just a special case of a more general informativity constraint on assertion: it rules out vacuous uses of modals.

    Klecha (2016:27) argues that the diversity condition has difficulties with necessity modals when the ordering source is empty, such as in *It logically must be the case that 1 + 1 = 2.* Diversity fails here, yet the modal is fine. Klecha offers an alternative proposal, which we do not have space to go into here, but in principle any account that derives the future orientation of circumstantial modals suffices for our purposes.

This condition is satisfied by an epistemic modal with a nonfuture TO (since an epistemic modal base can simultaneously contain worlds in which a nonfuture prejacent is true, and worlds in which it is false). Condoravdi argues that the condition is violated by a METAPHYSICAL modal with a nonfuture TO, since all worlds in a metaphysical modal base share the same truth value for propositions about past or present events.[24]

Condoravdi assumes that the relevant nonepistemic readings all involve metaphysical modal bases, and therefore that the diversity condition suffices to derive the restriction of nonfuture TO to epistemic modals. However, the TO restrictions actually extend beyond metaphysical modals proper to other modals with circumstantial modal bases. We will see this below for our four languages, and the problem has been discussed by, for example, Abusch (2012) and Thomas (2014). It is not our main purpose here to explain the correlation between nonfuture TO and epistemic interpretations. We simply assume (following Abusch 2012) that what Condoravdi calls 'metaphysical' modality is actually circumstantial modality with a past TP, and that some restriction along the lines of the diversity condition suffices to derive the modal flavor/TO restrictions.

In the following subsections we will see evidence from all four languages that supports the prediction that circumstantial modals are restricted to future TO. We will also see that in all four languages, TO in addition depends on lower-scoping temporal operators, namely ordering and inclusion aspects. The evidence supports our proposed universal architecture in which modals scope under TP-restricting operators and over TO-restricting operators.

3.2. DUTCH AND ENGLISH. In Dutch and English, a modal's TO is determined by the viewpoint and lexical aspect of the prejacent clause, and its modal flavor is restricted by the diversity condition. We go through each of the main factors in turn.

PERFECT. In Dutch, the perfect is marked by means of the auxiliary *hebben* 'have' or *zijn* 'be' (depending on the verb), combined with a past participle. This is also possible in the complement of a modal. In that case, the perfect determines TO while TP is unaffected. This is illustrated in 69a, which has present TP (because the modals are in the simple present) and past TO (because the complement of the modals has perfect aspect). The counterpart of 69a with the modals in the simple past is 69b; here we have past TP and past TO. Due to the diversity condition, the modal flavor of such past-TO sentences can only be epistemic.

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[24] As pointed out by a referee, this condition is falsified (at least under some analyses) by circumstantial modals in the perfective aspect that give rise to actuality entailments. A French example is given in (i); this sentence asserts that it was possible at a (past) time t for John to leave at t, and he did leave at time t. See Bhatt 1999, Hacquard 2006, and much subsequent research.

    (i) John a pu   partir.
       John could.PFV leave
          'John was able to leave.'

A parallel Dutch example involving the present perfect is given in (ii); this likewise carries an actuality entailment.

    (ii) Hij heeft   kunn-en vertrekk-en.
       he have.PRS.3SG POS-INF leave-INF
          'He was able to leave.'

The referee's point is a good one, but an analysis of actuality entailments and their interaction with TO goes beyond the scope of this article. Our purpose in this section is simply to provide crosslinguistic support for basic diversity-condition effects. (For discussion of actuality entailments in St'át'imcets, see Davis et al. 2010, and for Gitksan, see Matthewson 2012.)

(69) a. Hij **moet**   / **kan**   **hebb-en** ge-wonn-en.
        he NEC.PRS.3SG / POS.PRS.3SG have-INF PTCP-win-PTCP
         'He must/may have won.'/'It is possible that he (has) won.'

<div align="right">(present TP, past TO)</div>

    b. Hij **moest**   / **kon**   **hebb-en** ge-wonn-en.
        he NEC.PST.3SG / POS.PST.3SG have-INF PTCP-win-PTCP
         'He had to have won.'/'It was possible that he (had) won.'

<div align="right">(past TP, past TO)</div>

With respect to perfect prejacents, English behaves exactly the same way as Dutch, except for complications caused by the inability of English modal auxiliaries to express past TP by means of tense inflection. To compensate for this gap in expressability, English has recruited combinations like *might have* and *could have* to encode past TP rather than past TO, rendering these expressions ambiguous. We return to this issue in §5.

LEXICAL ASPECT: STATIVE VS. EVENTIVE. In Dutch and English, prejacents that are unmarked for overt viewpoint aspect show a stative/eventive split with respect to possible TOs. Stative prejacents allow present TO (or future, in the right discourse context), as shown in 70. This is true whether the TP is present or past.

(70) De sleutel **moet**   / **kan**   / **moest**   / **kon**
      the key   NEC.PRS.3SG / POS.PRS.3SG / NEC.PST.3SG / POS.PST.3SG
        in de la   ligg-en.
        in the drawer lie-INF
       'The key must be/might be/had to be/might have been in the drawer.'

<div align="right">(present TO)</div>

When the prejacent contains an eventive verb, however, the TO can only be future, in both English and Dutch (unless the verb has an imperfective interpretation; see below for details). Again this is independent of whether the TP is present or past; see 71.

(71) Ze **moet**   / **kan**   / **moest**   / **kon**   winn-en.
    she NEC.PRS.3SG / POS.PRS.3SG / NEC.PST.3SG / POS.PST.3SG win-INF
      'She must/might/had to win/was able to win.'   (future TO)

(IM)PERFECTIVE AND NONPERFECT. Dutch and English do not have any overt morpheme dedicated to marking simple perfective or imperfective aspect. Progressive morphology, which typically appears only on eventive verbs, is a subtype of imperfective. We assume that statives receive an imperfective interpretation by default.

    In English, any eventive verb must be in the progressive when the event time includes the reference time. This is shown for past and present tense in 72a,b, respectively.

(72) a. She #{sings}/{is singing} right now.
    b. She #{sang}/{was singing} when he entered the room.
       (under the interpretation: Her singing began before he entered the room.)

In 72a,b, the perfective versions yield interpretations other than one where the event time includes the reference time. In the present tense case in 72a, the bare (perfective) verb must be interpreted as habitual (or as a 'reporter's present'). Bennett and Partee (1978) attribute the requirement for progressive with episodic eventive verbs in the present tense to the instantaneous nature of the English present tense. Eventive verbs lack the SUBINTERVAL PROPERTY (Dowty 1986) and therefore cannot fit inside the instantaneous utterance time; present perfective is therefore not an option for these predicates. The past-tense reflex of the same effect is seen in the fact that 72b with *sang* and an instantaneous reference-time adverbial can only be interpreted as inchoative, rather than as ongoing: she BEGAN to sing when he entered the room.

We see a parallel effect with modals. Example 73 shows that overt progressive marking is obligatory in English with a present-TP, present-TO modal and an eventive verb. Example 73a can only have future TO; to express present TO, the progressive is required, as in 73b.

(73) a. She must/might sing.   (only future TO)
     b. She must/might be singing.   (present or future TO)

In many analyses, this future-TO effect for eventive verbs is derived from an inherent futurity within the modal's lexical entry (for example, Condoravdi 2002). In our analysis, the future TO of eventive verbs in English follows instead from a separate nonperfect aspect, which is phonologically covert; its denotation is repeated in 74 (from 15).

(74) $[\![\text{NONPERF}]\!]^{\text{g},\text{t}_0,\text{w}_0,\text{f},\text{h}} = \lambda P_{\langle i,st \rangle} \, \lambda t \, \lambda w \, . \, \exists t' \, [t \le t' \, \& \, P(t')(w)]$

In Dutch, the facts are similar but slightly more complicated. This language has a progressive-like construction (the *aan het* construction), but it is not obligatory, in contrast to English. For example, 75 is perfectly fine both with and without *aan het*.[25]

(75) Ze {zing-t   op dit moment} / {is   op dit moment aan het
     she {sing-PRS.3SG at this moment} / {be.PRS.3SG at this moment at   the
        zing-en}.
        sing-INF}
     'She is singing at this moment.'

There are a couple of ways to interpret these facts. It could be that in Dutch, at least some eventive verbs can be interpreted as imperfective without overtly occurring in the progressive (see de Vuyst 1985 for an analysis that is similar in spirit to this). Alternatively, it could be that the Dutch perfective does not enforce a strict inclusion relation between the reference time and the event time, but rather a weaker relation whereby the two times merely need to overlap (Klein 1994). For concreteness and simplicity we adopt the former explanation. The fact that eventive verbs can sometimes be interpreted imperfectively also accounts for the fact that (at least in some cases) Dutch modals with eventive prejacent verbs can have a present-TO reading either with or without progressive marking. However, they often prefer the progressive to receive present TO, much as in English, and without the progressive they are biased toward future TO (cf. Foolen & de Hoop 2009).

(76) Ze **kan**   (wel   eens) {zing-en} / {aan het zing-en zijn}.
     she **POS.PRS.3SG** (PTCL PTCL) {sing-INF} / {at   the sing-INF be}
        'She might be singing.'

We do not attempt to account for exactly when eventive verbs in the complement of a modal require progressive marking in order to obtain a present-TO reading in Dutch.

3.3. GITKSAN AND ST'ÁT'IMCETS. Recall from §2.3 and §2.4 that Gitksan and St'át'imcets possess a single covert nonfuture tense feature; we have also postulated that in the absence of overt prospective marking, there is a covert nonprospective aspect. Our null hypothesis that TO is provided by temporal operators below the modal predicts that in Gitksan and St'át'imcets, TO will be future if and only if overt prospective marking is present. In the absence of prospective marking, TO will be either pres-

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[25] There are some restrictions on the use of the *aan het* construction that we do not fully understand; for instance, using it with a nonagentive verb like *regenen* 'rain' would be odd.

ent or past. Crucially, we predict no restrictions on TO based on the eventive/stative distinction in these languages, unlike in English and Dutch. We saw above that in English and Dutch, present-TP modal sentences with eventive predicates in the (nonperfect) perfective must have future TO (cf. 73a). Present TO is disallowed for these predicates because events cannot fit inside the instantaneous present reference time. Since Gitksan and St'át'imcets lack an instantaneous present tense, this restriction on TO should be absent in these languages.

These predictions are upheld. Turning to Gitksan first, we observe that a prejacent that is unmarked for viewpoint aspect (and therefore is interpreted as perfective) and contains no overt prospective marker allows either past or present TO. This is shown in 77–78. The TP here is present—the speaker is talking about their utterance-time evidence. (The two forms of the modal in these examples represent dialect differences.)

(77) Yugw=**imaa/ima'**=hl wis.
    IPFV=**EPIS=CN**   rain
    'It might have rained.'/'It might be raining.'/≠'It might rain (in the future).'
    ✓Past-TO context: You see puddles, and the flowers looking fresh and damp.
    ✓Present-TO context: You hear pattering on the roof.
    # Future-TO context: You hear thunder, so you think it might rain soon.
                                   (Gitksan; Matthewson 2013:364–65)

(78) Yugw=**imaa/ima'**=hl siipxw-t.
    IPFV=**EPIS=CN**   sick-3.II
    'He might have been sick.'/'He might be sick (now).'/≠'He might be sick (in the future).'
    ✓Past-TO context: Why wasn't Joe at the meeting yesterday?
    ✓Present-TO context: Why isn't Joe here?
    # Future-TO context: He's wearing no coat in the rain; he might get sick.
                                        (Gitksan; Matthewson 2013:365)

Examples 79–80 show that the prospective-aspect marker *dim* is necessary and sufficient for a future TO, for both eventive and stative prejacent predicates.

(79) Yugw=**imaa/ima'**=hl **dim** wis.
    IPFV=**EPIS=CN**   **PROSP** rain
    ≠'It might have rained.'/≠'It might be raining.'/'It might rain (in the future).'
    # Past-TO context
    # Present-TO context
    ✓Future-TO context   (Gitksan; Matthewson 2013:365)

(80) Yugw=**imaa/ima'**=hl **dim** siipxw-t.
    IPFV=**EPIS=CN**   **PROSP** sick-3.II
    ≠'He might have been sick.'/≠'He might be sick (now).'/'He might be sick (in the future).'
    # Past-TO context
    # Present-TO context
    ✓Future-TO context   (Gitksan; Matthewson 2013:365)

Examples 81–84 contain past-TP epistemics. Again we see that past TO is achieved without any overt aspectual marking, for both eventive and stative prejacents, but future TO is marked by obligatory prospective aspect.

(81) [Context: When you looked out your window earlier today, the ground was wet, so it looked like it might have rained. But you found out later that the sprinklers had been watering the ground.]
Yugw=**imaa**=hl wis da'awhl.
IPFV=**EPIS**=CN rain then
  'It might have rained.' (based on my evidence earlier)
                                                          (Gitksan; Matthewson 2013:366)

(82) [Context: Joe left the meeting looking really green in the face and sweaty. Someone asks you why he left.]
Yugw=**imaa**=hl siipxw-t.
IPFV=**EPIS**=CN sick-3.II
  'He must have been sick.'   (Gitksan; Matthewson 2013:360)

(83) [Context: This morning you looked out your window and judging by the clouds, it looked like it might have been going to rain, so you took your rain-coat. Later you're explaining to me why you did that.]
Yugw=**imaa**=hl **dim** wis.
IPFV=**EPIS**=CN **PROSP** rain
  'It might have been going to rain.'   (Gitksan; Matthewson 2013:366)

(84) [Context: You saw your granddaughter going out into the pouring rain with-out any coat and you thought she might get sick from that. So you told her to take her coat. Later you're explaining to me why you did that.]
Yugw=**imaa**=hl #(**dim**) siipxw-t.
IPFV=**EPIS**=CN #(**PROSP**) sick-3.II
  'She might have been going to get sick.'   (Gitksan; Matthewson 2013:366–67)

The same pattern holds for circumstantial modals, as shown in 85–87: future TO is obligatorily marked by prospective aspect. The difference here is that, following the diversity condition, circumstantial modals are restricted to future TO. Given the overt marking of prospective in this language, the result is that circumstantial modals are un-grammatical without a following *dim*.

(85) **Da'akhlxw**-i-s Henry *(**dim**) jam-t.
CIRC.POS-TR-PN Henry *(**PROSP**) cook-3.II
  'Henry is able to cook.'/'Henry was able to cook.'
                                                          (past or present TP, future TO)
                                                          (Gitksan; adapted from Matthewson 2013:371)

(86) [Context: You were watching the Canucks and at one point in the first period they were up 2–1. At that point, they might have still won (but they didn't in the end).]
K'ay **da'akxw**-diit *(**dim**) xsdaa-diit, ii ap nee=dii
still **CIRC.POS**-3PL.II *(**PROSP**) win-3PL.II CCNJ VERUM NEG=FOC
    xsdaa-diit.
    win-3PL.II
  'They still could have won, but they didn't win.'   (past TP, future TO)
                                                          (Gitksan; adapted from Matthewson 2013:375)

(87) **Sgi**   *(**dim**) (ap) ha'w=s Lisa.
CIRC.NEC *(**PROSP**) (VERUM) go.home=PN Lisa
  'Lisa should/must go home.'/'Lisa should have gone home.'
                                                          (past or present TP, future TO)
                                                          (Gitksan; adapted from Matthewson 2013:380)

The data in 77–87 show that (whether the predicate is stative or eventive, and regardless of modal flavor) TO in Gitksan is determined by viewpoint aspect: prospective marking appears if and only if the TO is future.

We now turn to St'át'imcets. Just like in Gitksan, epistemic modals in St'át'imcets allow either past or present TO without any overt marking, but future TO is obligatorily overtly marked. Future TO can be marked either via the prospective auxiliary *cuz'* or the prospective clitic *kelh*. These generalizations are illustrated for modals with present TPs in 88–90.

(88) [Context: You've been watching the gold medal hockey game, and in the middle of it the power went off, so you had no TV. My power is out too, so I call up and ask, 'Did the Canadians win?']
T'cúm=wit=**k'a**, cw7aoz kw=s=áts'x-en=an.
win=3PL=EPIS   NEG   DET=NMLZ=see-DIR=1SG.ERG
  'They might have won, I don't know.'   (St'át'imcets; present TP, past TO)

(89) Wá7=**k'a** séna7   qwenúxw.
IPFV=EPIS COUNTER sick
  'He may be sick.' (context: Maybe that's why he's not here.)
                                                                (present TP, present TO)
                                                (St'át'imcets; Rullmann et al. 2008:321)

(90) [Context: Your grandson is celebrating a Canadian victory, but the game is only half over and so you say, 'The Americans might win.']
Sxek t'cúm#(=**kelh**)=tu7 i=tlh7álqw-emc=a.
EPIS   win#(=PROSP)=then DET.PL=border-person=EXIS
  'The Americans might win.'   (St'át'imcets; present TP, future TO)

The same facts about TO hold if the TP is past, as in 91–93.

(91) [Context: As in 81: When you looked out your window earlier today, the ground was wet, so it looked like it might have rained. But you find out later that the sprinklers had been watering the ground.]
Kwís=**k'a**=tu7.
rain=EPIS=then
  'It might have rained.'   (St'át'imcets; past TP, past TO)

(92) [Context: As in 48: The Canucks were playing last night … Today, your friend asks you why you had told him there was good sports news when the Canucks had actually lost. You say:]
Wá7=**k'a** t'cum i=Canucks=a.
IPFV=EPIS win   DET.PL=Canucks=EXIS
  'The Canucks might have been winning.'   (St'át'imcets; past TP, present TO)

(93) [Context: When you looked out your window earlier today it was cloudy, so it looked like it must have been going to rain. So you took your raincoat, but in the end it cleared up and the weather was sunny. Someone asks you later why you have your coat, and you say:]
Cúz'=**k'a**(=tu7)   séna7   kwis.
PROSP=EPIS(=then) COUNTER rain
  'It might have been going to rain.'   (St'át'imcets; past TP, future TO)

Circumstantial data are shown in 94–95. St'át'imcets patterns similarly to Gitksan in that there is a strict diversity-condition effect whereby circumstantial modals are future-oriented. However, the way St'át'imcets manifests this effect is opposite to Gitksan: rather than having obligatory overt marking of prospective aspect, in St'át'imcets the

circumstantial modals convey their own inherent futurity, and overt prospective marking does not appear.

(94) Ts'ex-ts'x-ílc=kacw**(*=kelh)=ka(*=kelh)**.
     clean-REDUP-AUT=2SG.SBJ**(*=PROSP)=DEON(*=PROSP)**
          'You should clean up.'   (St'át'imcets; present TP, future TO)

(95) Wá7=lhkan   **ka**-cát-s-**a**   ta=k'ét'h=a.
     IPFV=1SG.SBJ **CIRC**-lift-CAUS-**CIRC** DET=rock=EXIS
          'I can lift the rock.'   (St'át'imcets; present TP, future TO)

3.4. SUMMARY. Epistemic and circumstantial modals behave differently with respect to TO, unlike with TP. For epistemic TOs, the four languages divide into two pairs. In Dutch and English, modals cooccurring with a perfect operator necessarily have past TO, and modals with covert nonperfect allow either present or future TO.[26] In Gitksan and St'át'imcets, modals cooccurring with prospective aspect allow only future TO, and modals with (covert) nonprospective allow either past or present TO.

Circumstantial modals in all four languages (and any language, assuming the diversity condition generalizes) can only be future-oriented. They are thus incompatible with a real perfect aspect that scopes under the modal. The languages in our sample differ in whether they overtly mark the prospective (or nonperfect) aspect that circumstantial modals require: Gitksan is the only language that has overt prospective under circumstantials.[27]

Our proposal that in English and Dutch, there is a separate, phonologically null, nonperfect aspect that gives present or future TO (rather than assigning the modal itself some inherent futurity; cf. discussion in §3.2) is not a crucial feature of our analysis. However, the overt manifestation of PROSP below the modal in Gitksan, and in St'át'imcets for epistemic modals, provides indirect crosslinguistic support for the analysis. Moreover, Kratzer (2011) argues on independent grounds that English possesses a null prospective that cooccurs with modals (we would call this a 'nonperfect'), and Louie (2015) motivates a null prospective in some Blackfoot modal constructions.

In summary, the same basic architecture can be applied in all four languages, with independent differences in the tense and aspect systems deriving surface differences in modal-temporal interactions. Many of the crosslinguistic differences have to do merely with phonological (c)overtness. The nonperfect is phonologically null in English and Dutch under modals, but the prospective is spelled out as *dim* in Gitksan, and as *kelh* in St'át'imcets under epistemic modals.

4. EXEMPLIFICATION OF THE FORMAL ANALYSIS. In this section we apply the analysis to a representative range of examples to show that it derives the right truth conditions. We discuss Dutch first, then Gitksan and St'át'imcets. English works mostly the same as Dutch, but has various complications. For that reason, we postpone a fuller discussion of English to §5.

4.1. DUTCH. Because Dutch modals generally do not have lexical restrictions on their modal flavor, the examples in this section in principle allow for both epistemic and

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[26] Recall that modals which in English surface with *have* do not necessarily contain a real perfect operator scoping under the modal; combinations like *might have* can have past TP and nonpast TO. See discussion above and in §5.

[27] An outstanding question is why in St'át'imcets, epistemic modals allow overt marking of prospective (as shown in 90 above), but circumstantials do not.

nonepistemic readings, modulo diversity-condition effects. Since our focus is on accounting for TP and TO, we do not usually comment on whether particular examples are biased toward any particular modal flavor. To illustrate our account, we use the modal verb *kunnen*, which is the closest analogue of English *might*.

In 96 we have present tense, an eventive predicate, and perfective inclusion aspect. In the absence of the perfect, the (covert) ordering aspect is nonperfect.

(96) Jan **kan**   dans-en.
     Jan **POS.PRS.3SG** dance-INF
      'Jan can/might dance.'   (present TP, future TO)
     $[[[\text{POS}(\text{NONPERF}(\text{PFV}(Jan\ dansen)))](\text{PRESENT}(t_i))]]^{g,t_0,w_0,f,h} =$
     $\lambda w . \exists w' [w' \in \text{BEST}_{h(w,t_0)}(\cap f(w,t_0)) \ \& \ \exists t' [t_0 \le t' \ \& \ \exists e [\text{Jan.dance}(e)(w') \ \& $
     $\tau(e) \subseteq t']]]$

Example 96 expresses the proposition that is true in an evaluation world w iff there is a world w′ that is accessible from w at the utterance time t_0 (according to modal base f and ordering source h) in which there is an event e of Jan dancing, whose run-time is contained within some interval t′ that starts no earlier than t_0. This correctly predicts (as in Condoravdi's system) that Jan's potential dancing is in the future.

Modal sentences containing stative predicates or imperfective viewpoint aspect are correctly predicted to allow either present or future TO. This is illustrated in 97.

(97) Jan **kan**   {ziek}/{**aan het** zing-en}   zijn.
     Jan **POS.PRS.3SG** {sick}/{**at   the** sing-INF} be.INF
      'Jan might be sick/singing.'   (present TP, present/future TO)
     $[[[\text{POS}(\text{NONPERF}(\text{IPFV}(Jan\ ziek\ zijn/zingen)))](\text{PRESENT}(t_i))]]^{g,t_0,w_0,f,h} =$
     $\lambda w . \exists w' [w' \in \text{BEST}_{h(w,t_0)}(\cap f(w,t_0)) \ \& \ \exists t' [t_0 \le t' \ \& \ \exists e [\text{Jan.be.sick}/$
     $\text{Jan.sing}(e)(w') \ \& \ t' \subseteq \tau(e)]]]$

Example 97 is true in w iff there is a world w′ accessible from $\langle w,t_0 \rangle$ in which there is an event e of Jan being sick/singing, whose run-time contains some interval t′ that starts no earlier than t_0. This means that Jan's sickness/singing can begin before, at, or after the utterance time; the requirement is that Jan's sickness/singing must contain a nonpast interval—that is, the event cannot be entirely located in the past.

Next we turn to sentences containing perfect aspect in the modal's prejacent. The surface scope ordering of the perfect auxiliary and the modal leads to the analysis in 98 for an eventive predicate. This is the reading that corresponds to English *might have* with present TP and past TO. For Dutch *kunnen* with a perfect complement, this is the only available reading.

(98) Jan **kan**   **zijn**   vertrokk-en.
     Jan **POS.PRS.3SG** be.INF   leave-PTCP
      'Jan may/might have left.'   (present TP, past TO)
     $[[[\text{POS}(\text{PERF}(\text{PFV}(Jan\ vertrekken)))](\text{PRESENT}(t_i))]]^{g,t_0,w_0,f,h} =$
     $\lambda w . \exists w' [w' \in \text{BEST}_{h(w,t_0)}(\cap f(w,t_0)) \ \& \ \exists t' [t' < t_0 \ \& \ \exists e [\text{Jan.leave}(e)(w') \ \& $
     $\tau(e) \subseteq t']]]$

Example 98 denotes the proposition that is true in w iff there is a world w′ that is (epistemically) accessible from $\langle w,t_0 \rangle$ in which there is an event of Jan leaving, whose run-time is contained within some interval t′ that precedes t_0. This correctly derives present TP and past TO. In 99, the perfect auxiliary combines with either a stative predicate or an overt imperfective (progressive). Both of these combinations derive present TP and past TO.

(99) Jan **kan** {ziek}/{aan het zing-en} **zijn** ge-wees-t
Jan **POS.PRS.3SG** {sick}/{at the sing-INF} **be.INF** PTCP-be-PTCP
'Jan may/might have been sick/singing.' (present TP, past TO)
$[[POS(PERF(IPFV(\textit{Jan ziek zijn/zingen})))](PRESENT(t_i))]^{g,t_0,w_0,f,h} =$
$\lambda w \ . \ \exists w' \ [w' \in BEST_{h(w,t_0)}(\cap f(w,t_0)) \ \& \ \exists t' \ [t' < t_0 \ \& \ \exists e \ [Jan.be.sick/$
$Jan.sing(e)(w') \ \& \ t' \subseteq \tau(e)]]]$

We have illustrated the analysis for examples with present TP here. Past-TP cases are exactly analogous, differing only in that the TP is not t_0, but instead is a past time interval given by the assignment function. We work through one example in 100, which is the past-tense counterpart of 98. Recall from §1 that these readings cannot be generated within Condoravdi's system.

(100) Jan **kon** **zijn** vertrokk-en.
Jan **can.PST.3SG** **be.INF** leave-PTCP
'It was possible that Jan (had) left.' (past TP, past TO)
$[[POS(PERF(PFV(\textit{Jan vertrekken})))](PAST(t_i))]^{g,t_0,w_0,f,h} =$
$\lambda w \ . \ \exists w' \ [w' \in BEST_{h(w,g(i))}(\cap f(w,g(i)) \ \& \ \exists t' \ [t' < g(i) \ \& \ \exists e \ [Jan.leave(e)(w')$
$\& \ \tau(e) \subseteq t']]]$ (where $g(i) < t_0$)

This proposition is true in w iff there is a world w′ that is (epistemically) accessible from a contextually salient past time $g(i)$ in which there is an event of Jan leaving, whose run-time is contained within some interval t′ that precedes $g(i)$.

This outline of our formal analysis confirms that in Dutch, TP is determined fully compositionally via the tense inflection on the modal, and TO is determined by aspect.

4.2. GITKSAN AND ST'ÁT'IMCETS. As shown in §2.3, Gitksan and St'át'imcets lexically distinguish epistemic from circumstantial modals, there is just one nonfuture tense, and both epistemic and circumstantial modals can have past TPs in these languages. The only relevant difference between the systems is that in Gitksan, future TO is obligatorily overtly marked by prospective aspect, while in St'át'imcets, this is the case only for epistemic modals. For St'át'imcets circumstantial modals, future TO is enforced by the diversity condition. These independent differences in the temporal systems of Gitksan and St'át'imcets as opposed to Dutch and English will correctly derive the different surface patterns of modal-temporal interactions, even though there is an identical hierarchy of elements, system of semantic types, and the same general architecture whereby tense provides TP and aspect TO.

Before working through some concrete examples in these languages, we present lexical entries for the modals that incorporate the lexicalized modal flavor. These are given in 101–103, following ideas in Matthewson et al. 2007, Rullmann et al. 2008, Davis et al. 2009, Peterson 2010, and Matthewson 2013. We are setting aside differences in the precise types of modal base and ordering source the modals require; these include evidential restrictions, which are not relevant for current concerns.[28]

(101) $[[\textit{k'a}$ (St'át'imcets)/\textit{imaa} (Gitksan)$]]^{g,t_0,w_0,f,h}$ is only defined if f is an epistemic modal base.
If defined, $[[\textit{k'a/imaa}]]^{g,t_0,w_0,f,h} = \lambda P_{\langle i,st \rangle} \lambda t \lambda w \ . \ \forall w' \ [w' \in BEST_{h(w,t)}(\cap f(w,t))$
$\rightarrow P(t)(w')]$

---

[28] The modals in 101–102 are translated as universal quantifiers, but all of them except *sgi* are felicitous both in contexts that support necessity claims and in contexts that support possibility claims. For detailed discussion, see Rullmann et al. 2008, Peterson 2010, and Matthewson 2013.

(102) $\llbracket ka$ (St'át'imcets)/sgi (Gitksan)$\rrbracket^{g,t_0,w_0,f,h}$ is only defined if f is a circumstantial modal base.

If defined, $\llbracket ka/sgi \rrbracket^{g,t_0,w_0,f,h} = \lambda P_{\langle i,st \rangle} \lambda t \lambda w$. $\forall w'$ [w' $\in$ BEST$_{h(w,t)}$($\cap$f(w,t)) $\rightarrow$ P(t)(w')]

(103) $\llbracket da'a\underline{k}xw$ (Gitksan)$\rrbracket^{g,t_0,w_0,f,h}$ is only defined if f is a circumstantial modal base.

If defined, $\llbracket da'a\underline{k}xw \rrbracket^{g,t_0,w_0,f,h} = \lambda P_{\langle i,st \rangle} \lambda t \lambda w$. $\exists w'$ [w' $\in$ BEST$_{h(w,t)}$($\cap$f(w,t)) & P(t)(w')]

We work through just two representative examples here. Example 104 is from St'át'imcets and contains an epistemic modal with a present TP and a past TO. The example parallels the Dutch case in 98, except that St'át'imcets has a covert nonprospective aspect rather than an overt perfect one.[29] The other difference between this example and the two Germanic languages is due to the nonfuture tense. The discourse context here enforces present TP, so the value of g(i) is t_0. In a different discourse context, the same modal could have past TP without any additional marking. We thus see that although Gitksan and St'át'imcets have neither obligatory tense marking nor a past/present distinction, our analysis still involves tense providing the TP in these languages.

(104) [Context: You've been watching the gold medal hockey game, and in the middle of it the power went off, so you had no TV. My power is out too, so I call up and ask, 'Did the Canadians win?']

T'cúm=wit=**k'a**.

win=3PL=**EPIS**

   'They might have won.'   (St'át'imcets; nonfuture TP, past TO)

$\llbracket [k'a(\text{NONPROSP}(\text{PFV}(t'cúmwit)))](\text{NONFUTURE}(t_i)) \rrbracket^{g,t_0,w_0,f,h} =$

λw . $\forall w'$ [w' $\in$ BEST$_{h(w,g(i))}$($\cap$f(w,g(i))) $\rightarrow$ $\exists t'$ [t' $\leq$ g(i) & $\exists e$ [they.win(e)(w') & τ(e) $\subseteq$ t']]] (where f is an epistemic modal base and g(i) $\leq t_0$)

This expresses the proposition that is true in a world w iff in all worlds w' that are epistemically accessible from w at some nonfuture time g(i), there is an event of the Canadians winning whose run-time is contained within some interval t' that is no later than g(i).

The Gitksan example in 105 contains a circumstantial modal with past TP and future TO. Here, the discourse context ensures that the value given to the nonfuture tense is in the past, giving past TP.

(105) $\underline{K}$'ay **da'a$\underline{k}$xw**-diit   **dim** $\underline{x}$sdaa-diit, ii   ap   nee=dii $\underline{x}$sdaa-diit.

   still **CIRC.POS**-3PL.II **PROSP** win-3PL.II CCNJ VERUM NEG=FOC win-3PL.II

   'They still could have won, but they didn't win.'   (past TP, future TO)

                                                              (Gitksan; Matthewson 2013:375)

$\llbracket [da'a\underline{k}xw(\text{PROSP}(\text{PFV}(\underline{x}sdaadiit)))](\text{NONFUTURE}(t_i)) \rrbracket^{g,t_0,w_0,f,h} =$

λw . $\exists w'$ [w' $\in$ BEST$_{h(w,g(i))}$($\cap$f(w,g(i))) & $\exists t'$ [g(i) $<$ t' & $\exists e$ [they.win(e)(w') & τ(e) $\subseteq$ t']]] (where f is a circumstantial modal base and g(i) $\leq t_0$)

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[29] There is a potential candidate for an overt perfect morpheme in St'át'imcets: *plan* (Davis 2010, Matthewson 2013). However, it is not clear whether this is a perfect or simply a lexical item meaning 'already' (cf. Vander Klok & Matthewson 2015). Importantly, *plan* does not function to give past TO under modals.

5. Past TP in english.

> '[T]here is another set of data where we find that for a certain modal meaning, English chooses a designated lexical item, while other languages choose a "transparent" way of conveying that meaning. This seems to support the view that it is English that is the outlier.'
>
> (von Fintel & Iatridou 2008:132)

> 'Not the least use in the world for him to say he *could* be better. Might, could, would—they are contemptible auxiliaries.' (*Middlemarch*, by George Eliot, Ch. 14)

5.1. Variation in the english modal system. Compared to the other three languages discussed in this article, the modal-temporal system of English is complex and messy. Presumably, this is due in large part to a purely morphosyntactic constraint prohibiting the cooccurrence of overt tense marking with a modal auxiliary. English has to resort to 'patches' in its grammar in order to express past-TP readings of modals, resulting among other things in the ambiguity of *might have*.

Looking beyond *might*, it becomes clear that English modals do not all behave the same way. For instance, *may* differs from *might* in that *may have* is unambiguous; it can only have a present-TP, past-TO reading (at least in the 'standard' dialect; see §5.4 for discussion of cross-speaker variation). These generalizations are summarized in Table 3.

	PRESENT TP, PAST TO	PAST TP, PRESENT/FUTURE TO	PAST TP, PAST TO
Mary might have left.	✓	✓	✓
Mary may have left.	✓	*	*

TABLE 3. Interpretations of *might have* vs. *may have*.

In this section we explore the different subclasses of English modals, which are defined in terms of their temporal interpretation, taking into account not only their interaction with *have*, but also their behavior with respect to the sequence-of-tense (SOT) phenomenon. The SOT data show that some English modals include the specification of tense in their lexical entry, whereas others do not. We implement this in our formal framework by analyzing individual modal auxiliaries as spelling out different parts of the tree given in 18 above. In particular, English modals realize the combination of the T head plus the Mod head, with some modals always including the tense feature [PRESENT], whereas others can also have a [ZERO] tense feature. As for the interaction with *have*, we argue that the combination *might have* (and similarly for other modals in the same subclass) has an additional lexicalized interpretation, in which it functions as a single lexical item with past TP.

5.2. Semi-modals. Before we discuss the English modal auxiliaries proper, we take a brief look at semi-modals such as *have to*, *be able to*, *be allowed to*, and *be possible*. These behave exactly as our analysis predicts, and essentially the same way as the Dutch modal verbs do. TP is determined by tense scoping above the modal, and TO is determined by aspect scoping below it and the Aktionsart of the prejacent predicate. The modal flavor is constrained by the diversity condition in the usual way. This is illustrated for *have to* in Table 4.[30]

5.3. Three classes of modal auxiliaries. When not followed by *have* and when not in an FID environment, the modal auxiliaries *may*, *must*, and *might* allow only present TP in matrix clauses. (In the rest of this section, we ignore FID; see §6.)

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[30] A referee suggests that *Sue had to be sick* allows present, as well as past, TP. As noted above, most of the speakers we consulted rejected the use of *had to* with present TP in 65b. Future research may determine whether there is speaker variation in this area.

	TP	TO
Sue has to leave.	present	future
Sue has to be sick.	present	present/future
Sue had to leave.	past	future
Sue had to be sick.	past	present/future
Sue has to have left.	present	past
Sue had to have left.	past	past

TABLE 4. TP and TO for the semi-modal *have to*.

(106) Mary **may**/**must**/**might** {leave}/{be home}.
        —only present TP, present/future TO

However, these and other modal auxiliaries fall into (at least) three distinct classes, depending on whether they can have past TP when followed by *have*, and whether they can have a simultaneous reading in SOT contexts (see also Huddleston & Pullum 2002:196ff., Portner 2009:223ff. for related discussion). The SIMULTANEOUS reading is illustrated in 107a for a nonmodal sentence: the event time of the embedded past-tense stative predicate coincides with that of the matrix verb. This contrasts with the so-called DOUBLE-ACCESS reading in 107b, where the event time of the embedded present-tense stative predicate overlaps with both the utterance time and the event time of the matrix verb (see Ogihara 1996, Abusch 1997, among others). When a modal appears in an embedded clause under a past-tense matrix verb, the simultaneous reading corresponds to past TP, and the double-access reading to present TP (see examples below).

(107) a. John said that Sue was pregnant.   (simultaneous)
        b. John said that Sue is pregnant.   (double access)

The three classes of modal auxiliaries are as follows; the information is summarized in Table 5.[31]

- Class I: Modals that always have present TP: *may*, *can*, *shall*, *will*.
- Class II: Modals that can behave as if inflected for past tense in SOT contexts (i.e. allow the simultaneous reading when in the scope of a matrix past-tense verb): *must*.
- Class III: Modals that can have the simultaneous reading in SOT contexts and that ADDITIONALLY allow a past-TP interpretation when their complement is morphosyntactically in the perfect: *might*, *could*, *should*, *would*.

	SIMULTANEOUS READING WITH SOT	
	−	+
PAST TP WHEN FOLLOWED BY *have* −	class I (e.g. *may*)	class II (*must*)
+		class III (e.g. *might*)

TABLE 5. Classification of English modals.

In the rest of this section we present data that support the classification in Table 5 and then propose an analysis in the theoretical framework developed above.

CLASS I: *MAY*, *CAN*, *SHALL*, *WILL*. We use *may* to illustrate the behavior of class I modals. The other modals in this class behave essentially the same way when it comes to TP and TO, but have idiosyncratic restrictions involving modal flavor and things like register. For instance, *can* resists epistemic readings (except when negated), *will* expresses futurity, and *shall* is archaic.

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[31] This table raises the question of why there are no English modals that can have past TP with *have* but reject the simultaneous reading in SOT contexts. This might just be an accidental gap; we leave the question for further research.

When embedded under a past-tense matrix verb, class I modals cannot have the simultaneous reading and only allow for the double-access interpretation (although see §5.4 for discussion of variation concerning *may*).[32]

(108) John said that Mary **may** {leave}/{be home}.
—only double-access reading (present TP, present/future TO)
—no simultaneous reading (*past TP, present/future TO)

When followed by *have*, class I modals can only express present TP and past TO; this is true not only in main clauses (as in 109), but also when embedded in a past-tense matrix clause, where again only the double-access reading is possible (110).

(109) Mary **may** have {left}/{been home since 7 PM}.
—only present TP, past TO

(110) John said that Mary **may** have {left}/{been home since 7 PM}.
—only double-access reading (present TP, past TO)
—no simultaneous reading (*past TP, past TO)

Class II: *must*. Unlike class I modals, *must* can have the simultaneous reading when embedded under a past-tense verb, as in 111. The naturally occurring examples in 112 involve simultaneous readings for *must*.

(111) John said that Mary **must** {leave}/{be home}.
—simultaneous (past TP, present/future TO)
—double-access (present TP, present/future TO)

(112) a. Charlie never wrote of his health, so I supposed he **must** be all right.
(*The cunning man*, by Robertson Davies, p. 174)
b. They dutifully supported him in office until a conflict-of-interest commissioner … told Vander Zalm he **must** go.
(*1867*, by Christopher Moore, p. 223)

However, when it occurs in a matrix clause and is followed by *have*, *must* behaves just like the class I modals in that it can only have a present-TP/past-TO reading.

(113) Mary **must** have {left}/{been home since 7 PM}.
—only present TP, past TO

As expected, when *must have* is embedded under a matrix past-tense verb, it is again ambiguous between the simultaneous and double-access readings (so the TP is either past or present), but this time the TO is past, as shown in 114; some attested examples of the simultaneous (i.e. past TP) reading with *must have* are given in 115.

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[32] The following is a contextualized example showing that *may* cannot have the simultaneous reading, whereas *must* and *might* can.

(i) [Context: Yesterday, I was looking for my supervisor, Mary. I couldn't find her anywhere, so I asked my colleague John, who said that he thought she was away on a business trip. Today, I ran into Mary, who told me that she had been at a doctor's appointment.]
John said that Mary **must/might/#may** be out of town.

Here the (hypothetical) state of Mary's being out of town obtains (according to John) at the time of John's utterance (yesterday), but not at the utterance time (today). An example demonstrating that all three modals allow the double-access reading is given in (ii); in this case, the state of Mary (supposedly) being from Quebec applies both at the time of John's saying and at the utterance time.

(ii) [Context: Yesterday, I was introduced to a new coworker, Mary. I couldn't quite place her accent, so I wondered where she was from. According to my colleague, John, she sounded like a Quebec francophone.]
John said that Mary **must/might/may** be from Quebec.

(114) John said that Mary **must** have {left}/{been home since 7 PM}.
     —double-access (present TP, past TO)
     —simultaneous (past TP, past TO)

(115) a. I thought someone **must have** given him my name to divert attention
     from the others.   (*Fifth business*, by Robertson Davies, p. 38)
    b. We knew your Ma **must have** sent you.
                                  (*Fifth business*, by Robertson Davies, p. 96)

CLASS III: *MIGHT*, *COULD*, *SHOULD*, *WOULD*. We use *might* as our paradigm case for class III modals; the other members of the class behave largely the same way with respect to TO (although they are sometimes more limited or idiosyncratic in other ways).[33]

Class III modals behave like *must* in that they can have the simultaneous, past-TP reading when embedded under a past-tense verb (cf. Abusch 1997).

(116) John said that Mary **might** {leave}/{be home}.
     —double-access (present TP, present/future TO)
     —simultaneous (past TP, present/future TO)

However, class III modals differ from *must* in allowing past-TP readings when they are nonembedded but followed by *have*. This results in the famous ambiguity of *might have* that was the focus of Condoravdi 2002. As we have argued in this article, these past-TP readings can be not only circumstantial, but also epistemic.

The past-TP readings of *might have* allow not only present or future TO (as in the cases discussed in the literature), but also past TO, as shown by the following variant of von Fintel and Gillies's (2008) ice cream example (cf. 21).

(117) A: Why did you look in the freezer?
    B: Somebody **might have** put the ice cream in there.   (past TP, past TO)

Here B is talking about a past epistemic state (past TP) concerning a hypothetical event (the putting of the ice cream in the freezer) that is located BEFORE the epistemic perspective time (past TO).

Again, we see the same pattern in embedded clauses as in main clauses, as shown in 118–119.

(118) Mary **might** have {left}/{been home}.
     —past TP, past/present/future TO
     —present TP, past TO

(119) John said that Mary **might** have {left}/{been home}.
     —simultaneous (past TP, past/present/future TO)
     —double-access (present TP, past TO)

5.4. A PARTIALLY LEXICAL ANALYSIS. How can this classification of English modals be accounted for in our theory of modal/temporal interaction? Let us start with class I modals (*may*, *can*, *shall*, *will*). These behave exactly the same way as Dutch modal verbs and English semi-modals when they are inflected for present tense. We therefore analyze class I modals as including an inherent present-tense feature on T in their lexical entry, similar to Abusch's (1985) decomposition of *will* into a present tense and an atemporal modal WOLL. This means that class I modals spell out the subtree in 120 (the details of how this spell-out works will depend on one's theory of the syntax-morphology interface).

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[33] Our classification may need further refinement, since some class III modals (*would* and *could*) can have past TP in main clauses, unlike *might*. See §5.5 for discussion.

(120)

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                              TenseP
                         ╱              ╲
                       T′                ModP
                    ╱      ╲           ╱       ╲
            [PRESENT]    T₁      Mod          Asp_OrdP
                │          └──────┤      │
                │               POS
                └───────────┬─────┘
                           may
```
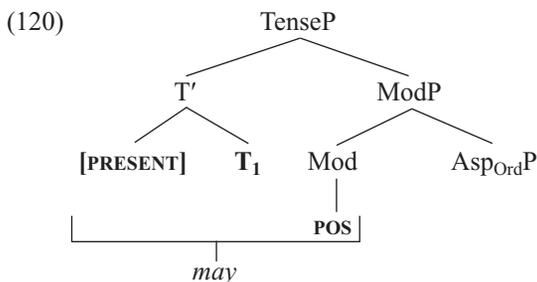
Giving a full analysis of SOT goes beyond the scope of this article; for concreteness, we follow Kratzer's (1998) 'zero tense' approach. (However, in principle our account should be equally compatible with a deletion approach to SOT, as in Ogihara 1995 or von Stechow 1995, for instance.) We assume that the simultaneous reading involves a [ZERO] tense feature, which simply denotes the identity function (in other words, it is just a presuppositionless counterpart of the nonzero tense features defined in 7–9). The simultaneous reading of 108 is ruled out since *may* requires a [PRESENT] tense feature on T and is incompatible with [ZERO] tense.

The class II modal is a bit more mysterious. At first sight, *must* appears to be ambiguous between a present-TP interpretation (in main clauses like 106 and 113) and a past-TP interpretation (when embedded under a past-tense matrix verb, as in 111 and 114). One possibility might be to assume that *must* is ambiguous between having an inherent [PRESENT] feature or an inherent [PAST] feature (with the latter option being unavailable in main clauses for some reason). However, the facts are more complicated (and interesting) when *must* is in embedded clauses. As is well known from the literature on SOT, (nonmodal) past-tense verbs embedded under a past-tense matrix verb not only allow the simultaneous interpretation, but also have a BACKSHIFTED reading.

(121) Mary said that Jane was angry.
    a. Mary said last week that Jane was angry last week.   (simultaneous)
    b. Mary said last week that Jane was angry a year ago.   (backshifted)

In the backshifted reading, the past tense in the embedded clause moves the evaluation time backward relative to the (past) evaluation time of the matrix clause. Past-tense forms of semi-modals allow the backshifted reading, as we expect since they are ordinary verbs (the same holds in Dutch). By contrast, the class II modal *must* cannot have the backshifted reading (Boogaart 2007).[34]

(122) Mary said last week that Jane **had to/#must** be angry a year ago.
    —backshifted reading OK for *had to*, bad for *must*

These data show that although *must* can count as past tense for the purposes of SOT, it does not have a semantically active past-tense morpheme that can shift the evaluation time backward. We conclude that *must* can have either a [PRESENT] or a [ZERO] tense feature on T. The [PRESENT] feature occurs when *must* appears in a main clause, or

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[34] Here is a context showing that *had to* allows backshifting, but *must* and *might* do not.

    (i) [Context: Last week, Mary told me a story about her cousin, Jane. About a year ago, Jane's chihuahua was attacked by a vicious pitbull terrier. Jane took a stick and chased away the pitbull.]
      Mary said that Jane **had to/#must/#might** be very angry, because she wasn't even afraid of the pitbull.

It is possible to obtain something like the backshifted reading by adding perfect *have* to the modal.

    (ii) Mary said that Jane **must have/might have** been very angry.

But in that case, it is the past TO caused by *have* that is responsible for the apparent backshifting.

when it has the double-access reading as in 111, and the [ZERO] feature appears in the simultaneous reading. We assume that a T head with the [ZERO] feature is uninterpretable in matrix clauses, or that by default it refers to the utterance time t_0 (except in FID contexts—see §6).[35]

Summarizing, in our analysis *must* spells out the following configuration, where the [PRESENT] feature is optional.

(123)
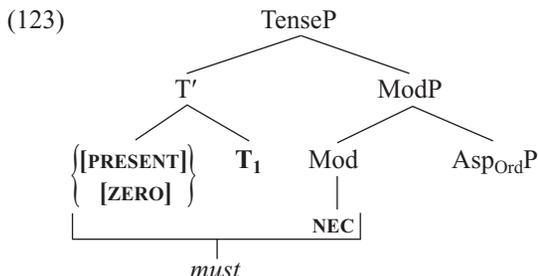
Finally, let us consider class III modals (*might*, *could*, *would*, *should*). Recall that these are similar to *must* (class II) in allowing the simultaneous reading (116). They also behave like *must* in not allowing the backshifted reading, as shown in 124 (Abusch 1997).[36]

(124) Mary said last week that Jane **might** be angry (#a year ago).
　　　　—simultaneous
　　　　—#backshifted

However, class III modals ADDITIONALLY allow a past-TP reading expressed by means of *have* following the modal. Condoravdi (2002) analyzed this ambiguity in terms of *have* being able to raise over the modal at LF so that it assigns past TP instead of past TO. Although this is an attractive idea because it offers a compositional way to derive the past-TP reading, it has several conceptual and empirical problems (see Arregui

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[35] A referee pointed out a potential problem with our analysis. Suppose that the SOT rule involves wholesale REPLACEMENT of the [ZERO] feature by a [PAST] feature copied from the T in the matrix clause. Assuming that this feature replacement takes place at PF (the representation that is the input to the phonology) and that lexical insertion can only 'see' the PF and not the LF (the representation that is the input to the semantics), then lexical insertion will be unable to distinguish between a real past tense (which has the [PAST] feature in both PF and LF, resulting in the backshifted reading) and a 'fake' one (which has [PAST] in PF but [ZERO] in LF, yielding the simultaneous reading). This is not a problem for nonmodal verbs (such as in 121) or semi-modals (such as the version of 122 with *had to*), because these allow both the simultaneous and the backshifted reading. However, for modals like *must* and *might*, this is problematic, because they allow only the simultaneous reading, so insertion of the modal should be allowed only if there is a [ZERO] feature on T IN THE LF.

To solve this problem, we tentatively suggest an approach to SOT inspired by Klecha (2016). In his analysis, morphological tense marking is a kind of agreement between a (main or auxiliary) verb and a c-commanding T head. The (interpretable) tense feature carried by T is copied onto the verb/auxiliary as an uninterpretable feature, which eventually gets spelled out as past-tense morphology. In the case of SOT, the uninterpretable tense feature on the embedded verb/auxiliary is copied not from the T in the embedded clause, but from the T in the matrix clause (see Klecha's example 49 for illustration). Under these assumptions, the SOT rule does not get rid of the [ZERO] feature on the embedded T, so it is still visible at the point when lexical insertion of the modal takes place. (Note also that modals actually do not show any overt tense inflection, so perhaps they do not even need to get a tense feature from the matrix clause.) Working out the details of the morphosyntax of SOT is a very complex matter, which would go far beyond the scope of this article. We thank the referee for thoughtful discussion of this issue.

[36] But as Portner (2009:224) points out, *could* (unlike *might*) does allow the backshifted reading in its ability interpretation. This suggests that ability *could* may have a [PAST] feature. See also §5.5.

2005, Hacquard 2006, Laca 2008 for discussion).[37] First of all, raising the Asp head over the Mod head would violate the well-known head-movement constraint of Travis 1984 (see Fălăuş & Laca 2016 for this point). Second, the raising account cannot explain why *have* following a modal can express a past-TP reading only for class III modals and not for classes I or II. For class I this could perhaps be accounted for in terms of the inherent [PRESENT] blocking the raising of Asp, but no such explanation is available for *must* (class II), which is otherwise exactly like class III modals in having either an inherent [PRESENT] or [ZERO] tense feature. We conclude that the ability to allow a past-TP reading with *have* must be a lexical property, which class III modals have but which *must* lacks.

A third problem for the *have*-raising account (pointed out in Portner 2009:229) is that it cannot easily explain why it is possible for class III modals followed by *have* to have a past-TP/past-TO reading (as in 117 above), since *have* would have to do double duty: it would have to scope both over the modal (to explain the past TP) and under the modal (to explain the past TO) at the same time. A lexical analysis appears instead to be called for, in which *might have* forms a lexicalized unit that encodes both types of 'pastness' simultaneously.

We propose that class III modals with *have* are in fact ambiguous: in addition to the regular interpretation in 125 in which *might have* consists of two separate lexical items, *might* followed by *have*, there also is a single lexical item *might have* represented in 126.

(125)

```
                    TenseP
              ┌────────┴────────┐
            T′                 ModP
        ┌────┴────┐        ┌────┴────┐
    ⎧[PRESENT]⎫  T₁      Mod      Asp_Ord P
    ⎩ [ZERO] ⎭           │      ┌────┴────┐
        │               POS   Asp_Ord   Asp_Inc P
        └──────────────────┘    │
              might            PERF
                                │
                               have        (present TP, past TO)
```

(126)

```
                    TenseP
              ┌────────┴────────┐
            T′                 ModP
        ┌────┴────┐        ┌────┴────┐
     PAST        T₁      Mod      Asp_Ord P
                          │      ┌────┴────┐
                         POS   Asp_Ord   Asp_Inc P
                                  │
                              ⎧ PERF  ⎫
                              ⎩NONPERF⎭
        └──────────────────────────┘
              might have        (past TP, past/present/future TO)
```
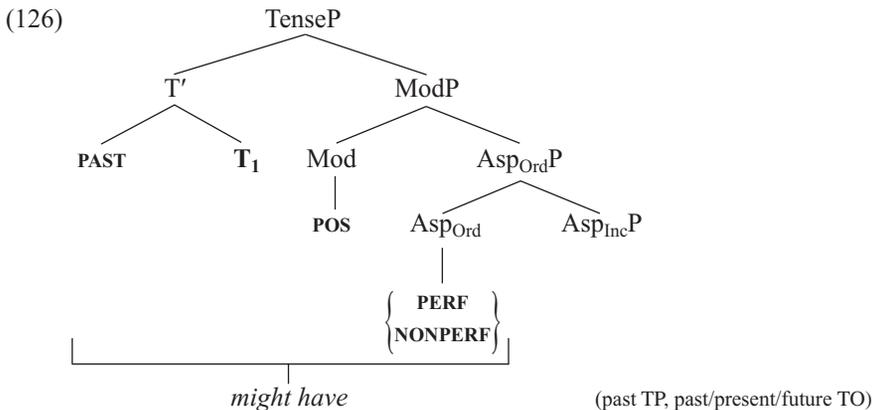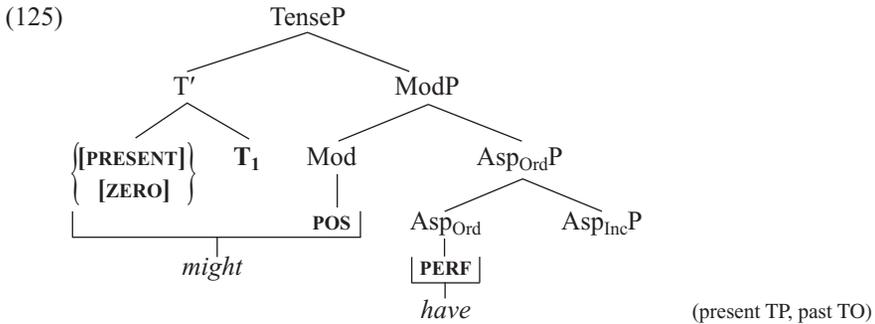
This single lexical item *might have* morphologically spells out the combination of the tense head T with a past-tense feature, the possibility modal POS, and the aspect head

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[37] See Demirdache & Uribe-Etxebarria 2008a for support of the claim that the perfect scopes over the modal.

Asp$_{\text{Ord}}$, which can be filled by either PERF or NONPERF.[38] The result is that whereas the TP is past, the TO can be either past, present, or future. That all three options are indeed attested can be seen in the following examples.

(127) Why did you set the freezer to the lowest temperature?
   a. Mary might have put the ice cream in there (and I didn't want it to melt).
       [≈ 117] (past TP, past TO)
   b. The ice cream might have been in there (and I didn't want it to melt).
       [≈ 21] (past TP, present TO)
   c. (I thought Mary just put the ice cream in there, and) it might have melted.   (past TP, future TO)

It is important to note that our analysis of *might have* as a single lexical item does not entail that it consists of a single morphological WORD. As pointed out by Tim Stowell (p.c.), the lexicalized *might have* form allows other elements, such as negation, to intervene on the surface (***might** not **have***). In this respect it is like other multiword lexical items that can also be discontinuous, including particle verbs (e.g. *I **pick**ed it **up***) and many idioms (*It **gives** me **pause***).

Our account makes the past-TP readings of class III modals a purely lexical property, which is appropriate given the fact that such readings are possible only for some modals and not others. In particular, the fact that *must have* lacks past-TP readings is telling, because in all other respects, *must* behaves the same way as the class III modals.

Before concluding this section, we return to the issue of backshifting, since this has received attention in the literature on epistemic modals. In our account, *might have* should have the lexicalized meaning in 126 in embedded clauses as well. In other words, we predict that when it occurs in the scope of a matrix past tense, *might have* (as opposed to plain *might*) should allow backshifting. Moreover, this should in principle be independent of modal flavor (epistemic or nonepistemic). And in fact, although backshifted readings for epistemic modals may be difficult to get (Iatridou 1990, Eide 2003, Boogaart 2007, among others), they are sometimes possible, as pointed out by Homer (2010) for French (see also Martin 2011, and Eide 2003 for Norwegian). For English *might have*, the generalization appears to be that backshifting is possible when it is embedded under an attitude verb that is not one of thinking or believing. This is shown in 128. Example 128a is compatible with a backshifted situation where yesterday, I no longer considered it possible that my bracelet was in my mother's jewelry box. Example 128b, in contrast, can only mean that it was consistent with my epistemic state yesterday that the bracelet had been in the jewelry box the day before.[39]

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[38] An anonymous referee suggests that a simplification of our analysis might be achieved by adopting an old idea proposed by McCawley (1971). In his analysis, *have* is really an instantiation of past that occurs in nonfinite environments; multiple occurrences of *have* can be generated, but only one is ever spelled out due to a haplology rule. On this view, in the past-TP, past-TO reading of *might have* there would actually be a second, 'silent', *have* in the Asp$_{\text{Ord}}$ head of 126, which would not be part of the lexical entry for *might have* itself (i.e. the bracket in 126 would have its right edge just to the left of Asp$_{\text{Ord}}$). Such an analysis could account for the (apparent) double duty of *have* in the past-TP, past-TO reading: there would actually be two *have*s, an overt one expressing past TP, and a covert one (due to haplology) representing past TO. Another advantage of this proposal would be that it could potentially allow for a unification of the two readings of *might have*: *might* is spelled out as *might have* whenever it has either past TO (as in 125) or past TP (as in 126). We thank the referee for this intriguing suggestion. Working out the ramifications of this idea in more detail (such as the mechanics of the haplology rule) goes beyond the scope of this article and is left for future research.

[39] *Had to* similarly allows backshifting in this context, supporting our claim to this effect in 122 above. As predicted, plain *might* without *have* here does not allow backshifting.

(128) [Context: On Monday, I looked in my mother's jewelry box for my bracelet, thinking it might have been put in there by mistake. On Tuesday, my mother asked me why I had looked in her jewelry box the day before, and I told her that for all I knew, my bracelet might have been in there. Now it's Wednesday and I'm telling the whole story to a friend.]

    a.   I **told** my mother (yesterday) that my bracelet **might have** been in her jewelry box.

    b.   #I **thought** (yesterday) that my bracelet **might have** been in her jewelry box.

We argue that although epistemic modals with a [PAST] feature (i.e. semi-modals with past-tense inflection and class III modals followed by *have*) can in principle have back-shifted readings, they are for pragmatic reasons unable to do so when the attitude is one of belief. This is because epistemic modals are closely tied to epistemic states—or, at least, to bodies of evidence that support beliefs by agents. Expecting an epistemic modal to have a TP that differs from the contextually or overtly given belief-time would be akin to expecting the 'judge' (in the sense of Lasersohn 2005 and Stephenson 2007) in 129a to not be Mary, or the modal in 129b to rely on evidence available to someone other than Mary. While in principle possible, it would be for obvious reasons extremely pragmatically dispreferred. The same is true of 128b, which introduces my epistemic state yesterday, and therefore does not allow the modal to target my epistemic state the day before.

(129) a. According to Mary, Whiskas is tasty.

      b. According to Mary, it might rain tomorrow.

5.5. CONSTRAINTS ON LEXICALIZATION? Our lexical analysis of class III modals with *have* raises the question of what the limits are (if any) on this sort of lexicalization. What parts of the tree can be spelled out as a single lexical item? Presumably, there are principled constraints, but what they are cannot be determined with certainty without further investigation. Given the idiosyncratic behavior of the English modals, we would caution against drawing hasty conclusions based on just a few lexical items. We have found evidence for this kind of lexicalization in only one of the four languages investigated here, and since the number of modal auxiliaries in English is quite small, it is impossible to decide whether any generalizations are robust and reflect semantic or morphosyntactic constraints of a more fundamental nature. For instance, is the absence of any modals that can have a (lexicalized) past TP in combination with *have* but that do not allow for simultaneous readings in SOT (i.e. the emptiness of the lower-left cell in Table 5 above) just an accidental gap, or is it evidence of some more principled constraint? In this connection it is significant that class II has only a single member. If due to the diachronic vagaries of lexicalization *must* had had slightly different properties and behaved just like the class III modals, we might have been tempted to draw some far-reaching but incorrect conclusions about the lexicalization possibilities of English modals, in particular the (false) generalization that all modals that allow for the simultaneous reading in SOT contexts can have past-TP readings in combination with *have*.

  Our lexical approach is further supported by the fact that there exists variation among speakers and dialects with respect to the behavior of individual modals, which may indicate that the English modal system is still in a state of flux. We briefly discuss three such instances of variation here. The first concerns *may*. While *may* is clearly a class I modal in (what we consider to be) the standard dialect of English, many (younger?) speakers seem to treat it as a class III modal, that is, as equivalent to *might*. In the literature, it has been pointed out that it is not uncommon to find *may have* used counterfac-

tually, that is, with a past TP in a situation in which it is known at the utterance time that the prejacent is false, as in 130 (Denison 1992, Huddleston & Pullum 2002:202–3). Attested examples of past-TP *may have* are given in 131.

(130) If our goalie had not been injured, we **might/%may** have won.

(131) a. 'An irrevocable catastrophe **may have** occurred if a worker or visitor had been in this location,' wrote Thomas Quasney …

<div style="text-align:right">(Ubyssey, March 1, 2012)</div>

  b. Had Roosevelt not died an untimely death … , the world **may** well **have** been spared the agonies of the cold war. (*NYRB* 60(5).24, March 21, 2013)

  c. If he had thought about it, he **may have** reasoned it was somewhere near midnight. (*The narrow road to the deep north*, by Richard Flanagan, p. 239)

We also have come across examples where *may* behaves just like *might* for the purposes of SOT.

(132) A woman who was last seen in Surrey in 1961 has been found alive in the Yukon. … Lucy Ann Johnson was originally reported missing on May 14, 1965. … Police believed she **may have** met with foul play and conducted a thorough investigation into her disappearance, but they never solved the case. (globalnews.ca, retrieved July 19, 2013)

(133) She had not felt sorry for the child. Instead, holding that tiny warm body, she had felt a conscious serendipity, a sense that this **may** not **have** been planned but had become, the minute it happened, what was meant to be.

<div style="text-align:right">(Half of a yellow sun, by Chimamanda Ngozi Adichie, p. 314)</div>

In all of these cases, speakers of the 'standard' dialect would have to use *might* instead of *may*. We speculate (without having any real evidence at this point) that there is a link between the variation we see with respect to counterfactuals in examples like 130–131 and the variation in SOT behavior in 132–133, and that they are both reflexes of a single ongoing process of lexical change, namely the shift of *may* from class I to class III.

 A second example of lexical variation and/or change involves *must have* in counterfactual conditionals, which we take to be impossible in the current standard dialect. According to Huddleston and Pullum (2002:109), there are 'rare and marginal' examples such as *If he had stayed in the army, he must surely have become a colonel*. The following are two attested cases from George Eliot's *Middlemarch*.

(134) a. … and if she had written a book she **must have** done it as Saint Theresa did, under the command of an authority that constrained her conscience.

<div style="text-align:right">(Ch. 10)</div>

  b. Under any other name than 'pleasure' the society of Messieurs Bambridge and Horrock **must** certainly **have** been regarded as monotonous; …

<div style="text-align:right">(Ch. 23)</div>

 Our last example of lexical variation among English modals involves class III. As Huddleston and Pullum (2002:196–97) point out, nonepistemic *could* and *would* can sometimes have past-TP readings in main clauses, as in their examples given in 135a–c, unlike *might* and *should* (see also Portner 2009:224ff.).

(135) a. In those days we **could** borrow as many books as we wished.
  b. Water **could** still get in.
  c. Only a few months later their love **would** change to hate.

This suggests that a further refinement of our classification may be in order, in that some (but not all) class III modals can have an inherent [PAST] tense feature in their lexical entry, but apparently only for their nonepistemic readings.

We conclude that the English modal system is rather complex and variable, and probably still in flux. It seems likely that diachronically this instability is the result of the loss of productive (overt) tense inflection on the modal auxiliaries, which caused the tense feature to be lexicalized as part of the modals themselves. The lack of an overt way of marking past TP on modals may have led to the recruitment of the perfect *have*, which ordinarily marks past TO, as a way of marking past TP instead, encoded in the lexical entries for class III modals such as 126. We suspect that this is a peripheral and exceptional phenomenon, which is probably rare crosslinguistically and subject to idiosyncratic lexical variation.

However, we would like to conclude this section on a more positive (though speculative) note. All of the cases of idiosyncratic lexicalization we have seen involve TP, not TO. Even in English, TO is determined in a completely predictable way by the interaction between Aktionsart, aspectual marking (both ordering and inclusion aspect), and the diversity condition. We have not found any cases in our (very small!) language sample in which a modal is idiosyncratically specified in the lexicon as having, say, past TO. Whether this is a generalization that will be upheld if we inspect a much wider range of languages is a question we leave for future research.

6. Comparison with other analyses. In this section, we discuss research that challenges the ideas on which our analysis is based. The focus is once again on epistemic modals with past TPs.

Although the majority of the literature has assumed that epistemic modals cannot take past TP, some researchers have argued that these readings do exist, usually in languages other than English (see for example Eide 2003, 2005, Kratzer 2009, Soare 2009, Homer 2010, Mari 2010, and Martin 2011). Even when the existence of the past-TP readings is admitted, authors often try to explain the readings away, denying that they reflect the simple ability of an epistemic modal to scope under past tense. For example, it has been proposed that the readings involve an elided embedding attitude verb (Hacquard 2006, 2011), or that they are felicitous only in contexts of FID (Fagan 2001, Boogaart 2007). See also Portner 2009:222–36.

The researcher who has most systematically addressed the complexities of the data in this area is Hacquard (2006, 2010, 2011). Hacquard's claim for English is that the TP of an epistemic modal is always the local time of evaluation, which is the utterance time in a main clause. Although epistemic modals do allow past TP in some contexts, according to Hacquard this is never due to the modal simply being able to scope under a clausemate past tense. Rather, the readings are licensed by a range of mitigating factors, and are usually not cases of 'real' semantic past. Our position is that although Hacquard is right about the types of contexts that FAVOR past TPs for epistemic modals, the mitigating contexts are not NECESSARY for the relevant readings. Moreover, there are empirical and theoretical problems with some of the individual proposals about mitigating factors.

Hacquard's empirical claim is that epistemic modals can have past TPs only in a restricted set of circumstances: either (a) when embedded under an attitude verb, (b) in an FID environment, (c) when an adverbial specifies an overt conversational background with a past TP, or (d) when there is an elided *because*. In earlier work (2006), Hacquard also allowed for the possibility of (e) elision of a matrix attitude verb. These options are illustrated in 136a–e, respectively.

(136) a. Two days ago, Poirot thought that Mary **had to** be the murderer.
<div align="right">(Hacquard 2011:1501)</div>

   b. This didn't make sense, thought Poirot … Mary **had to** be the murderer.
<div align="right">(Hacquard 2011:1501)</div>

    c. Given what we knew then, Mary **had to** be the murderer.

<div align="right">(Hacquard 2011:1501)</div>

    d. A: Why did you look in the drawer?

         B: (I looked in the drawer because) my keys **might have** been in there.

<div align="right">(adapted from von Fintel & Gillies 2008; cf. discussion in Hacquard 2011:1501)</div>

    e. A: Why did you look in the drawer?

         B: (I thought that) my keys **might have** been in there.

<div align="right">(Hacquard 2006:159; adapted from von Fintel & Gillies 2008)</div>

The first thing to note is that these data involve either *had to* (136a–c) or *might have* (136d–e), but as we showed in the preceding section, English modals fall into different classes with respect to their behavior in past-TP contexts. A full assessment of Hacquard's proposals would require a detailed look at each of these classes in each of the five environments in 136. Here we limit ourselves to pointing out some places where Hacquard's analysis either under- or overgenerates readings.

    With respect to cases like 136a, Hacquard argues that past TP arises here because the TP of the embedded modal is set to the internal 'now' of the attitude verb. One piece of evidence for this is that the apparent past interpretation of the modal 'lacks the characteristic backshifting of a true semantic past tense. For instance in [136a], the modal's time of evaluation must be Poirot's thinking time; it cannot precede it' (Hacquard 2011:1501). Hacquard therefore argues that apparent past tense on epistemic modals is actually SOT; there is morphological agreement, but no real past semantics (Hacquard 2011:1501; see also Iatridou 1990).

    However, as we argued in §5, some classes of English modals DO allow backshifted readings under attitude verbs when interpreted epistemically. For *must*, or for plain *might* without *have*, Hacquard's claim that backshifted readings do not exist is upheld, but *had to* and *might have* do allow backshifting (see 122, 128a). Hacquard's analysis therefore undergenerates the available readings here.

    The next environment that Hacquard argues licenses past epistemic readings is FID. The general phenomenon of FID is illustrated in 137. The adverb *tomorrow* is interpreted with respect to an earlier time at which a character in the story had the relevant thought. Temporal-adverb shifting is a diagnostic for FID interpretations (Banfield 1982, Doron 1991, Schlenker 2004, Sharvit 2008, Eckardt 2015).

    (137) Tomorrow was Monday, Monday, the beginning of another school week!

<div align="right">(Schlenker 2004; originally from *Women in love*, by D. H. Lawrence)</div>

    FID certainly facilitates past-TP readings for epistemic modals. The class II modal *must* and class III modals like *might* allow past-TP readings in FID environments, as revealed by a mini-corpus search of one English novel (*Capital*, by John Lanchester, W. W. Norton & Company, 2012).[40] Two of many instances in this novel of past-TP *must*/*might* in FID environments are given in 138.

    (138) a. Today, turning the corner of Pepys Road, she caught the smell of burning wood, of hot ash, and was suddenly back on the outskirts of Harare … . An odd time for someone to be burning wood in London; it **must** be a fire someone had held back because of the terrible weather.   (Ch. 73)

         b. Patrick had not wanted to betray his own anxieties by asking too many questions about what Freddy really felt. The end result was that now, … he had no reliable idea about Freddy's state of mind. He **might** be panicking, just as Patrick was.   (Ch. 16)

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[40] See also de Hoop & Lestrade 2015 for examples of *might* in FID.

Providing a full analysis of FID would go far beyond the scope of this article, but we offer a brief sketch of how our analysis might account for the facts. The first important point is that in English the licensing of past TP by FID is possible only with modals belonging to classes II and III; if we substitute a class I modal such as *may* in 138, a past-TP reading is completely impossible. The inability of class I modals to undergo shifting to a past TP follows from the inherent present-tense feature we have postulated for these modals; see 120 above.

The class II modal (*must*) and class III modals like *might* were analyzed above as allowing an interpretation involving a zero tense (see 123 and 125), which does not carry any presupposition about the location of the reference time relative to the utterance time. Under this interpretation, we assume that an FID discourse context is capable of providing a value for the reference time. As predicted, this possibility is not restricted to EPISTEMIC modals; nonepistemic readings, such as deontics, are equally possible.

(139) I suppose this is what they call denial, thought Mary. Except it didn't seem to her that she was denying anything; what she mainly felt was numb. Anaesthetised. She **must** call Alan. (*Capital*, Ch. 57)

However, outside of the restricted narrative contexts supporting FID, English plain modals with zero tense (classes II and III) cannot have past TP in main clauses. This distinguishes them from the past-tense forms of semi-modals, and also from the lexicalized *have* forms of class III modals (e.g. *might have*). Thus, although we agree with Hacquard that FID plays a role in SOME cases of epistemic modals with past TP, the special narrative contexts required for FID are not in general a necessary condition for past-TP epistemic readings.

Another proponent of the idea that epistemic modals can have past TPs ONLY in FID contexts is Boogaart (2007). While Boogaart argues that the past TP of Dutch epistemic modals reflects a real past tense (rejecting an SOT analysis), he nevertheless claims that the relevant readings arise only when there has been a perspective shift away from the speaker. (See Fagan 2001 for a similar claim for German.) As pointed out by Homer (2010), however, (some) epistemic modals can have past TPs in nonnarrative contexts without perspective shift away from the speaker, as in von Fintel and Gillies's (2008) ice cream example. Homer (2010) also points out that in French, (some) epistemic modals can occur with past TP even when they do not correlate with the prime diagnostic for FID, the shifting of indexicals like *today* or *tomorrow*. Compare 140, where *today* picks out the day of Betty's attitude, with 141, where *today* cannot refer to the day on which B held the relevant epistemic state.

(140) Betty woke up feeling nervous. **Today** was going to be awful.

(141) A (talking about what B did yesterday): Why did you look in the freezer?
B: The ice cream **might have** been/**had** to be in there (**#today**).

Data like these show that *might have* and *had to* can have past TP even in contexts where temporal adverbs cannot shift, and which therefore cannot be instances of FID.[41]

The next method by which Hacquard aims to explain past TP for epistemic modals without recourse to past tense is overt conversational backgrounds (as in 136c). The fact that an overt conversational background facilitates the relevant reading is not surprising, but it is not required, as shown by the data presented throughout §3 and §5.

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[41] Plain *might* or *must* would be unacceptable in B's answer in 141 (either with or without *today*); cf. 143b. This is predicted by our analysis because the zero tense of these class II/III modals is not able to backshift the TP in a main clause outside of an FID context.

Turning finally to the proposal that elision is involved in cases like 136d,e, we observe that there is an empirical problem with the attitude-verb cases, illustrated in 142–143. Examples 142a–b are fine for the elision analysis, since they have equivalent temporal properties, as the elision account predicts. But 143a–b are problematic. Example 143a allows past TP, indicating that the presence of *have* is not crucial for the past-TP reading in an SOT environment (cf. Abusch 1997:21–22, and §5). But then 143b is incorrectly also predicted to allow a past TP.

(142) a. I thought the ice cream might have been in there.   (past TP)
      b. ~~I thought~~ the ice cream might have been in there.   (past TP)
(143) a. I thought the ice cream might be in there.   (past TP)
      b. ~~I thought~~ the ice cream might be in there.   (*past TP)

Under our proposal, no elision is involved. We have argued that the different classes of modals differ with respect to whether they allow past TP in the absence of a higher past-tense attitude verb. Semi-modals and *might have* allow these readings, but plain *might*, *must*, and *may* do not. The only cases in which plain *might* (without *have*) and *must* can have past TP is when they occur under a matrix past-tense verb (as in 143a) or in FID, which is possible only in very specific kinds of narrative contexts, such as 138. The issue for Hacquard's account is that it does not distinguish between the behavior of *might* and *might have* (and ignores *must*).

What about the cases of elided matrix clauses plus *because*? Hacquard's idea here builds on Stephenson's (2007) proposal that epistemic modals have a judge parameter, representing the agent whose knowledge or beliefs are relevant. Stephenson proposes (2007:506) that 'in *because*-clauses which express a person's conscious reasoning or rationale, the judge parameter is shifted to the person whose reasoning is involved'. However, although *because* may shift the judge to being a different epistemic agent, there is no independent evidence that *because* shifts the TIME at which the judging takes place. In fact, *because* does NOT shift the judging time to the past in the absence of other elements with past semantics. In 144, for example, the judge of the taste predicate *tasty* shifts to Fido, but there is no effect of the perceived tastiness being in the past.

(144) Fido always eats Whiskas because it's tasty.

Similarly, *because* does not induce pastness for modals in the absence of either a real past-tense inflection on the modal, *have*, or a higher attitude verb. For example, 145 does not allow past TP. Our analysis correctly predicts this, since *might* cannot have past TP without the help of *have*.

(145) I looked in the freezer because the ice cream **might** be in there.

We have now considered the main ways in which authors explain away past TPs for epistemic modals. We have argued that while past-TP readings are certainly facilitated by higher attitude verbs, FID, and overt conversational backgrounds, none of these conditions are NECESSARY for the past-TP readings to arise. We have thus argued that past-TP readings are more generally possible than is often assumed. Conversely, we have shown that none of these environments produce past TPs by themselves; instead, only certain classes of epistemic modals allow these readings, either because they accept past-tense morphology (as with semi-modals in English or all modal verbs in Dutch), because they allow a zero tense that can receive its value from a matrix past-tense verb (SOT) or a narrative discourse context (FID), or because they have special lexicalized forms with past TP (such as English *might have*).

7. CONCLUDING REMARKS. This article has provided a compositional analysis of modal-temporal interactions in Dutch, English, Gitksan, and St'át'imcets. The analysis

allows modals to interact freely with the tense-aspect architecture in each language. The analysis includes no extra restrictions on possible combinations of modal flavor and temporal perspective. It freely allows epistemic modals to have past TPs, a result that we have argued is empirically correct for at least the four languages discussed here. Our basic compositional architecture straightforwardly accounts for the crosslinguistically more transparent systems (Dutch, Gitksan, and St'át'imcets). It allows language-specific features of each tense-aspect system to influence modal-temporal interactions in predictable ways, and it correctly casts English as an idiosyncratic and (partly) lexicalized system.

Our main proposals—which rely in part on insights of prior literature, in particular on Condoravdi 2002—are that a modal's TP is determined by a higher operator, usually tense, while TO is determined by lower operators, usually aspect (and further restricted by the diversity condition). In contrast to some previous research, we have argued that epistemic past-TP readings should not be stipulated to be unavailable and are not always dependent on FID or other special licensing environments. Also in contrast to much previous research, we have pointed out that English modal auxiliaries cannot be treated as a single class, but fall into at least three classes with different temporal idiosyncrasies. Our analysis contrasts with a theory like that of Condoravdi (2002) in which aspect is partly built into the meaning of the modal itself (see also Enç 1996), and in which there is an added restriction against past tense or perfect aspect scoping over an epistemic modal. However, our analysis does allow for the possibility of individual modals or classes of modals in a language to have lexicalized interpretations that potentially include certain temporal operators. In particular, some English modals are argued to contain an inherent past tense in their lexical entry. But such cases are exceptions that are probably driven by a reorganization of the morphosyntax of the modal system (in the case of English, the loss of productive tense inflection on modal auxiliaries).

Further research is clearly required on a range of issues. We have not discussed other languages for which there is literature on modal-temporal interactions, such as French (Hacquard 2006, Laca 2008, Homer 2010, Mari 2010, Martin 2011, among others). Our proposals also need to be tested on languages for which there has as yet been little or no work in this area. For preliminary research of this type on twelve languages, see Chen et al. 2017.

A major question left open by the current article is whether there is a need to assume ANY restrictions on the scope of epistemic modals. The literature has investigated the scopal relations of epistemic modals not only with respect to tense, but also with respect to cooccurring nonepistemic modals, quantifiers, negation, and adverbs (see, among others, Groenendijk & Stokhof 1975, Picallo 1990, Brennan 1993, Cinque 1999, Drubig 2001, von Fintel & Iatridou 2003, Hacquard 2006, 2011, Huitink 2008, Portner 2009). Results are not fully conclusive, but there is at least a general tendency for epistemic modals to prefer higher scope than nonepistemic ones. We have little to add to that debate at this time, beyond our core proposal that there is no general restriction against epistemic modals appearing in the scope of tense. As pointed out by Chen and colleagues (2017), some epistemic modals in some languages DO necessarily scope over tense. In the languages discussed by Chen and colleagues, these are syntactically analyzable as adverbials. Notice that the same phenomenon is evident in English, where epistemic modal auxiliaries and semi-modals scope under tense, but epistemic adverbials like *maybe* do not (witness the absence of a past-TP reading for *Maybe there was ice cream in the freezer*). See also Hacquard 2013 for relevant discussion of the relation between the grammatical category of a modal element and its scope possibilities.

There is one potential outstanding empirical issue for our analysis, brought to our attention by a referee (and mentioned already at the end of §2.6 and in n. 30). The issue is that past-inflected semi-modals in English sometimes, for some speakers, appear to allow present TP. Two examples are given in 146–147.

(146) [Context: Up until just now, all of the evidence pointed to Mary being home last night. But now, fresh evidence proves that Mary's home was empty last night.]
Mary **had to** be out last night.

(147) [Context: You are telling someone about how many people were at a party that was held last night. You were at the party and while it was going on, you thought there were only about fifty people there. But now it's the next day and you are cleaning up, and based on the number of dirty glasses and other evidence, you realize it must have been more like 100 people. You say:]
There **had to** be a hundred people here.

As noted above, the problematic interpretations are (at best) marginal for many speakers. In an informal survey of eight native speakers of English, three viewed 146 as marginal, and only three speakers accepted 147, with four viewing it as marginal and one rejecting it. The responses to 65b above were even more negative.[42] Nevertheless, we briefly address here how we might account for the speakers for whom *had to* seems to allow present TP. (Note that these speakers' judgments would be problematic not only for our proposal, but also for any proposal that does anything more than stipulate that TP is completely free for English past-inflected semi-modals.)

We see two different possible approaches. One is to claim that *had to* exceptionally allows past tense to scope under the modal, therefore supplying past TO rather than past TP in such cases. In our framework this could be achieved by giving *had to* a lexicalized interpretation in which it consists of a constellation of present tense, the necessity modal, and perfect ordering aspect.

The other approach would be a pragmatic one. In many contexts, there is a certain amount of vagueness or 'slack' in the TP of an epistemic modal. For instance, in 147 it seems that the relevant evidence for the modal claim involves not just facts that are available at the utterance time, but also things that were observed earlier (such as the fact that there was a party at all, that there were many guests, that it was hard to tell exactly how many there were, etc.). Moreover, even the crucial evidence of the number of dirty glasses already existed well before the utterance time. It is therefore conceivable that for speakers who accept the sentence in this context the epistemic vantage point includes an interval located some time before (and maybe up to) the speech time. The vagueness in determining the exact location of the TP may be an important factor in the acceptability of such examples for some speakers. (For related discussion concerning similar facts in French, see also Homer 2010 and Pasternak 2016.)

A major avenue for future investigation raised by our analysis concerns our proposal that in each of the four languages, there is one overt and one covert ordering aspect (perfect vs. nonperfect in English/Dutch, and prospective vs. nonprospective in Gitksan/St'át'imcets). The two systems are essentially inverses of each other: in both the overt aspect is more specific (excluding the utterance time, or more generally the eval-

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[42] In Dutch, past-tense *moest(en)* does not seem to have this present-TP, past-TO reading, at least according to the intuitions of the first author.

uation time), while the covert aspect covers the rest of the timeline. We have shown that our analysis captures the facts in these four languages both in nonmodal and modal sentences. The question arises of whether similar systems exist in other languages, and of what other ordering aspect systems might be possible. Further crosslinguistic research will have to determine the answer.

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