Asserting Epistemic Modals*

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INTRODUCTION

Consider the following sentence:

(1)   Cal might have been at the party last night.

I'll refer to sentences of this form as MIGHT-CLAIMS.

Many influential accounts of *might*-claims assign them an INFORMATION-SENSITIVE semantics: their interpretation involves reference to a body of information i, relative to which the proposition denoted by the sentence without the modal (its PREJACENT) is a possibility. One classic proposal is that *might* is a quantifier over possible worlds, and i determines which worlds *might* quantifies over (e.g. Kratzer 1977, Yalcin 2007):

(2) $[\![\text{might}]\!]^i = \lambda p.\lambda w.[\exists w' : w' \in i]p(w') = 1$
      (adapted from Yalcin 2007)

That is to say: the interpretation function is parameterized to a body of information i.[1] On the simplest version of the information-sensitive semantics, as presented in (2), that body of information is simply the set of all worlds compatible with what is known, providing a

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[1]Note that here and throughout I've suppressed orthographic representation of all other parameters of evaluation, for the sake of legibility.

domain of quantification for the modal.[2] The sentence is true iff there is a world in that domain at which the prejacent is true—i.e., iff the prejacent is compatible with what is known. This talk of 'what is known' immediately raises a question: known by who?[3] That is to say, what body of knowledge is relevant to the interpretation of BARE epistemic modals, or unembedded epistemic modals unaccompanied by overt modifiers (e.g. *given what John believes*)?

Since at least Frege's *Begriffsschrift*, an intuitive answer to the question 'known by who' has been: known to the speaker.[4] The crucial intuition is that a speaker's assertion of a *might*-claim is licensed by consideration only of their own knowledge, not by the presumption that they have authoritative information about any other knowledge state. To make this answer more formal: we could answer this question by saying that the information parameter i is determined by the context of utterance of a sentence containing a bare epistemic modal, and always represents the speaker's epistemic state. That is to say, i gives the set of worlds compatible with what the speaker knows at the time of utterance. Let's call this view SOLIPSISTIC CONTEXTUALISM, following MacFarlane (2011).[5]

Despite the intuitive appeal of solipsitic contextualism, a surprisingly broad consensus has emerged that disagreement data like (3), the relevance of which was first noted by Hawthorne (2004), are fatal to it.

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[2]I'll call the 'simple quantificational account' of modals. On the more complicated 'ordering semantics' (Kratzer 1981, 1991), modals are interpreted relative to both a domain of quantification and an ordering over that domain, as discussed in detail in §4 of this paper. There are two major implementations of the simple quantificational semantics for epistemic modals: RELATIONAL semantics and DOMAIN semantics. On a relational semantics (e.g. Kratzer 1977), the interpretation of modals involves a function mapping from each world to the set of worlds epistemically accessible from it, with the set of worlds accessible from the world of evaluation determining the domain of quantification for the modal. On a domain semantics (e.g. Yalcin 2007), the domain of quantification is simply given directly, without making use of a function from worlds to domains. These two implementations are expressively equivalent provided they're given the same resources and supplemented with the same assumptions (q.v. Ninan 2016), so I will not be concerned with distinguishing between relational and domain semantics in this paper. Throughout this paper I use a domain semantics for simplicity, but equivalent results are derived from a relational semantics, provided that the epistemic accessibility relations are closed, an assumption independently made elsewhere in the literature on epistemic modals (q.v. Gillies 2004, von Fintel & Gillies 2010). Appendix B shows that this is so.

[3]Note that this question is not specific to accounts on which modals are quantifiers over worlds—it's also pertinent to probabilistic versions of information-sensitive semantics for epistemic modals (Swanson 2011, 2015, Lassiter 2011, 2015, 2016, Moss 2015). The question for these theories becomes: probable in whose estimation?

[4]As Karttunen (1972) summarizes it, Frege's position was that "to say that something is possible is to say that the *speaker* knows nothing from which the negation of the proposition would follow" (emphasis mine).

[5]Throughout, I use the term 'solipsistic contextualism' to refer to the proposal that the information parameter i is set by default as the speaker's epistemic state in the world of utterance. When I say 'set by default' I'm referring to the fact that the value of the information parameter can be shifted by operators like *given what x knows* or attitude verbs (Yalcin 2007, Anand & Hacquard 2013, Ninan 2016). The term has been used in different ways throughout the literature—see for example Yalcin (2011), who uses the term to describe a claim about the update potential of *might*-claims, not their truth conditions. I've chosen my terminology here because the project of this paper is the development of a system that derives update potentials from the semantic interpretation of declarative sentences; solipsistic contextualism is important in the context of this paper because of the potential constraints that solipsistic contextualist truth conditions place on possible update potentials that can be assigned to modal claims.

(3)   **A**lice: Cal might have been at the party last night.
      Bizzy: {You're wrong, No way}, he was in Virginia.

The reason why data like (3) have been taken to be problematic for solipsistic contextualism is this: if **A**'s claim is a claim about **A**'s own knowledge state, i.e. it is true iff Cal having been at the party last night is an epistemic possibility available to **A** at the time of utterance, then **B**'s response of *you're wrong* should mean 'your epistemic state does not actually allow for that possibility'. But that's not what is going on in (3). Rather, **B**'s response expresses that the prejacent is not an epistemic possibility *for him* (and goes on to specify why that is so). Intuitively, an interlocutor's disagreement with a *might*-claim is licensed by the relationship of that *might*-claim to their own epistemic state, not the speaker's, an intuition that is seemingly at odds with the intuition that underlies solipsistic contextualism. As Stalnaker (2014) puts it, "The puzzle is that no way of pinning the relevant knowledge state down seems to be able to explain both why we are in a position to make the epistemic "might" claims we seem to be in a position to make, and also why it is often reasonable to disagree with "might" claims made by others" (pp. 137-138).

The responses to this problem (in addition to other problems posed by discourse data, q.v. Yalcin 2011, Swanson 2011, Knobe & Yalcin 2014, MacFarlane 2014, and, for a useful overview, Cariani 2020) that have been proposed in recent literature are wide-ranging. Some proposals maintain CONTEXTUALISM, or the assumption that i is fixed by the context of utterance, while pursuing non-solipsistic approaches to how the context fixes the body of information that unmodified and unembedded epistemic modals quantify over. For instance, Egan et al. (2005) and Dowell (2011) associate the relevant body of information with the knowledge of a group rather than any particular individual (q.v. Teller 1972, DeRose 1991), von Fintel & Gillies (2011) propose that epistemic modals are ambiguous with respect to what body of information they are to be interpreted relative to, giving rise to a 'cloud' of possible denotations, Yanovich (2014) proposes that the body of information relevant to the interpretation of epistemic modals is sensitive to a broader set of contextual factors like the practical goals of the current conversation (q.v. Hacking 1967), and Mandelkern (2019) proposes that the semantics of epistemic modals describe the state of the Common Ground following the assertion of their containing sentence. Other proposals in the information-sensitive literature give up the Kaplanian assumption that truth conditions are fixed by the context of utterance, and pursue RELATIVISM about epistemic modals, on which the semantics of epistemic modal claims are sensitive to parameters of interpretation that vary independently of the context of utterance (Egan et al. 2005, Egan 2007). Those independent parameters are taken to represent judges (Stephenson 2007), information states (Yalcin 2007, Stalnaker 2014), or contexts of assessment (MacFarlane 2011). Still other proposals abandon the assumption that epistemic modal sentences describe what the world is like at all, pursuing EXPRESSIVISM (and/or NONFACTUALISM) about epistemic modals (Yalcin 2011, Rothschild 2012). Such accounts often treat *might* as a syncategorematically-defined update operator (Veltman 1996) that indicates that its prejacent is a 'live possibility' (Willer 2013), imposes constraints on possible resulting contexts (Swanson 2015), or expresses lack of belief in the complement of its prejacent (Hawke & Steinert-Threlkeld 2016), though there are also non-dynamic expressivist accounts on which epistemic modal sentences denote predi-

cates of information states, rather than predicates of worlds (Hawke & Steinert-Threlkeld 2020).

In this paper, I argue that the conclusion that data like (3) are incompatible with solipsistic contextualism was premature. I show that disagreement data like (3) are not problematic for solipsistic contextualism *simpliciter*, but rather are problematic for solipsistic contextualism *in conjunction with* some standard Stalnakerian assumptions about how to formalize the discourse update carried out by assertions. Therefore, the problem could be solved by changing something about the semantics of epistemic modals, or by changing the formalization of assertive updates (or both). Prior literature has focused overwhelmingly on the former path, sometimes incorporating elements of the latter path as well; I develop here a solution following the latter path exclusively. In fact, I argue that solipsistic contextualism can provide a key to explaining *why* epistemic modals have funky update effects: it's because they're speaker-orientedly epistemic *in the same way* that assertion is.[6]

I present here a change of camera angle on the standard Stalnakerian formalization of assertive update, which stays close to the core intuitions that motivated the classic view, and behaves identically to Stalnaker (1978) for all sentences whose semantics is not affected by the setting of the i parameter, but which accurately derives the disagreement behavior of bare epistemic modals from their solipsistic contextualist interpretation, on which the interpretation of that parameter is fixed as the speaker's epistemic state. The informal version of this formalization of assertive update, which is developed formally below, is that when a speaker asserts a sentence, they are presenting themselves as though they know it to be true—i.e. they are predicating something of their epistemic state—and they are proposing that the context be modified such that it will be a member of the same predicate of states they've indicated their own epistemic state to be a member of. Crucially, despite its similarity in conception to the classic Stalnakerian view of assertion, this formalization does not deliver the result that any successful assertion adds the propositional denotation of the sentence used to carry out that assertion to the Common Ground. On this view of assertion, the explanation for the *prima facie* unexpected (given solipsistic contextualism) discourse behavior of epistemic modals follows from how their speaker-oriented epistemicity interacts with the speaker-oriented epistemicity of assertion.

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[6]This paper's proposal is closest to the proposal of Yalcin (2011), and so a special foreshadowing note about what differentiates it is warranted. Yalcin assumes an information-sensitive semantics as in (2), but takes a nonfactualist stance toward the information parameter, resulting in a semantics on which epistemic modal sentences are not assumed to have truth conditions relative to a context of utterance. And Yalcin specifies an expressivist update mechanism for epistemic modal claims that is not generalized to an update mechanism that treats all declarative sentences equally. This paper differs on both fronts. First, this paper assumes a solipsistic contextualist account of epistemic modal semantics on which they *are* assigned truth conditions relative to a context of utterance. One of the paper's primary points is that solipsistic contextualist semantics is compatible with epistemic modal utterances expressing 'nonfactualist' update potentials—there is no incompatibility between standard truth-conditional semantics and expressivist context-update. Second, this paper presents a generalizes a Yalcin-style expressivist update mechanism to all declarative sentences, deriving a non-standard update potential for bare epistemic modals in the same stroke as it derives standard update potentials for other declarative sentences. In fact, I make the stronger claim that such a mechanism does not represent a novel theory of declarative update at all, but rather is an implementational variant of the familiar Stalnakerian theory of assertion. See below.

The account of assertion put forward in this paper delivers two primary results about *might*-claims. First, it derives Veltman's (1996) 'consistency test' semantics for *might* (q.v. Yalcin's 2007, 2011) from the simple quantificational semantics for *might* with which this paper began. Second, it derives a novel update from Kratzer's (1981, 1991) ordering semantics for *might*: that of adding its prejacent to the ordering source. Both are examples of how the proposed account of assertion allows us to build a bridge from a contextualist truth-conditional semantics to 'expressivist' update effects without sacrificing a univocal formalization of assertive update that applies equivalently to all declarative sentences. This allows us to unify the intuitions behind both propositional and expressivist accounts, while avoiding the *ad hoc* stipulations that threaten to render many expressivist accounts unconstrained and unexplanatory. The resulting system shows that the dividing lines between the various views on epistemic modals that have emerged over the last several decades are oversimple—we can derive 'relativist' effects with a relativistic illocutionary machinery, instead of a relativistic semantic machinery, and likewise we can derive 'expressivist' updates from traditional denotations without stipulating construction-specific discourse effects.

In presenting its results, this paper has two goals, which are separable in principle. The broad goal of the paper is to show that an information-sensitive formalization of assertive update, in conjunction with a garden-variety implementation of an information-sensitive semantics for epistemic modals, can derive special update effects for epistemic modals in the same stroke as it derives standard update effects for non-epistemic sentences, avoiding the need to stipulate *sui generis* update effects for epistemic modals or to treat them as having a different sort of denotation than ordinary declarative sentences. The narrow goal of the paper is to show how this system can reconcile solipsistic contextualism with purportedly anti-solipsistic phenomena, if the update system itself is glossed in terms of describing the speaker's epistemic state. That is to say, the narrow goal is to argue that solipsistic contextualism about epistemic modals doesn't actually have a disagreement problem. I've chosen to expositorily conflate these two goals for my own rhetorical purposes at various points in the paper, but a judicious reader may make use of one proposal while rejecting the other. A committed relativist is free to make use of the information-sensitive update system I've developed here while disregarding the solipsistic contextualist gloss I've given to its information-sensitive character. Likewise, a committed expressivist is free to make use of the updates this system delivers for epistemic modal sentences while disregarding the explanation of how they're derived from those sentences' truth conditions. I take the broad goal to be desirable insofar as a unified conception of the semantics of declarative sentences, and how assertions making use of them update the context, is desirable. I take the narrow goal to be desirable insofar as the intuitive appeal of solipsistic contextualism is compelling.

The structure of this paper is as follows: In §1 I further motivate this paper's positive contribution, by noting empirical and theoretical worries about the classes of prior accounts outlined above, and reframing them as desiderata that this paper's proposal satisfies. In §2 I briefly articulate the role played by (sometimes implicit) assumptions about the formal mechanism of assertion in the problem that (3) poses for the solipsistic contextualist interpretation of bare epistemic modals. In §3, I give the first pass through my positive proposal, a reframing of the Stalnakerian account of assertion that derives the disagreement behavior of bare epistemic modals while preserving standard Stalnakerian update for assertions of sen-

tences that are not sensitive to the same information parameter as epistemic modals. I show how the account deals with *might* on the simple quantificational semantics shown above. The most novel portion of the paper is §4, in which I apply this paper's account of assertion to the ordering semantics of Kratzer (1981, 1991), deriving a previously undescribed update potential for epistemic modals. §5 concludes. Appendix A shows the updates the system derives for *must*-claims, which are not crucial to the argument made in the main text. Appendix B shows that a Kratzer (1977) style relational implementation of modal semantics derives the same results as the Yalcin (2007) style domain implementation used in the main text.

1   WORRIES AND DESIDERATA

In this section, I express worries about the classes of prior solutions outlined in the introduction: contextualist solutions, relativist solutions, and expressivist solutions. My worries are both empirical and theoretical. At the end of this section, these worries are transmogrified into desiderata that this paper's proposal satisfies. The proposal satisfies those desiderata by dodging the demarcation lines between the three bins into which I've placed prior solutions: the proposal is solipsistic contextualist in its truth-conditional semantics, but uses relativist context-update machinery to derive expressivist update effects for epistemic modal sentences. One takeaway from the possibility of such a proposal is that thinking in terms of those bins may be less than helpful.

1.1   EMPIRICAL WORRIES

Several recent empirical studies of judgments of epistemic modal sentences establish a troubling pattern: judgments of the truth of epistemic modal sentences pull apart from judgments of whether epistemic modal sentences should be accepted or rejected. For expository purposes, I focus here on Khoo (2015); variations on these results in the domain of epistemic modality can be found in Knobe & Yalcin (2014) and Khoo & Phillips (2019), and similar patterns have emerged in the domains of moral predicates (Khoo & Knobe 2016) and 'quasi-indexicals' (Khoo 2018).

Khoo (2015) reports a study in which participants were presented with a scenario involving an assertion of a *might*-claim. The scenario makes it clear that the assertor's epistemic state is indeed compatible with the prejacent of the *might*-claim. It also makes it clear that, for reasons unbeknownst to the assertor, the prejacent is false. In other words, the scenario puts participants in the position of both knowing that the *might*-claim is true-relative-to-the-epistemic-state-of-the-speaker, and knowing that the *might*-claim is false-relative-to-their-own-epistemic-state. Khoo also probes for two different kinds of disagreement: participants were asked whether they would endorse the claim that what the assertor said is *false*, and they were also asked whether they would respond by rejecting the assertion: "No, actually…" Judgments were taken by rating each type of response on a 7-point Likert scale; see Khoo (2015) §II.i for details.

The results are striking: for control sentences without modals, there was no significant differ-

ence between truth value judgments and rejection judgments: if the participant's information is incompatible with the asserted proposition, they rated both falsity (mean Likert response 6.10) and rejection responses (mean Likert response 5.60) very highly, regardless of the assertor's information. But in the case of *might*-claims, there was a sharp split between truth value judgments and rejection judgments: though speakers still rated rejection responses very highly (mean Likert response 5.03), they did not agree that the *might*-claims were false (mean Likert response 2.42). In other words, people are perfectly willing to reject modal claims that they don't judge to be false.[7]

These results give evidence that we need a theory of how truth conditions relate to update potential that does not predict a biconditional relationship between assessment of truth and acceptance of an update proposal. For brevity's sake, in what follows I'll refer to this as a 'biconditional relationship between truth and acceptance'. Khoo's results demonstrate the lack of a biconditional relationship between truth and acceptance. The absence of such a relationship is problematic for all three classes of prior accounts discussed in the introduction.

Khoo notes that these results are problematic for both contextualist and relativist accounts of epistemic modal semantics. For contextualists, the falsehood results are expected, but the rejection results aren't—that's the disagreement problem in a nutshell. If the truth conditions are settled by the context of utterance, then the same considerations that go into assessing whether an epistemic modal claim is true should go into assessing whether its assertion should be rejected. For relativists, the rejection results are expected, but the falsehood results aren't. If the truth conditions of epistemic modals are sensitive to a context of assessment that isn't settled by the context of utterance, participants should be perfectly happy to judge the sentence false from their own context of assessment, for the same reason that they should be comfortable rejecting it.

What about expressivist accounts? The fact that participants have sharply differing intuitions about the truth of epistemic modal claims and the conditions under which assertions of them can be rejected is problematic for dynamic expressivist accounts, which don't assign truth-conditional interpretations to epistemic modal claims at all, and often don't distinguish between what they denote and what update they propose.

These empirical facts suggest the need for theories of epistemic modal assertions that assign them truth conditions, not just update conditions, to explain why judgments of truth pull apart from willingness to accept or reject an update proposal. But they also suggest that a successful theory of how truth conditions relate to update potential must not predict a biconditional relationship between truth and acceptance.

1.2 Theoretical Worries

In addition to the empirical worries above, I articulate two theoretical worries here. Both worries are specific to expressivist accounts that directly assign non-standard update effects to epistemic modal sentences. Such theories invite an explanatory worry about the

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[7]See Khoo (2015) Figure 1 and fn. 13 for the full details.

connection between syntactic clause typing and update potential. It's an extremely robust crosslinguistic fact that sentences are sorted into a small number of morphosyntactically distinct clause types, like declarative clauses, interrogative clauses, and imperative clauses, which are themselves strongly associated with different basic functions, like asserting, questioning, and directing (Sadock & Zwicky 1985). A rich vein of recent work pursues the explanatory project of capturing why this should be. One promising avenue is to treat the different clause types as having denotations of different semantic types (e.g. propositions for declarative clauses; sets of propositions for interrogative clauses, and so on), and to derive the differences in their basic force from differences in how those semantic types interact with a general-purpose update context-update procedure (see e.g. Portner 2004, Ciardelli et al. 2018, Farkas & Roelofsen 2017, Rudin 2018, 2022). If we start assigning update effects willy-nilly to sentences of the same clause type, we lose an account of this fundamental generalization about the relationship between syntactic clause typing and basic sentential force.[8] On these grounds, a theory that derives anomalous update effects for epistemic modal sentences while assigning them denotations of the same type as other syntactically declarative sentences, and using the same update mechanism that applies to other declarative sentences, is preferable to a theory that assigns heterogenous denotata or heterogenous update procedures to the morphosyntactically unified class of declarative sentences.

An interrelated worry: why is it that epistemic modals give rise to non-standard update effects? And why is it these update effects specifically? If we simply stipulate nonstandard update effects for epistemic modal sentences, our theories don't capture why it should be that epistemic modal sentences are the ones that give rise to these kinds of updates—why assigning special update potentials to *might*-claims is any less arbitrary than assigning special update potentials to sentences containing that word *juice*, or why the update potentials we're assigning to *might*-claims are any less arbitrary than assigning them the update potential of removing from the context set only those prejacent-compatible worlds in which the speaker likes french fries. A theory on which epistemic modal sentences derive non-standard update effects in virtue of their epistemic modal semantics has a chance of answering the two questions at the beginning of this paragraph; a theory that simply assigns them non-standard update effects has none.

1.3 DESIDERATA

This paper proposes an account that is not subject to the worries expressed in this section. This account, rather than making a tweak to the semantics of epistemic modals, makes a tweak to the machinery of assertion that relates the semantic interpretation of a sentence to its update potential. Because this machinery involves both truth-conditional semantics and update potentials, it avoids the empirical worry to which purely-dynamic expressivist accounts are subject due to not providing denotata that can be differentiated from update

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[8]Note that this worry only applies to expressivist proposals that directly stipulate update potentials; proposals for deriving expressivist update effects from static denotata allow for the possibility of expressing these fundamental generalizations in terms of recipes for deriving updates (q.v. Yalcin 2011, Hawke & Steinert-Threlkeld 2020). This paper belongs in that tradition; its novelty in this domain lies in deriving expressivist updates from a traditional contextualist semantics.

potentials. And the particular way that the machinery of assertion relates semantic interpretation to update potential severs the biconditional relationship between truth and acceptance that is problematic for both contextualism and relativism on more standard implementations of the machinery of assertion.

This paper's proposal likewise circumvents the explanatory worries articulated above. It retains the relationship between clause typing and sentential force, assigning epistemic modal sentences truth-conditional denotations that are subject to the same assertive machinery that all other declarative sentences are subject to. And it explains why epistemic modals give rise to different update effects than other declarative sentences, and why those update effects are as they are: epistemic modals give rise to distinctive update effects because they are speaker-orientedly epistemic *in the same way* that assertion is speaker-orientedly epistemic. That is to say, I argue for the opposite of the consensus invoked in the introduction. Solipsistic contextualism isn't challenged by the rejection data. Rather, solipsistic contextualism is the key to explaining the update profile of epistemic modals: they have idiosyncratic updates precisely *because* they are solipsistically contextualist.

The next section lays the groundwork for our positive proposal by reexamining the role of assumptions about the machinery of assertion in deriving the disagreement problem for epistemic modals. §3 builds on that groundwork by proposing an assertive machinery that is speaker-orientedly epistemic, showing that it delivers equivalent results to more familiar machinery when applied to non-epistemic sentences, and dissolves the disagreement problem for epistemic sentences.

2 The Role of Assertion in the Disagreement Problem

Let's revisit the problem of disagreement over *might*-claims and work through the explanation of why it is a problem for solipsistic contextualism a little more carefully.

Consider, first, a disagreement that doesn't involve epistemic modals.

(4) **A**lice: Cal was at the party last night.
     Bizzy: {You're wrong, No way}, he was in Virginia.

One intuitive account of what is going on here is that in this interaction, when **A** asserts p, she is presenting herself as if it is true given her knowledge. When **B** rejects p, he is presenting himself as if p is incompatible with his knowledge. The same intuitive account of what's going on seems to extend to disagreement over *might*-claims as well. Consider (3), repeated here as (5):

(5) **A**lice: Cal might have been at the party last night.
     Bizzy: {You're wrong, No way}, he was in Virginia.

We can characterize this interaction along the same lines as the disagreement over a non-modal claim above: when **A** asserts *might-p*, she is presenting herself as if p is a possibility

given her knowledge. When **B** rejects *might-p*, he is presenting himself as if p is not a possibility given his knowledge. This seems like the same thing as is going on with non-modal disagreements. So what is the problem?

Though the informal characterizations of the two disagreements given above seem parallel to each other, only the first follows from the standard Stalnakerian formalization of assertion, as originally put forward in Stalnaker (1978). That formalization begins with an assumption about the representation of a conversational context (q.v. Lewis's 1979 notion of a 'conversational scoreboard'):

(6) STALNAKERIAN CONTEXTS
     A conversational context c includes at least:
     a. The COMMON GROUND (CG_c), the set of all propositions representing the public mutual knowledge of all interlocutors
     b. The CONTEXT SET (CS_c), the set of all worlds compatible with all propositions in the Common Ground (i.e. $\forall c$, $CS_c = \cap CG_c$)

When we say that the Common Ground represents public mutual knowledge, we mean that it is the set of all propositions such that all interlocutors are publicly committed to behave for the purposes of the conversation as though they know those propositions to be true, and as though they take each other to know those propositions to be true, and so on recursively. In a perfectly cooperative conversation, the public mutual knowledge of the interlocutors will be the same as the private mutual knowledge of interlocutors, but assertions can be used to lie, or to tell made-up stories for each others' entertainment, and so on.

To make an assertion is to propose that the propositional content of the uttered sentence be added to CG; i.e., that all interlocutors agree to behave as though they know the actual world to be a member of the proposition that sentence denotes. Abstracting away from the 'proposal' aspect of this (though see Farkas & Bruce 2010 for a defense of its importance), the standard Stalnakerian account of successful assertive update can be formalized as a function from contexts to contexts:

(7) STALNAKERIAN UPDATE
     An assertion of p is a function from an input context c_i to an output context c_o, such that $CG_{c_o} = CG_{c_i} + p$ (and, therefore, $CS_{c_o} = CS_{c_i} \cap p$)

That is to say: the standard Stalnakerian formalization of assertion treats assertions as proposals that CS be intersected with the asserted proposition, resulting in a representation of the interlocutors' mutual information that does not include any worlds not contained in that proposition.[9]

Finally, because CS is a representation of mutual knowledge, rejection of an assertion of p is licensed iff the context set that would result isn't compatible with (i.e., has an empty

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[9]Note that this conception of update is a common starting point for theories of dynamic semantics, e.g. Heim's (1982, 1992) Context Change Semantics and Veltman's (1996) Update Semantics.

intersection with) the rejector's epistemic state.[10]

So, how does this standard formalization deal with the two cases with which this section started? In the former case, that of non-modal disagreement in (4), the speaker has proposed that CS be intersected with the proposition p, the result of which would be that all of the worlds in CS would be p-worlds. The addressee's rejection of that proposed update (achieved by asserting ¬p), then, indicates that she knows the actual world to not be a p-world, and so doesn't want to exclude all non-p worlds from the context set, as that would make it an inaccurate representation of the mutual knowledge of the interlocutors.

In the latter case, that of disagreement over a *might*-claim in (5), the speaker has proposed that the context set be intersected with the proposition *might-p*, which, assuming the solipsistic contextualist interpretation of bare epistemic modals, is the set of all worlds in which the speaker's knowledge is compatible with p. So the result of the speaker's proposed update would be the exclusion from the context set of all worlds in which the speaker's epistemic state rules out p. Given this, **B**'s rejection of the proposed update would indicate that he does not think that the actual world is a world in which **A**'s epistemic state is compatible with p. In other words, **B** should be understood to be rejecting **A**'s description of her own epistemic state, and claiming that **A** in fact knows p to be false: it should be roughly equivalent to: 'No, you know that he *wasn't* at the party'. That this interpretation of the disagreement in (5) is unavailable, and that the actual interpretation of that disagreement is that **B** believes the *might*-claim's prejacent to be false, are both wholly unexpected on this view.

What I want to stress about the above explanation is that the solipsistic contextualist truth conditions for *might* don't render the disagreement in (5) unexpected all by themselves. It's only when they're plugged into a theory of what a speaker is *doing* with a sentence's denotation when they assert it that we make any predictions whatsoever about what information that assertion is putting forward—i.e. what update to the conversational context is being proposed—and what it means to disagree with with that assertion—i.e. under what circumstances an interlocutor is justified in rejecting the proposed context update, and how to interpret what the rejection indicates about the rejector's epistemic state.

In the next section, I present a formal proposal for a change of camera angle on Stalnaker's account of assertion that captures the parallelism of the informal intuitive accounts given for the two disagreements above. On this formalization of assertive update, rather than assertion proposing that a propositional denotation be added directly to the Common Ground, when a speaker makes an assertion she presents herself as though she knows the asserted sentence to be true—i.e. she predicates of her epistemic state that the asserted sentence is true at every world in it—and proposes that the context be altered in as conservative a fashion as possible such that the resulting context is guaranteed to be a member of the same predicate of states as her own. Though this captures much the same intuition as Stalnaker's account—that an assertor presents herself as though she knows a sentence to be true, and proposes that that

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[10]Note that we are restricting our attention here entirely to cases of outright or 'hard' rejection (*you're wrong*, and so on), rather than expressions of skepticism prompting further discussion (*are you sure, do you really know, where'd you hear that*, and so on). A speaker may push back against an assertive update without outright rejecting it if the asserted proposition is compatible with but not entailed by their epistemic state.

knowledge be made mutual—unlike Stalnaker's formalization, it does not guarantee that all assertions propose that the propositional content of the sentence that has been uttered are intersected directly with the Context Set. Sentences containing bare epistemic modals will have somewhat different update potentials from other sentences because of how their speaker-oriented epistemicity interacts with the speaker-oriented epistemicity of assertion.

The possibility of a theory of assertion that does not always simply plop the denotation of the uttered sentence into a set of such denotations has been noted as a possibility worth taking seriously in several recent papers.[11] For instance, Ninan (2012) has this to say:

> Even [once] we've settled all of the relevant details of our compositional semantic theory, we still face a choice about what to take the information communicated by a sentence at a context to be. §5, p.412

And Rabern (2012) has this to say:

> . . . we utter words with certain meanings (and certain syntax) in order to say the things we say. This platitude, however, does not call for the *identification* of the two notions—all it calls for is that the assertoric content of a sentence in a context should be systematically *determined* by its compositional value. §2, p.88

The system proposed in the next section is a way of formally cashing out what is called for by Rabern's platitude: a system in which assertive updates are systematically determined by the compositional semantic value of the uttered sentence, but not equivalent to simply adding the proposition denoted by that sentence in the context of utterance to the stockpile of mutual knowledge.

The feasibility of this account demonstrates that solipsistic contextualism is not falsified by the disagreement data. The empirical threat this data poses hinges on the technical details of how the intuition that assertions use propositional content to build mutual knowledge is implemented; it can be dissolved entirely by tweaking the technical details of that implementation. The disagreement problem is shown thereby to be a problem for the theory of assertion, not a problem for the semantics of epistemic modals. There is no incompatibility between solipsistic contextualism and 'nonfactualist' expressive updates. Solipsistic contextualism, rather than a culprit, is recast as a hero: it explains *why* epistemic modals give rise to non-standard update effects.

3   THE ACCOUNT: FIRST PASS

In this section I present a revised formalization of the Stalnakerian account of assertion. This paper's proposal is a tweak to the machinery of assertion, not a tweak to the semantics of epistemic modals; that assertive machinery can be applied to whatever semantics of epistemic modals one prefers. To demonstrate this, I present applications of the machinery to two different proposals for the semantics of *might*-claims: a simple quantificational semantics (Kratzer 1977, Yalcin 2007), and the ordering semantics, familiar from Kratzer (1981, 1991).

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[11]Both papers cited in the main text cite **?** as an inspiration, as does Yalcin (2011) in articulating a proposal close to mine; see fn.6.

I show that the proposal accurately predicts the observed disagreement behavior of *might*-claims when applied to either semantic proposal, even given solipsistic contextualism. This section deals with the first implementation, which serves as a proof of concept for how the assertive machinery that I propose functions. The second implementation is given in §4. In §3.1, I present the revised formalization of the Stalnakerian account of assertion, and apply it to the assertion of a sentence whose semantics is not information-sensitive, showing that it derives the same results as Stalnaker (1978): intersection of the context set with the proposition denoted by the asserted sentence. Then, in §3.2, I show how the proposal deals with the simple quantificational semantics for epistemic modals. Specifically, I will show that the proposed formalization of assertion derives exactly the update proposed by Veltman (1996) for *might*-claims: the context set will be left unaltered if it has a non-trivial intersection with the prejacent, and anomaly will result otherwise (q.v. Yalcin's 2007 discussion of an update potential for *might*-claims based on 'informational consequence'). §3.3 takes stock by arguing that three potential worries about the system are actually strengths.

Because the implementation of this paper's assertive machinery derives Veltman's update, it inherits the problems of that proposal (see criticisms in Willer 2013, Rudin 2017)—it is inherently uninformative. The ordering semantics was designed in part to render possibility modals more informative. This paper's proposal is not a particular semantics for epistemic modals, or a particular update potential for epistemic modals, but rather an assertive machinery for deriving update potentials for declarative sentences. In §4, I demonstrate the power of this proposal by applying it to the ordering semantics for epistemic modals, extending the representation of contexts from the Stalnakerian context set to a tuple of a context set and an ordering source. The proposal derives a to my knowledge wholly novel update potential for assertions of *might-p*: such an assertion is a proposal that p be added to the context's ordering source (cf. Portner's 2004, 2007 proposal that imperatives serve to update prioritizing ordering sources). The most fundamental result of the paper is that these two non-standard update potentials can be derived from the simple quantificational semantics for *might* and the ordering semantics for *might*, respectively, using the same assertive machinery that applies to all other declarative sentences. The most novel result of this paper is the derivation of a previously undescribed update potential from the ordering semantics for *might*-claims in §4.

3.1   THE NEO-STALNAKERIAN FORMALIZATION OF ASSERTION

On the Stalnakerian account, assertions use the propositional content of a sentence to update a representation of public mutual knowledge. Adding a proposition to the representation of public mutual knowledge entails consideration of the individual public knowledge of the interlocutors: an assertor represents herself as though she knows the asserted proposition to be true, and asks interlocutors to do the same, by way of proposing that it be added to the interlocutors mutual knowledge.[12]. The standard formalization of the Stalnakerian account of assertion, from Stalnaker (1978) forward (presented above in §2), focuses on the way assertions update public mutual knowledge, and lets the assertor's publicization

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[12]For a clear explanation of the relation between individual public knowledge and mutual public knowledge in the Stalnakerian worldview, see Farkas & Bruce (2010).

of her individual knowledge go unformalized, though it's an obvious consequence of what is formalized. We can think of this as a choice of camera angle: it places the updating of mutual knowledge at the center of the frame, with the assertor's publicization of her individual knowledge out of focus in the periphery. What I propose here is a change of camera angle on the same scene: a formalization of the Stalnakerian account of assertion that places the assertor's publicization of her individual knowledge at the center of the frame. On this formal account, which I'll call the Neo-Stalnakerian Formalization of assertion (NSF), propositional content enters the picture with respect to what the assertor predicates of her epistemic state; update to the representation of mutual knowledge is then derived from that predication.[13]

To get off the ground with this formalization, I'll first specify the representation I'll assume for epistemic states. Throughout this subsection, I'll outline the minimal representation of epistemic states necessary to give an implementation of the simple quantificational semantics for epistemic modals; in §4, I change the representation of an epistemic state to be more congruent with the ordering semantics for epistemic modals, which is implemented therein.

I assume for now that an epistemic state i is simple a set of worlds, representing the set of all worlds compatible with what the state-holder knows:

(8) EPISTEMIC STATES (simple version):
$$D_i = \wp W$$

That is to say, the domain of epistemic states D_i is simply the set of all subsets of the set of all possible worlds W.

I assume, following Stalnaker (1978), a formalization of conversational contexts in terms of the public mutual knowledge of the interlocutors.[14] That is to say, the context is itself an epistemic state, that representing what is publicly mutually known by the interlocutors.

(9) NSF CONVERSATIONAL CONTEXTS
The domain of contexts $D_c = D_i$

That is to say: c is eligible to be a conversational context iff c is an epistemic state. I will adopt standard Stalnakerian terminology in sometimes referring to a context as the CONTEXT SET. Because in the NSF, an assertion does not directly add a proposition to the contextual representation of public mutual knowledge, a contextual representation like the Common Ground will not be useful; rather, assertive update will be modeled directly in terms of how it affects the context set.

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[13]In foregrounding that the speaker is predicating something of her epistemic state when making an assertion, I take inspiration from Hintikka (1962) and Karttunen (1972).

[14]Note that I focus here only on the context *qua* representation of mutual knowledge; the only aspect of contextual parameterization I'm interested in here is that it delivers a body of information i. For more finely elaborated models of conversational context, see e.g. Roberts (1996), Ginzburg (1996), Farkas & Bruce (2010). I assume this extremely simple notion of context for presentational simplicity, as the elaborations provided by the models above are irrelevant to the phenomena I discuss here.

When a speaker asserts a sentence s, they present themself as though they know s to be true.[15] That is to say, they present themself as though s is true at every world in their epistemic state. We can generate the set of all such states by using a meta-intensionalization function MI that maps sentences to the set of all epistemic states characterized by knowledge of the truth of that sentence:

(10) META-INTENSIONALIZATION (simple version):
$$MI = \lambda s.\{\ i\ :\ [\forall w : w \in i][\![s]\!]^i(w) = 1\ \}$$

Note that the information parameter i covaries with the epistemic states that the meta-intensionalizer builds a set of. This amounts to the assumption that assertions are information-sensitive *in the same way* that epistemic modals are information-sensitive. This follows from solipsistic contextualism: the information parameter is determined by the context of utterance to be the speaker's epistemic state. As this function returns the set of states the speaker could be in if they know s to be true in the context of utterance, if the speaker holds epistemic state i_1, then we are in a context that delivers i_1 as the information parameter for the interpretation of s; if they hold epistemic state i_2, then we are in a context that delivers i_2 as the information parameter for the interpretation of s, and so on.

When a speaker asserts s, then, they present themself as though their epistemic state is a member of the predicate of states derived by meta-intensionalizing s:

(11) NSF ASSERTIVE LICENSING:
An agent a is licensed to assert s iff $i_a \in MI(s)$
Where i_a is a's epistemic state

In the NSF, context update is derived from the predicate of states $MI(s)$ rather than through direct interaction between the propositional denotation of s and the context. Informally, the speaker is proposing that the context be modified such that it become a member of the same set of states that licensed her assertion; i.e., that it be updated to reflect the same knowledge that licensed her assertion.

(12) NSF ASSERTIVE UPDATE (informal version):
When a speaker asserts s in c, she is proposing that c be modified in the most conservative possible way such that the resulting context becomes a member of $MI(s)$

This notion of update requires some unpacking. I assume, following Stalnaker (1978) and Veltman (1996) among many others, that information growth in a well-behaved conversation is monotonic—if a conversational context requires non-monotonic modification, that is a signal that something has gone wrong, and the conversation up to this point has been

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[15]A note on terminology: it's typical to say that a speaker asserts a proposition, rather than that a speaker asserts a sentence. It would perhaps be more kosher to say that a speaker 'makes an assertion by way of uttering a sentence s' or some comparable phrasing. Any readers who are bothered by describing assertion as something that is done with a sentence, rather than with the semantic content of a sentence, can feel free to mentally swap out my simpler phrasing in the main text for the more complicated but more pedantically accurate phrasing discussed here.

defective in some way. Because a context c is just a set of worlds, there is only one way to monotonically increase the information represented by c: to remove worlds from it.[16] I will rely on the following notion of refinement in enforcing monotonicity of update:

(13) REFINEMENT: (simple version)
      A state i' is a refinement of a state i ($i' \leq_r i$) iff $i' \subseteq i$

Monotonicity of update can be enforced with the following stipulation:

(14) MONOTONICITY CONDITION ON CONTEXT UPDATE:
      For any context update mapping an input context c_i to an output context c_o, $c_o \leq_r c_i$

This defines the space of possible modifications that can be made to the context—so what exactly does it mean to modify the context 'in the most conservative possible way'?

(15) NSF ASSERTIVE UPDATE (formal version):
      When a speaker asserts s in c, she is proposing that an s-commensurate and s-conservative function be applied to c

There are three concepts that need to be defined to make sense of this update condition.

(16) COMMENSURATIVITY:
      For any function f, sentence s, f is s-commensurate iff $[\forall c : c$ is s-compatible$]f(c) \in MI(s)$

Informally: the context update associated with an assertion made using a sentence s must result in the context becoming a member of the set of epistemic states that licensed the assertion.

(17) CONSERVATIVITY:
      For any function f, sentence s, f is s-conservative iff $[\forall s' : [\forall c : c$ is s-compatible$]f(c) \in MI(s')][\![s]\!]^c \subseteq [\![s']\!]^c$

Informally: the context update associated with an assertion made using s must not guarantee that the resulting context entail anything that isn't already entailed by s.

(18) COMPATIBILITY (simple version):
      For any context c, sentence s, c is s-compatible iff $[\exists c' : c' \leq_r c]c' \in MI(s) \wedge c' \neq \varnothing$

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[16]Note, again, that in §4 the representation of epistemic states will be altered by inclusion of an ordering source that is not defined in terms of the modal base, expanding the possible ways of increasing the information represented by the context to either removing worlds from the context set or adding propositions to the ordering source.

Finally: when we are thinking about s-commensurativity and s-conservativity, we should restrict our attention to contexts that have non-empty refinements that are members of $MI(s)$—i.e., contexts that could be updated to reflect the speaker's epistemic state without resulting in anomaly. I take compatibility to also be a condition on the cooperativity of an assertion: an assertion of s is only cooperative relative to a s-compatible context, as if the context is not s-compatible, it will be impossible for the update to be successful.

(19) ANOMALOUS UPDATE (simple version):
      For any context c such that c is not s-compatible:
      $c[s] = \varnothing$

Read $c[s]$ as 'c updated by an assertion of s'. This states that incompatible updates are anomalous, resulting in the absurd context $\varnothing$.

The overall view of update we get from the definition in (15) is that an assertion of s is assigned an update potential that guarantees that the resulting context be a member of $MI(s)$ without guaranteeing that the context entail anything not entailed by s.

Before we move on to a concrete example, it is important that we define the licensing condition for rejection of an assertion. I define the licensing condition for rejection in terms of $MI(s)$, the set of all possible epistemic states the speaker could have if they indeed know the sentence they've asserted to be true:

(20) REJECTION:
      A speaker is licensed in outright rejecting an assertion made using s iff her epistemic state is not s-compatible.

In other words, when a speaker A rejects with an assertion of s by a speaker B, A is presenting herself as though there is no way in which she could monotonically update her epistemic state to make it share the property that B has predicated of her own epistemic state by virtue of her assertion: that of being a member of $MI(s)$. This follows from the role the context is taken to play in a Stalnakerian framework: the representation of public mutual knowledge. If the proposed update would result in a context that is incompatible with an interlocutor's epistemic state, then there is no way for her to monotonically update her epistemic state to bring it into congruence with the representation of public mutual knowledge that would result, and she is licensed in rejecting that update.

3.1.1 A SIMPLE EXAMPLE

The above comprises the entire system put forward in this paper as it applies to frameworks whose representation of epistemic states is a simple set of worlds. In §4, I'll extend the system to include ordering sources, which will affect anything above labeled 'simple version'. I'll now walk through a concrete example to make the operation of the system clear.

Consider a simple sentence like *John is dead*. I assume the following propositional denotation for this sentence, abstracting away from irrelevant complexities:

(21) $[\![\text{John is dead}]\!]^i = \lambda w.dead'(j)(w)$

When a speaker asserts this sentence, she presents herself as though her epistemic state is a member of MI(John is dead) and proposes that the context be modified so as to become a member of that set as well.

(22) MI(John is dead)
$= \lambda s.\{\ i:\ [\forall w:w \in i][\![s]\!]^i(w) = 1\ \}$(John is dead)
$= \{\ i:\ [\forall w:w \in i][\![\text{John is dead}]\!]^i(w) = 1\ \}$
$= \{\ i:\ [\forall w:w \in i]dead'(j)(w) = 1\ \}$

The meta-intensionalized denotation in (22) is a set of epistemic states. In this case, the set of epistemic states the speaker could possibly hold if she knows the sentence *John is dead* to be true is the set of all subsets of the proposition denoted by that sentence in the context of utterance. To see this, imagine that the set of all possible worlds W contains only three worlds, w_1, w_2, and w_3. The proposition $\lambda w.dead'(j)(w)$ maps w_1 and w_2 to 1, and w_3 to 0. Relative to this set of worlds, (22) is the following set:

(23) $\left\{ \begin{array}{c} \{w_1,\ w_2\} \\ \{w_1\}\quad \{w_2\} \\ \varnothing \end{array} \right\}$

Call the proposition denoted by *John is dead* in the context of utterance p. In this case, $MI(s)$ returns the set of all epistemic states that contain only p-worlds—the downward closure of p.[17] It's easy to see that a comparable result will obtain for all sentences whose denotation does not vary with the information parameter i: for any sentence s such that $[\![s]\!]^i = [\![s]\!]^{i'} = p$ for all i,i', for any i, $[\![s]\!]^i$ is true at every w in i iff i is a subset of p. However, we will see in §3.2 that this will not be the case for sentences whose denotation varies with the information parameter i.[18]

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[17]The downward closure of a set is the set containing all of its subsets.

[18]A brief comment on the fact that the proposed formalization of assertion can be productively discussed in terms of the generation of a set of sets of worlds.

The use of sets of sets of worlds in the modeling of context update is a familiar feature of a variety of proposals—see for instance Beaver (2001), Yalcin (2011), Willer (2013). However, I have not proposed that the context itself be lifted to a set of sets of worlds, as Beaver and Willer do, nor have I proposed that sentences themselves denote sets of sets of worlds, as in Inquisitive Semantics (Ciardelli et al. 2013, 2018). Rather, in my proposal these sets of sets of worlds enter the picture only as part of the formalization of the licensing and update potential of assertions, in terms of cashing out what it means to say that the speaker is presenting herself as though she knows the asserted sentence to be true, and in terms of how that property of states is used to propose that the context be updated. The model of contexts and how they are updated that I am presenting here is still quite close to the familiar Stalnakerian one: there is a context set that is simply a set of worlds, and it is updated by having worlds removed from it.

There is an especially strong parallel between the meta-intensionalized denotations used here, which often result in sets that are downward closed, and the sentential denotations of Inquisitive Semantics, which treats all sentential denotations as downward closed sets of sets of worlds. However, closure under subset is not an inherent property of the sets of sets of worlds generated by the meta-intensionalization function, and in §3.2 we'll see that that operation generates sets with quite different properties when applied to *might*-claims.

3.1.2 UPDATE POTENTIAL

Given that in this case, $MI(s)$ is the set of all epistemic states that are subsets of the proposition p denoted by s in the context of utterance, it is trivial to derive the update potential associated with the assertion: it is Stalnakerian update, i.e. intersection of the context set with p.

> (24) UPDATE POTENTIAL FOR NON-EPISTEMIC SENTENCES (simple version):
> For any c, and for any s such that for all i, i', $[\![s]\!]^i = [\![s]\!]^{i'}$,
> $c[s] = c \cap [\![s]\!]^c$

This states that for sentences whose denotation is unaffected by the information parameter i, the update potential of an assertion of that sentence is the intersection of the context set with the proposition denoted by that sentence in the context of utterance. This is not an ad hoc stipulation; rather, it is a special case of the general formalization of update potential given in (15).

To see this, recall the update condition from (15). It specifies that the update potential of an assertion of s is an operation that guarantees that any s-compatible context to which it is applied will become a member of $MI(s)$, but doesn't guarantee that the resulting contexts will entail anything not entailed by s. Recall as well that we've assumed that updates must take the form of monotonic information increase, i.e. the only maneuver available to us is to remove worlds from the context set. Given that we're dealing with a sentence s that denotes the same proposition p regardless of the information parameter, whose meta-intensionalized denotation is simply the set of all epistemic states that are a subset of p, this means that we need an operation that will render the context set a subset of p (s-commensurativity), without removing any worlds that aren't necessary to achieve that (s-conservativity)—an operation that will remove all and only those worlds from the context that prevent it from being a subset of p. Intersection with p is precisely such an operation. Because this reasoning follows from the characteristic downward-closed structure of (23), it follows that the NSF derives classical Stalnakerian intersective updates as the update potential of all sentences s that denote the same proposition p regardless of the information parameter, and whose meta-intensionalized denotations therefore comprise the set of all epistemic states whose modal base component is a subset of p—i.e., all sentences whose denotation does not vary with the information parameter. In §3.2, we'll see how a sentence whose denotation *is* sensitive to the information parameter can have a meta-intensionalized denotation that does not have the property of being closed under subset, and therefore does not license classical Stalnakerian intersective update.

3.1.3 REJECTION

Finally, consider what a speaker does when they reject an assertion of *John is dead*: they represent themself as though their epistemic state is not s-compatible. Recalling the definition of s-compatibility from (18), this means that in rejecting an assertion of s, the rejector represents themself as though there is no refinement of their epistemic state (other than the absurd state, the empty set) that is a member of $MI(s)$. As in the case at hand $MI(s)$

is simply the set of all epistemic states that are a subset of the proposition p denoted by s, the rejector therefore represents herself as though there are no p-worlds in her epistemic state—i.e., as though she knows p to be false.

In the next section we'll see that if the sentence includes a bare epistemic modal (given the solipsistic contextualist semantics), its meta-intensionalized denotation will not be the set of all epistemic states that are a subset of its propositional denotation in the context of utterance, and so update and rejection will both proceed somewhat differently.

3.2 Implementing the Simple Quantificational Semantics

In this section, I show how the NSF interacts with the simple quantificational semantics for *might* (Kratzer 1977, Yalcin 2007). I'll show that the NSF derives the 'consistency test' semantics for *might* (proposed by Veltman 1996 in the context of Update Semantics; see also Yalcin's 2007 discussion of an 'informational consequence' account of the update potential of *might*-claims) as the update potential of *might*-claims given the simple quantificational semantics. This will suffice to show that the NSF can account for the disagreement behavior of *might*-claims given the solipsistic contextualist semantics for *might*. However, the consistency test semantics has been criticized for predicting all assertions of *might*-claims to be informationally trivial (see e.g. Willer 2013, Rudin 2017). In §4, I show how the NSF deals with the ordering semantics of Kratzer (1981, 1991), which assigns a stronger semantics to *might*, deriving a novel, informative update for *might*-claims.

The simple quantificational semantics for *might* which we will be concerned with in this section is given in (2), repeated here as (25):

(25) $[\![\text{might}]\!]^i = \lambda p.\lambda w.[\exists w' : w' \in i]p(w') = 1$

On this semantics, a *might*-claim is true in a world w relative to a contextually-determined body of information i iff there is at least one world w' in i such that the prejacent proposition is true in w'. I call this the simple quantificational semantics because it treats *might*-claims as simply existentially quantifying over a set of epistemically accessible worlds.

A solipsistic contextualist semantics for *might* is one on which the value of i is fixed by the context of utterance as the epistemic state of the speaker in the world of utterance. This guarantees that bare epistemic modals will be interpreted as claims about the speaker's information, although of course the value of i can be shifted by operators, like *given what Sue knows*, or attitude verbs under which *might*-claims are embedded (Yalcin 2007, Anand & Hacquard 2013, Ninan 2016). Given solipsistic contextualism, (25) says that an utterance of *might-p* in w will be true iff there is a world accessible to the speaker from w (i.e., there is a world in i) at which p is true.

However, if we meta-intensionalize a *might*-claim on the solipsistic contextualist interpretation of the simple quantificational semantics, we do not derive the set of all subsets of the proposition the sentence denotes, as we do for a sentence whose denotation is insensitive to the information parameter in §3.1. Rather, we get the following:

(26) a. $[\![\text{John might be dead}]\!]^i = \lambda w.[\exists w' : w' \in i]dead'(j)(w') = 1$

b. $MI(\text{John might be dead})$
$= \{i : [\forall w : w \in i][\![\text{John might be dead}]\!]^i(w) = 1\}$
$= \{i : [\forall w : w \in i][\exists w' : w' \in i]dead'(j)(w') = 1\}$
$= \{i : [\exists w' : w' \in i]dead'(j)(w') = 1\}$

On the semantics in (25), the interpretation of *might*-claims is insensitive to the world of evaluation: the prejacent proposition is instead assessed for truth relative to the worlds in the domain of quantification. This renders the outer layer of universal quantification over worlds introduced by the meta-intensionalization operator vacuous.[19]

We can generalize the above to any *might*-claim whose prejacent's denotation does not vary with the information parameter; I'll say that such a sentence is of the form *might-p*:

(27) a. $[\![\text{might-}p]\!]^i = \lambda w.[\exists w' : w' \in i]p(w') = 1$

b. $MI(\text{might-}p)$
$= \{i : [\forall w : w \in i][\![\text{might-}p]\!]^i(w) = 1\}$
$= \{i : [\forall w : w \in i][\exists w' : w' \in i]p(w') = 1\}$
$= \{i : [\exists w' : w' \in i]p(w') = 1\}$
$= \{ i : i \cap p \neq \varnothing \}$

Recall that meta-intensionalization in a way of representing the set of epistemic states the speaker could hold if they indeed know the sentence they've asserted to be true. By virtue of solipsistic contextualism, whatever epistemic state the speaker is in is the value of the information parameter. So given any arbitrary state i, if i is a state in which the speaker knows the *might*-claim she's asserted to be true, that means that the *might*-claim is true given i as the information parameter. By virtue of the simple quantificational semantics, the set of all such states is simply the set of all states containing at least one p-world.[20]

Assuming the simple quantificational semantics for *might*, the meta-intensionalized denotation for *might-p* is the set of all epistemic states that contain at least one p-world. Imagine again a set of worlds W containing w_1, w_2, and w_3, where the proposition denoted by *John is dead* maps w_1 and w_2 to 1, and w_3 to 0. Relative to this set of worlds, (26b) looks like this:

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[19]It might appear concerning that, on this semantics, the truth conditions of epistemic modals are not sensitive to the world of evaluation. This is a property of the domain implementation of modal semantics that is not shared by the relational implementation of modal semantics (see discussion in footnote 2). But the strangeness is mediated by assuming that the setting of the i parameter is sensitive to the world of evaluation. Solipsistic contextualism is one particularly concrete such assumption about how the setting of the i parameter is sensitive to the world of evaluation in unembedded contexts.

[20]Note the similarity to Yalcin's (2011) proposal for deriving update potentials for *might*-claims in a 'nonfactualist' context, which makes use of the same set of states. My proposal differs in deriving things from a solipsistic contextualist semantics, not a relativist one, and in deriving expressivist updates for *might*-claims from a fully general implementation of assertive machinery that treats all declarative sentences equally (see fn.6).

$$(28) \quad \left\{ \begin{array}{c} \{w_1, w_2, w_3\} \\ \{w_1, w_2\} \quad \{w_1, w_3\} \quad \{w_2, w_3\} \\ \{w_1\} \; \{w_2\} \end{array} \right\}$$

Note that this set has a different structure from the previous meta-intensionalized denotation that we saw in (23). We saw in the previous section that the meta-intensionalized denotation of a sentence whose denotation is not affected by the information parameter will simply be the set of all subsets of that propositional denotation. What we've seen here is that when a sentence has a denotation that varies depending on the information parameter, meta-intensionalizing it does not necessarily result in the set of all subsets of that proposition denoted by that sentence in the context of utterance. This is not due to ad hoc stipulation, but is derived entirely from the interaction between the sentence's interpretational dependence on the information parameter, and the way that MI makes use of the information parameter. To put it formally, this set of states has a distinctive structure because the semantic interpretation of a *might*-claim is sensitive to the information parameter manipulated by the machinery of assertion. To put it informally, *might*-claims have a distinctive assertive profile because bare epistemic modals are speaker-orientedly epistemic *in the same way* that assertion is. Solipsistic contextualism *explains* why epistemic modal assertions are funky.

3.2.1 REJECTION

The formulation of the licensing of rejection given in (20) specifies that in rejecting an assertion of s, the rejector presents herself as though her epistemic state is not s-compatible. The meta-intensionalized denotation of *might-p*, given in (27b), is the set of all epistemic states including at least one p-world. Given the definition of compatibility in (18), a speaker's epistemic state is not *might-p*-compatible relative to the denotation in (28) iff it has no p-worlds in it. This captures precisely the intuitive meaning of disagreement over *might*-claims: when a speaker rejects an assertion of *might-p*, she presents herself as though p is incompatible with her epistemic state. The NSF predicts that rejection is licensed by the rejector's lack of epistemically accessible p-worlds, and that in rejecting *might-p* the rejector indicates that she knows p to be false, even though the semantics of *might* is sensitive only to the assertor's epistemic state.

3.2.2 UPDATE POTENTIAL

In the section §3.1, I showed that the NSF derives intersective update as the update potential for all sentences whose denotation is not affected by the information parameter, and whose meta-intensionalized denotation therefore comprises the set of all subsets of the proposition it denotes in the context of utterance. This is because intersection is the most conservative operation that guarantees that one set will become a subset of another. That logic does not go through for a meta-intensionalized denotation that is not closed under subset, like (28).

So what will the update potential for a sentence of the form *might-p* be, if not intersection? To see the answer to this, consider first which contexts are compatible (in the sense of (18))

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with the denotation in (28). All contexts either have a p-world in them, or have no p-worlds in them. Contexts with no p-worlds in them are not compatible with this denotation: no refinement of them is a member of (28). Contexts with p-worlds in them are already members of (28), as it is the set of all sets of worlds containing at least one p-world. In other words, it is a logical necessity that any context is either incompatible with (28), or is already a member of it. For contexts of the latter class, no further modification is necessary to make it a member of (28), so the most conservative update is to leave it alone. For contexts in the former class, no monotonic modification can make it a member of (28), so the update fails.[21].

(29)   UPDATE POTENTIAL FOR *MIGHT*-p (simple version):
      For any c,
      $$c[\text{might-}p] = \begin{cases} c \text{ if } c \cap p \neq \varnothing \\ \varnothing \text{ otherwise} \end{cases}$$

Again, this is not an ad hoc stipulation, but a special case of the general formalization of update potential given in (15), as applied to sentences whose meta-intensionalized denotation has the characteristic structure of (28). See the condition on anomalous update in (19) for an explanation of the 'otherwise' case.

To summarize: the update potential of a sentence of the form *might-p*, given the simple quantificational semantics for *might*, is exactly that proposed by Veltman (1996) (q.v. Yalcin 2007, 2011): it leaves the context untouched if it has a p-world in it, and it is anomalous otherwise. It's worth noting that this result, which Veltman (1996) achieved by analyzing *might* as a syncategorematically-defined update operator, is derived from the interaction between the fully general proposal for the update potential of assertions and the simple quantificational semantics of *might* that has been familiar since Kratzer (1977)—the special behavior of *might*-claims comes without needing to treat them as denoting anything other than a standard proposition.

I'll stress here that this paper's proposal is the tweak to the assertive machinery that has allowed us to derive this update potential from the same machinery that assigns ordinary update potentials to non-modal declarative sentences. The paper's proposal is not a particular semantics for epistemic modals, or a particular update potential for epistemic modals. One immediate problem for the Veltmanian consistency test semantics for *might* is that it renders *might*-claims intrinsically uninformative (Willer 2013, Rudin 2017). The ordering semantics for modality (Kratzer 1981, 1991) was designed in part to address informativity issues related to modal claims, strengthening possibility modals and weakening necessity modals. In §4, I show how the NSF can be extended to implement the ordering semantics. I do this by extending the notion of epistemic states (and, therefore, contexts) from a set of worlds to a tuple of a set of worlds and an ordering source. I show that this extension has no effect on

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[21]Peter Klecha (p.c.) notes that this result follows only given the assumption that all updates are monotonic. If information growth were allowed to be non-monotonic, i.e. if updates were allowed to add worlds to the context, the update potential of *might-p* relative to a context with no p-worlds in it could be to add p-worlds to the context. A fuller discussion of the possibilities made available by non-monotonic update systems, and the problems posed by them, is outside the scope of this paper.

the update potential of sentences whose denotation doesn't vary with the choice of ordering source, which still update contexts by intersecting the context set with the proposition they denote in the context of utterance. Then I show how it derives a novel, informative update effect for *might*-claims, without altering the result that speakers are licensed to disagree with *might*-claims when they have no epistemically accessible *p*-worlds.

Before moving on, however, I pause to address two potential worries about this system.

3.3   Taking Stock

Before moving on to the application of the NSF to the ordering semantics for epistemic modals, let's take stock of what's happened so far. First, I outline how the theory that we have an hand at this point in the paper successfully addresses the empirical desiderata presented in §1.1. I then address three potential worries about this system, and argue that they actually comprise strengths.

Our major empirical desiderata from §1.1 have to do with the observed lack of a biconditional relationship between truth and acceptance. Khoo (2015) presents empirical results showing that in the case of *might*-claims, but not in the case of non-modal sentences, people are willing to reject assertions whose content they are not willing to judge to be false. That is to say, if the prejacent of a *might*-claim is compatible with the speaker's information, people are not willing to judge the claim false, even if they find it appropriate to reject the claim on the basis of the prejacent's incompatibility with their own information. So we need a theory of epistemic modal assertions that (i) assigns epistemic modal sentences truth conditions, to explain the fact that people have intuitions about their truth that are not reducible to the acceptability of the update the propose, but (ii) does not predict that epistemic modal assertions will be rejectable iff the asserted sentence is false. On the standard Stalnakerian formalization of assertive update, both contextualism and relativism about epistemic modal semantics erroneously predict a biconditional relationship between truth and acceptance; expressivism struggles to explain why people have intuitions about the truth values of epistemic modal sentences that differ from evaluations of whether the context updates they propose are acceptable.

But we can now see that the theory we have in hand satisfies the desiderata suggested by these empirical observations. *Might*-claims, on this view, have a solipsistic contextualist semantics, explaining the observed pattern of truth value judgments: a *might*-claim is true iff the speaker's information is compatible with the prejacent. However, because of how the information-sensitivity of epistemic modals interacts with the information-sensitivity of assertion, assertions of *might*-claims do not propose that the context become a subset of the set of all worlds in which the *might*-claim is true. Rather, they propose that the context be compatible with the prejacent. So they are rejectable if the rejector's information is incompatible with the prejacent. This predicts the observed pattern of rejectability judgments, on which the rejector's information, not the assertor's, is decisive.

The theory in hand delivers the split between the contextualist behavior of truth value judgments and the relativist behavior of rejection judgments via the distinctive pathway it proposes from truth conditions to update potentials. Because *might*-claims are information-

sensitive in the same way that assertion is information-sensitive, their update potential is not simply to reduce the context to the worlds in which they're true, severing the biconditional relationship between truth and acceptance. On the NSF, unlike on the standard Stalnakerian formalization of the mechanism of assertion, such a biconditional relationship does not exist in the case of epistemic modal claims, meeting the desiderata derived from Khoo's observations in §1.1.[22]

On to the discussion of three potential worries about this system, which I argue actually comprise strengths.

The first worry, addressed in §3.3.1, is a worry about whether this account is actually contextualist at all. It is. But a signature property of the NSF is that it severs truth conditions from update potential in the case of epistemic modals. Maintaining the assumption that epistemic modal sentences have solipsistic contextualist truth conditions in spite of their non-solipsistic update potential allows the account to capture the otherwise troubling empirical facts discussed in §1.1.

The second worry, addressed in §3.3.2, is that solipsistic contextualism predicts truth-conditional equivalence between epistemic modal sentences and corresponding knowledge ascriptions using the indexical pronoun *I*. But the latter class of sentences do not display the same problematic disagreement patterns as epistemic modal claims. This worry is misplaced: indexical pronouns are not sensitive to the information parameter i, so the theory predicts, counterintuitively but correctly, that truth-conditionally equivalent sentences do not always share an update potential.

The third worry, addressed in §3.3.3, is that there are putative counterexamples to solipsistic contextualism in which a bare epistemic modal is interpreted relative to the information of somebody other than the speaker. The contexts in which this occurs are perspective-shift contexts in which the assertion itself is attributed to somebody other than the speaker. Rather than counterexemplifying solipsistic contextualism, this follows from it, and its formal implementation developed above, if we take the sense of the term 'speaker' invoked in the definition of solipsistic contextualism to be the agent whose beliefs the assertion expresses (**?**).

3.3.1   In What Sense Is This Account Contextualist?

I call an account of epistemic modal semantics solipsistically contextualist if it assigns bare epistemic modals truth conditions that describe the speaker's epistemic state. One might worry about in what sense this account can really be given a solipsistic contextualist gloss. What does it even mean to say that the truth conditions of epistemic modal sentences is fixed by the context of utterance if those truth conditions are only used to derive an update potential that doesn't directly put the denoted proposition forward?

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[22]Khoo (2015) pursues a different solution to the problem posed by his observations, suggesting that epistemic modal disagreements may provide evidence that there are multiple types of disagreement, some of which involve disputation about truth and others of which don't. Though this conceptual distinction is of course legitimate, the system presented in this paper does not necessitate reifying that conceptual distinction, deriving modal and non-modal disagreements from one and the same mechanism.

To see how to answer that question, note that the speaker's interlocutors are almost certainly unsure of the exact identity of the speaker's epistemic state—if this were not so, then it would be impossible for the speaker to contribute any new information to the conversation! A consequence of this is that, if the context of utterance provides the speaker's epistemic state as a parameter of interpretation, then the interlocutors are not able to fully determine what context they're in. This might seem worrisome, but it's actually fine. Though the interlocutors almost certainly don't know exactly what epistemic state the speaker holds, the crucial feature of the NSF implementation of assertion is that interlocutors can still reason about *which epistemic states* the speaker *could* be in if they indeed know the sentence they've uttered to be true. Uncertainty about exactly what the context is (i.e., exactly what epistemic state the speaker holds) doesn't prevent interlocutors from deriving a *set* of candidate states the speaker *could* be in, and deriving an update potential from that set.

So when I say that the update system put forward in this section is compatible with a solipsistic contextualist view, on which the truth conditions of epistemic modal claims are fixed by the context of utterance, I mean the following. The truth conditions of epistemic modal claims are fixed by the context of utterance. However, speakers are unable to determine the exact identity of the context of utterance, in a technical sense: they know that the value of i is whatever the speaker's epistemic state is, but they don't know exactly what the speaker's epistemic state is, so they are not able to determine the exact value of i (though they may be aware of many constraints on it). This situation is saved from catastrophe, because speakers do not need to know the value of i to know what the speaker is predicating of their epistemic state: they know what the interpretation of the modal claim would be for any setting of the information parameter i; therefore they know for any setting of the information parameter i whether a speaker whose epistemic state is i would know the modal claim to be true; therefore they know how to generate the set of all epistemic states a speaker could have if they know the modal claim is true in the context of utterance. And the key feature of the NSF is that it derives update potentials from that set of states, meaning that speakers can know precisely what the update potential of a modal claim is even if they cannot fully specify the value of the crucial contextual parameter relevant to determining its precise truth conditions.

The appeal I've made here to a degree of uncertainty on the part of the interlocutors about the exact identity of the context is not a *sui generis* property of this explanation. For especially lucid discussion of the applicability of contextual underspecification to the semantics of vagueness see Barker (2002), and see von Fintel & Gillies (2011) for a very different take on how contextual underdetermination could solve some problems in the interpretation of epistemic modals.

For the reasons outlined above, I believe that it's not only coherent to describe this system as solipsistically contextualist, but indeed it's a *natural* way to think about how assertions of solipsistically contextualist epistemic modals *should* work in a formalization of assertion that foregrounds what a speaker is predicating of her own epistemic state by virtue of her assertion.

Finally, I'll note here that the potentially counterintuitive way that this proposal separates

the solipsistic contextualist truth conditions of epistemic modals from their update potential, which does not propose that interlocutors coordinate on agreement about what the speaker's epistemic state is like, is exactly in line with the empirical results discussed in §1.1, the explanation of which is one desideratum for the success of this proposal. Given the NSF, epistemic modals have solipsistic contextualist truth conditions, but propose updates coordinating on compatibility of the context with p, not coordinating on the context representing that the speaker's epistemic state is compatible with p. This predicts the crucial empirical results. If epistemic modals have solipsistic contextualist truth conditions, then people should be hesitant to judge them to be false in contexts where the speaker's epistemic state is compatible with the prejacent. And indeed they are hesitant. If the assertion of a *might*-claim is a proposal that the interlocutors coordinate on a mutual epistemic state relative to which p is a possibility, then people should not be hesitant to *reject* epistemic assertions regardless of the speaker's epistemic state. And indeed they are not. This proposal's signature property—that epistemic modals have solipsistic contextualist truth conditions, but that their update potential is *not* that the speakers coordinate on the truth of the proposition that the sentence denotes in the context of utterance—is exactly what is needed to explain these otherwise problematic facts.

3.3.2 COMPARISON WITH INDEXICAL BELIEF REPORTS

Note the crucial piece of the formal explanation of why epistemic modal sentences are assigned non-standard update effects: they are speaker-orientedly epistemic *in the same way* as assertions are. That is to say, their interpretation covaries with the same i parameter that is manipulated by the assertive machinery. There are other ways to achieve reference to the speaker's information that don't make use of that parameter. For instance, descriptions of the speaker's information can be made using indexical pronouns:

(30)   I don't know whether Cal was at the party.

In this case, the speaker's information enters the picture not via the information parameter, but via an attitude verb whose subject is the indexical pronoun *I*. Indexical pronouns make fixed, invariable reference determined by the context parameter, a parameter that I have thus far been suppressing for readability. For the purpose of this section alone, I'll stop suppressing it:

(31) $\llbracket \cdot \rrbracket^{i,c}$

There. The reference of indexical pronouns is determined by the c parameter:

(32) $\llbracket \text{I} \rrbracket^{i,c} = \textsc{speaker}(c)$

The distinction between the information parameter and the context parameter is crucial, because indexical expressions, unlike epistemic modals, do not shift under attitudes:[23]

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[23]This is true in English, at least. Some languages do display 'indexical shift' in such constructions; see Deal (2020) for an overview.

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(33)   John thinks that I might have been at the party.

In this case, the attitude verb *think* unambiguously shifts the information parameter relevant to the interpretation of *might* to John's belief worlds (Anand & Hacquard 2013), but the value of the indexical pronoun *I* has not been shifted: it still refers to the speaker, not John.[24] So we can tell that attitude verbs shift only the i parameter, not the c parameter:

(34) $[\![x \text{ think/know might-}p]\!]^{i,c} = [\![\text{might-}p]\!]^{\mathbf{think/know}_x,c}$
        Where $\mathbf{think}_x$ is x's belief-worlds, and $\mathbf{know}_x$ is x's knowledge-worlds

And the same mutatis mutandis for adjunctive information-shifters like *given what x knows* or *for all x knows*.

Because c is independent of i, and the interpretation of an indexical pronoun is determined by c, changing the value of i does not affect the interpretation of indexical pronouns. So descriptions of the speaker's epistemic state that make use of indexical pronouns will not give rise to the non-standard update potentials that epistemic modal claims give rise to, by virtue of their denotation not being sensitive to the value of i.

This leads to the surprising result that one and the same assertive machinery can derive different update potentials for truth-conditionally equivalent sentences, one of the counter-intuitive properties of the NSF that is unfamiliar with respect to more standard formal implementations of assertion. Given solipsistic contextualism, the following two sentences are plausibly truth-conditionally equivalent:

(35)   a. Cal might have been at the party.
        b. For all I know, Cal was at the party.

However, they do not display identical patterns of disagreement. (35a) can be rejected on the basis of the rejector's information, regardless of the assertor's; (35b) cannot:

(36)   a. **A:** Cal might have been at the party.
            B: You're wrong that Cal might have been at the party, the surveillance tapes show him at the library.
        b. **A:** For all I know, Cal was at the party.
            B: #You're wrong that, for all you know, Cal was at the party. The surveillance tapes show him at the library.

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[24]Note that apparent cases of exocentric interpretations of epistemic modals, in which they are not shifted to reflect the attitude holder's information, have been discussed by e.g. Egan et al. (2005), von Fintel & Gillies (2011), Roberts (2023). Whether these observations genuinely demonstrate the possibility of exocentric interpretations of epistemic modals has been debated (see especially Stephenson 2007); at the very least it is clear that epistemic modals do not receive exocentric interpretations as freely as uncontroversially potentially-exocentric elements like subjective predicates. Whether or not such interpretations are possible is orthogonal to my proposal; what is crucial is only that it is possible for epistemic modal interpretations to shift where indexical pronouns don't.

Note that it's crucial that the adverbial *for all you know* be included in the scope of *wrong* in (36b), just as *might* is included in the scope of *wrong* in (36a). Unlike a *might*-claim, a *for-all-I-know*-claim cannot be rejected on the basis of the rejector's information alone, regardless of whether the assertor's is compatible with the prejacent.

The NSF derives the fact that these truth-conditionally-equivalent sentences give rise to different disagreement profiles. Despite their truth-conditional equivalence, they will nonetheless be assigned different update potentials, because (35a) has a denotation that covaries with the value of i, and (35b), which refers to the speaker's epistemic state by way of an indexical pronoun, does not.[25] The meta-intensionalized denotation of (35b) will have a typical downward-closed structure, and an update potential of intersecting the context with the set of all worlds in which the speaker's information is compatible with p, by virtue of its insensitivity to the i parameter. So the NSF reconciles the intuitive truth-conditional equivalence of these two sentences with the fact that they license different patterns of disagreement.

3.3.3 Solipsistic contextualism under perspective shift

In rich contexts, bare epistemic modals can be interpreted relative to a body of information other than the speaker's, despite not being syntactically embedded under any modal operators like *in view of* adverbials or attitude verbs:

(37) **A**lice: What did Izzy say when you asked where Cal was last night?
      Bizzy: Cal might have been at the party. But that's nonsense, he was in Virginia.

B's *might*-claim can be interpreted relative to Izzy's information, not **B**'s own, as evidenced by the non-contradictory status of **B**'s follow-up about his own knowledge.[26]

Roberts (2023) gives a useful taxonomy of such examples, which include cases of bare epistemic modals under modal subordination (38, Roberts' ex.32) and Free Indirect Discourse (39, Roberts' ex.5):

(38) Local meteorologists believe that a hurricane is in the offing. It might hit the coast, or it might veer out to sea. I myself doubt this forecast.

(39) John pondered his situation. Where was Clarissa now? She might be in New Orleans with Sydney. But she might be in Chicago.

In (38), the bare epistemic modal is 'subordinated' to the attitude verb *believe* in the previous sentence (Roberts 1987); its domain is interpreted as the belief-worlds of the local meteorologists, which, as the non-contradictory follow-up indicates, need not be shared by the speaker. In (39), exemplifying Free Indirect Discourse, the sequence following the initial sentence is understood as articulating John's thoughts, and the bare epistemic modals are interpreted relative to John's epistemic state, not that of the author of the passage.

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[25]In this sense, epistemic modals do not have an 'indexical character', contra Roberts (2023).

[26]Thanks to an anonymous reviewer for noting the relevance of examples like those discussed in this section.

The possibility of such interpretations of bare epistemic modals *prima facie* cases doubt on the idea that bare epistemic modals have a solipsistic contextualist semantics in the general case, and therefore on the formalization of their domain in terms of an information parameter i that covaries with the speaker's epistemic state under meta-intensionalization. But I believe that these examples still display solipsistic contextualism, and reveal instead a sensitivity of assertion itself to perspective-shifting.

The cases above are all cases in which the speaker is taken to 'attribute' an assertion to someone other than themself. I.e., the assertion is understood to express the beliefs of somebody other than the speaker. To see this, note that the epistemic modal is not crucial in deriving this interpretation; non-modal assertions can still be interpreted as attributing a belief to a third party, not to the speaker, in such contexts:

(40)   **A**lice: What did Izzy say when you asked where Cal was last night?
       Bizzy: Cal was at the party. But that's nonsense, he was in Virginia.

(41)   Local meteorologists believe that a hurricane is in the offing. It will hit the coast. I myself doubt this forecast.

(42)   John pondered his situation. Who was Clarissa with? She was in New Orleans, but with who?

In (40), **B**'s first sentence is taken to express Izzy's beliefs, not **B**'s own, despite the lack of an epistemic modal; in (41), the second sentence is taken to express the local meteorologists' beliefs, not the speaker's own, despite the lack of an epistemic modal; in (42), the third sentence is taken to express John's belief, not the authors' own (John may be mistaken about Clarissa's location), despite the lack of an epistemic modal. This establishes that perspective-shifting is a feature of whose beliefs these assertions are taken to express in these contexts, rather than a property specific to the resolution of a domain for an epistemic modal.

The relevance of this is that the epistemic modals in this sections first three examples are all given solipsistic contextualist interpretations *relative to the shifted perspective of the assertion*: the epistemic state that the assertion expresses gives the domain of the epistemic modal.

What exactly does it mean to say that these uses of epistemic modals are solipsistically contextualist, if the modal domain is not the speaker's epistemic state, but instead the epistemic state of the person whose beliefs are being expressed? A terminological clarification is in order. **?** notes that the term 'speaker' is in need of conceptual disambiguation between a number of roles, including two relevant to our purposes: PRINCIPAL and ANIMATOR. The animator of an utterance is the agent who physically produces it. The principal of an utterance is the agent whose beliefs are being expressed via that utterance. There's a good reason that these two roles are often conflated via the single term 'speaker': they typically corefer. But Roberts' contexts are precisely contexts that pull these two conceptions of the 'speaker' apart. They are cases in which the person physically articulating the utterance—its animator—is not the person whose beliefs the utterance is taken to express—its principal.

It should be clear now that the above discussion in this very section uses the term 'speaker' in the sense of animator, and these examples pose a problem for solipsistic contextualism only if we understand it to be the claim that a bare epistemic modal's domain is understood to be the epistemic state of the animator. These examples make the point that when we use the term 'speaker' in articulating solipsistic contextualism, we should understand it to mean principal. So construed, these examples *exemplify* solipsistic contextualism, rather than counterexemplifying it: they are cases in which the domain of the modal is understood to be the epistemic state of the principal. They are situations in which the principal is understood to be distinct from the animator: they predicate something of a third party's epistemic state. Solipsistic contextualism—understood in terms of the principal, not the animator—predicts that in such contexts, the third-party principal's epistemic state will be understood as the domain of a bare epistemic modal. This prediction, Roberts' examples show, is borne out. And the formal system articulated above, with its signature property of expressing the principal's epistemic state the the domain for a bare epistemic modal as the same parameter, i, captures the facts discussed in this section.

4 THE ORDERING SEMANTICS

Above, we saw that applying the NSF to the simple quantificational semantics for epistemic modals derives a Veltmanian 'consistency test' update for *might*-claims from the same assertive machinery that derives ordinary Stalnakerian update for non-modal sentences. But this paper's proposal, namely, the NSF machinery for deriving update potentials from the semantics of declarative sentences, isn't leashed to any one semantics for epistemic modals, or any one update potential for *might*-claims. This section demonstrates the power of the proposal by applying it to a different semantics for epistemic modals, the ordering semantics, and showing that it derives a novel, informative update potential for *might*-claims that dissolves the disagreement problem in the same manner as the previous implementation.

In this section, I extend the NSF to include ordering sources in its representation of contexts and epistemic states. The ordering semantics for modality (Kratzer 1981, 1991) is predicated on just such an extension—it takes the interpretation of epistemic modals to be sensitive to not just a set of worlds, but a set of worlds plus a set of propositions from which an ordering over them is induced. I extend the concept of an epistemic state to incorporate both an epistemic modal base and an ordering source:

(43)   EPISTEMIC STATES (ordering version):
       $D_i = \{ \langle b_i, o_i \rangle : b_i \in D_{st} \land o_i \in \wp D_{st} \}$

An epistemic state is a pair of an epistemic modal base b_i (a set of worlds) and an epistemic ordering source o_i (a set of propositions). We maintain the assumption that $D_c = D_i$, i.e. that a conversational context is an epistemic state with a particular interpretation (representing the public mutual knowledge of the interlocutors), meaning that now a conversational context is also a pair of a modal base and an ordering source.

An ordering source is used to induce an ordering over worlds in the modal base. Simplifying

things via the limit assumption (q.v. Portner 2009 p.66), an ordering source returns the subset of the modal base containing only worlds which are maximal with respect to that ordering:

(44) $\text{BEST}_{b_i,o_i} = \{\ w : w \in b_i \land \neg\exists w' \in b_i \text{ s.t. } w' >_{o_i} w\ \}$
      Where $\forall w, w', w \geq_{o_i} w'$ iff $\forall p \in o_i, w' \in p \rightarrow w \in p$ ($w >_{o_w} w'$ iff $w \geq_{o_i} w'$ and $w' \not\geq_{o_i} w$)

A world w is a BESTworld with respect to a modal base and an ordering source iff no other world in that modal base is a member of a proper superset of the ordering propositions that w is a member of. We can think of an epistemic ordering source as a set of propositions that are most normal or most likely, giving the set of salient 'live' possibilities relative to that epistemic state (q.v. Willer 2013 for a different formal implementation of 'live' possibility as relevant to the interpretation of epistemic modals). So the BESTworlds with respect to some epistemic state i are the epistemically possible worlds compatible with the largest number of 'live' possibilities in i.

On the ordering semantics for *might*, its domain of quantification is only the BEST epistemically accessible worlds:

(45) ORDERING SEMANTICS FOR *MIGHT*:
      $[\![might]\!]^i = \lambda p.\lambda w.[\exists w' : w' \in \text{BEST}_{b_i,o_i}]p(w') = 1$

The information parameter determines both a modal base and an ordering source; *might* can then existentially quantify over a special subset of that epistemic modal base: the set of all worlds in that modal base that are most compatible with the 'live' possibilities given by the ordering source. This allows for more informative *might*-claims—rather than entailing that the prejacent is merely not ruled out by the contextually-given modal base, they entail that the prejacent is represented among the most normal/likely options highlighted by the relevant epistemic state.[27] The solipsistic contextualist interpretation of the ordering semantics for epistemic modals works the same as on the simple quantificational semantics: the information parameter relative to which bare epistemic modals are interpreted is always fixed by the context of utterance as the speaker's epistemic state.

The addition of ordering sources to the conception of a context means that there are now two possible ways to monotonically increase the information expressed by a context: to remove worlds from the context set, or to alter the ordering source.[28] I revise the notion of refinement below, to capture this:

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[27]Note that probabilistic semantics for modals also allow for stronger possibility modals. Probabilistic accounts generally treat epistemic modals as entailing that their prejacents are associated with epistemic probability above some threshold. This analysis has been applied to a variety of phenomena: for example to statements of comparative probability by Lassiter (2015), to strengthening inferences associated with statements of epistemic possibility by Rudin (2016), and to free choice inferences by Santorio & Romoli (2017). (Cf. Holliday & Icard 2013, who argue that it is more difficult to pull apart the empirical predictions made by probabilistic and Kratzerian accounts than is often claimed.)

[28]Note that the definition in (46) allows an ordering source to be altered in any way as a context is refined. Readers might wonder why a monotonicity condition on context update shouldn't restrict ways in which the ordering source can be altered, say, by requiring that propositions be added to it, not removed from it. But observe that live possibilities can both appear and disappear in the course of monotonic information

(46) REFINEMENT (ordering version):
A context c' is a refinement of a context c ($c' \leq_r c$) iff $b_{c'} \subseteq b_c$

Because contexts and epistemic states are now tuples, of which a modal base is only one component, we will need to make small adjustments to three previous definitions:

(47) COMPATIBILITY (ordering version):
For any context c, sentence s, c is s-compatible if $[\exists c' : c' \leq_r c]c' \in MI(s) \wedge b_{c'} \neq \emptyset$

(48) ANOMALOUS UPDATE (ordering version):
For any context c such that c is not s-compatible:
$c[s] = \langle \emptyset, o_i \rangle$

(49) META-INTENSIONALIZATION (ordering version):
$MI = \lambda s.\{ i : [\forall w : w \in b_i][\![s]\!]^i(w) = 1 \}$

In these definitions, reference to a context and an epistemic state, respectively, have been changed to explicitly reference the modal base component of that context and epistemic state. I will refer to any context whose modal base component is empty as 'the absurd context' All other definitions from §3.1 persist unchanged.

4.1 NON-EPISTEMIC PROPOSITIONS

In the ordering version of the NSF, sentences whose denotation does not vary with the information parameter will behave the same as before: they will intersect the context set with the proposition they denote in the context of utterance (and leave the ordering source unchanged). To see this, let's revisit the example of *John is dead*. Meta-intensionalization will proceed just as in (22):

(50) MI(John is dead)
$= \{ i : [\forall w \in b_i][\![\text{John is dead}]\!]^i(w) = 1 \}$
$= \{ i : [\forall w \in b_i]dead(j)(w) = 1 \}$

Because we are now treating epistemic states i as tuples $\langle b_i, o_i \rangle$, rather than as simple sets of worlds, this meta-intensionalized denotation is a set of such tuples: all such tuples in which the proposition denoted by *John is dead* is true at every world in the modal base. Because the sentence's denotation is always the same proposition p regardless of the information parameter, each i in (50) has a modal base component that is a subset of p, for the reasons discussed in §3.1. Note that the ordering source has no effect on the truth of this proposition,

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increase. For instance, in a context in which Cal is an indecisive partygoer, it could be a live possibility that Cal was at the party, and a live possibility that he wasn't. Later, we can gain the information that he indeed was present, rendering the latter possibility no longer a live possibility, and indeed no longer a possibility at all. That live possibilities can become dead possibilities via the monotonic increase of information shows that a monotonicity condition on context update should not preclude propositions being removed from the ordering source.

and so the speaker is not placing any restrictions on what the ordering source component of their epistemic state is like by virtue of their assertion—the set of all epistemic states they could hold contains all states whose modal base is a subset of p, irrespective of what the ordering source is:

(51) (50) $= \{ i \; : \; b_i \subseteq \{ w : dead'(j)(w) = 1 \} \}$

The update potential associated with an assertion of *John is dead*, then, will be the same Stalnakerian update potential as before we added ordering sources into the mix: intersection of the context set with p.

(52) UPDATE POTENTIAL FOR NON-EPISTEMIC SENTENCES (ordering version):
For any c, and for any s such that for all i, i', $[\![s]\!]^i = [\![s]\!]^{i'}$,
$c[s] = \langle b_c \cap [\![s]\!]^c, o_c \rangle$

For any such sentence, any context that has no p-worlds in its context set will not be s-compatible, as there is no way to either subtract worlds from the context set or alter the ordering source that will result in the context set becoming a (non-empty) subset of p. Assuming that we're dealing with an s-compatible context, with at least one p-world in its context set, altering the context's ordering source could not possibly change whether it is a member of the set given in (51), as altering the ordering source would have no effect on whether the context set is a subset of p. That leaves us with the strategy of removing worlds from the context set. Again, the most conservative way to remove worlds from the context set to guarantee that it will be a subset of p is to intersect it with p.

Rejection of assertions of such sentences also works the same as before: the rejector is presenting herself as though her epistemic state is not s-compatible; as discussed above, an epistemic state is not compatible with (51) iff its modal base has no p-worlds in it. Therefore, the disagreer is presenting herself as though she knows p to be false.

4.2 *MIGHT*-CLAIMS

We've seen that assertions of sentences whose denotation is not affected by the information parameter work the same in the ordering version of the NSF as they did in the version without ordering sources. What about assertions of *might*-claims?

First, the meta-intensionalized denotation of a *might*-claim, given the ordering semantics in (45):

(53) a. $[\![\text{John might be dead}]\!]^i = \lambda w.[\exists w' : w' \in \text{BEST}_{b_i, o_i}] dead'(j)(w') = 1$
      b. $MI(\text{John might be dead})$
          $= \{ \; i \; : \; [\forall w : w \in b_i][\![\text{John might be dead}]\!]^i(w) = 1 \; \}$
          $= \{ \; i \; : \; [\forall w : w \in b_i][\exists w' : w' \in \text{BEST}_{b_i, o_i}] dead'(j)(w) = 1 \; \}$
          $= \{ \; i \; : \; [\exists w' : w' \in \text{BEST}_{b_i, o_i}] dead'(j)(w) = 1 \; \}$

The same holds for any *might*-claim whose prejacent's denotation does not vary with the information parameter; for any such sentence of the form *might-p*:

(54) a. $[\![\text{might-}p]\!]^i = \lambda w.[\exists w' : w' \in \text{BEST}_{b_i,o_i}]p(w') = 1$

　　b. $MI(\text{might-}p)$
　　　$= \{\ i\ :\ [\forall w\ :\ w \in b_i][\![\text{might-}p]\!]^i(w) = 1\ \}$
　　　$= \{\ i\ :\ [\forall w\ :\ w \in b_i][\exists w' : w' \in \text{BEST}_{b_i,o_i}]p(w) = 1\ \}$
　　　$= \{\ i\ :\ [\exists w' : w' \in \text{BEST}_{b_i,o_i}]p(w) = 1\ \}$
　　　$= \{\ i\ :\ \text{BEST}_{b_i,o_i} \cap p \neq \varnothing\ \}$

Just as was the case for the simple quantificational semantics in §3.2, the truth conditions of *might*-claims here are insensitive to the world of evaluation, rendering the universal quantification introduced by the meta-intensionalizer vacuous. Meta-intensionalizing *might-p*, given the ordering semantics, returns the set of all epistemic states whose ordering source picks out at least one *p*-world from its modal base as a BESTworld.

4.3 Update potential

How can we determine the update potential of the denotation in (54b)? Let's first divide the set of all possible contexts into those whose context set contains at least one *p*-world, and those whose context set contains no *p*-worlds. All contexts of the latter kind are incompatible with (54b)—there can be no *p*-worlds in BEST_{b_i,o_i} if there are no *p*-worlds in b_i, and no refinement of such a context can reintroduce *p*-worlds into b_i, by (46). Because all such contexts aren't *might-p*-compatible, we can safely restrict our attention to the set of all contexts whose context set contains at least one *p*-world. Contexts in this set may or may not already be members of (54b), depending on whether their ordering source picks out a *p*-world as maximal. The question facing us is: what operation will guarantee that all such contexts will become a member of (54b) (*s*-commensurativity) without guaranteeing that the resulting context will entail anything stronger than (54b) (*s*-conservativity)?

Adding *p* to the context's ordering source has exactly those properties. It is commensurate with (54b) by definition (16), meaning that adding *p* to the ordering source of any context with a *p*-world in its context set will result in that context being a member of (54b). To see this, consider the definition of maximality relative to an ordering source given in (44), repeated here:

(55) $\text{BEST}_{b_i,o_i} = \{\ w\ :\ w \in b_i\ \wedge\ \neg\exists w' \in b_i\ \text{s.t.}\ w' >_{o_i} w\ \}$
　　　Where $\forall w, w',\ w \geq_{o_i} w'$ iff $\forall p \in o_i,\ w' \in p \rightarrow w \in p$　$(w >_{o_w} w'$ iff $w \geq_{o_i} w'$ and $w' \not\geq_{o_i} w)$

A world w in c's context set is maximal with respect to that context's ordering source (i.e., is a member of BEST_{b_i,o_i}) iff there are no worlds in the context set that are members of a proper superset of the propositions in the ordering source that w is a member of. This has the logical consequence that for any proposition p in o_i, as long as there is at least one *p*-world in b_i, there will be a *p*-world in BEST_c. The only way a *p*-world w could fail to be maximal with respect to an ordering source that includes p is if there is some other world that is a member of a proper superset of the ordering propositions that w is a member of, guaranteeing that such a world is also a *p*-world—i.e., if p is in the ordering source, the only thing that can be ranked strictly higher than a *p*-world is another *p*-world.

This demonstrates that adding p to the ordering source of a context whose modal base contains at least one p-world guarantees that that context will become a member of (54b), the set of all contexts c such that BEST_{b_i,o_i} contains a p-world.

It should also be clear that adding p to the ordering source is conservative with respect to (54b) given definition (17), satisfying the other half of the update condition. Adding p to the ordering source does not guarantee that any non-p world will become maximal with respect to the ordering for any arbitrary *might-p*-compatible context, and so the update does not guarantee that contexts updated with it will entail anything other than what is already entailed by *might-p*.

(56) UPDATE POTENTIAL FOR *MIGHT*-p (ordering version):
For any c
$$c[\text{might-}p] = \begin{cases} \langle b_c, o_c + p \rangle \text{ if } b_c \cap p \neq \varnothing \\ \langle \varnothing, o_c \rangle \text{ otherwise} \end{cases}$$

This update is informative: relative to a context whose ordering source did not already contain p, the resulting context is a proper refinement of the context prior to the update. On this account, an assertion of a *might*-claim is a proposal that the context be made to pick out the prejacent as a live possibility (q.v. the discussion of 'live possibility' as the result of *might*-updates in Willer 2013).

Note that Portner (2004, 2007) develops an account of imperatives on which they serve to update a priority ordering source. Portner (2007) observes that there does not appear to be a parallel in the epistemic domain:

> . . . . . . we have a canonical mechanism for building up the [epistemic] modal base (declaratives) and a canonical mechanism for building up the ordering source for deontic modals (imperatives); it would provide a nice symmetry if we could find a grammatical mechanism for helping to determine the ordering source for epistemic modals as well. p.353–354

Portner goes on to speculate that evidentials might supply such a grammatical mechanism. Given an ordering semantics for epistemic modals, the NSF derives the result that *might*-claims serve a function directly parallel to Portner's proposed update for imperatives: they serve to add a proposition to an epistemic ordering source. On the proposal developed here, only *some* assertions of declarative sentences serve to restrict an epistemic modal base; because of the interaction between the information-sensitivity of epistemic modals and the information-sensitivity of the NSF model of assertion, *might*-claims serve a different function.

4.4 REJECTION

Rejection of a *might*-claim given the ordering semantics is predicted to work exactly as it did for the simple quantificational semantics. As we saw in the discussion above, the only contexts that are incompatible with the meta-intensionalized denotation of *might-p* are those whose modal base has no p-worlds in it. As rejection is licensed by the rejector's epistemic

state being incompatible with that meta-intensionalized denotation, a rejector is presenting themselves as though they have no p-worlds epistemically accessible to them, just as in the implementation of the simple quantificational semantics for *might*.

5   CONCLUSION

This paper has proposed a novel Neo-Stalnakerian Formalization of the assertive machinery that derives update potentials from the semantic interpretation of declarative sentences. This proposal meets the desiderata outlined in §1. Empirically, it predicts a distinction between the solipsistic contextualist truth conditions of epistemic modal claims, and their non-solipsistic update potential. This prediction matches the empirical observation that people who are inclined to reject epistemic modal assertions aren't necessarily inclined to describe them as false. And theoretically, it derives non-standard update potentials for epistemic modal claims while assigning them denotations of the same kind as all other declarative sentences, and using the same assertive machinery that applies to all other declarative sentences. The non-standard update potentials of epistemic modals are derived from their semantics. The disagreement profile of epistemic modals, far from being problematic for solipsistic contextualism, is *explained* by solipsistic contextualism: epistemic modal claims give rise to non-standard update potentials because they're speaker-orientedly epistemic *in the same way* that assertion is. The proposal is distinguished from neighbors like Yalcin (2011) by showing that there is no incompatibility between solipsistic contextualism about epistemic modal semantics, and expressivism about the update potential of epistemic modal sentences.

It is also distinguished from its neighbors by deriving expressivist update effects for epistemic modals via a fully generalized implementational variant on the classic Stalnakerian theory of assertion. The machinery of assertion developed here has properties that don't match how we're used to thinking about assertion. It's not the case that asserting a sentence always plunks its denotation into a representation of mutual knowledge—for special cases, like epistemic modals, the update potential of an assertion is markedly different from the denotation of the asserted sentence, though they are principledly related to each other. And, as a corollary of that property, it's not always the case that truth-conditionally equivalent sentences are assigned the same update potential, as in the case of descriptions of the speaker's knowledge state that refer to it using indexical pronouns (§3.3.2).

This paper adds its voice to a growing literature questioning the soundness of the conclusions that motivated the move from solipsistic contextualism about epistemic modals to the family of approaches discussed in the introduction. This growing literature includes work by Phillips & Mandelkern (2020), who show that 'eavesdropper' effects, argued to be a desideratum for the semantics of epistemic modals, obtain for all sentences, regardless of their context-sensitivity. It also includes Kroll & Rysling (2019), who show that the QUD-sensitivity of truth value judgments are likewise not restricted to such elements (cf. Beddor & Egan 2018, who argue that the QUD-sensitivity of truth value judgments of modal sentences are evidence for a relativistic semantics for epistemic modals). Taken together, these papers suggest that much of the motivation for non-contextualist treatments of

epistemic modals actually reflects properties of truth-value judgment tasks in general, rather than particular properties of epistemic modals.

This paper adds to that literature not in the domain of experimental investigation of the properties of truth value judgment tasks, but rather in the domain of theorizing about the formalization of assertive update. The moral, however, is the same: what has been taken to represent a property that motivates an exceptional treatment of epistemic modals with respect to 'ordinary' declarative sentences may actually fall out of a mechanism that applies to all declarative sentences equally. It's not just epistemic modal sentences in which it's the speaker's information that's relevant to the assertion, but the rejector's information that's relevant to the rejection.

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APPENDIX A: *MUST*-CLAIMS

The literature on the disagreement problem has focused predominantly on *might*; hence my exclusive focus on *might* in the main text. However, any account of epistemic modals must be able to account not just for *might*, but also for its dual, *must*. In this appendix I show the update potentials the NSF derives for *must* on both the simple quantificational semantics (§5.1) and on the ordering semantics (§5.2).

5.1 THE SIMPLE QUANTIFICATIONAL SEMANTICS

On the simple quantificational semantics, *must*, being the dual of *might*, quantifies universally over the same set of worlds over which *might* quantifies existentially:

(57) $[\![\text{must}]\!]^i = \lambda p.\lambda w.[\forall w' : w' \in i]p(w') = 1$

This being the simple quantificational semantics, I'll derive the update potential for this version of the semantics of a *must*-claim using the simple version of the NSF from §3.1, as ordering sources will serve no purpose here.

For any sentence of the form *must-p* (i.e., a *must*-claim whose prejacent denotes p regardless of the information parameter):

(58) $MI(\text{must-}p)$
 $= \{\ i :\ [\forall w : w \in i][\![\text{must-}p]\!]^i(w) = 1\ \}$
 $= \{\ i :\ [\forall w : w \in i][\forall w' : w' \in i]p(w') = 1\ \}$
 $= \{\ i :\ [\forall w' : w' \in i]p(w') = 1\ \}$
 $= \{\ i :\ i \subseteq p\ \}$

That is to say: the meta-intensionalized denotation of *must-p*, given the simple quantificational semantics, is *identical* to the meta-intensionalized denotation of its prejacent. Therefore, *must-p* will have the same update potential as a non-epistemic sentence denoting p, for the reasons discussed in §3.1.

(59) UPDATE POTENTIAL FOR *MUST*-p (simple version):
 For any c,
 $c[\text{must-}p] = c \cap p$

This is *prima facie* a very undesirable result: surely, asserting that p *must* be true accomplishes something different *in some way or another* than simply asserting that p *is* true. For

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context, however, note that it is currently up for debate whether *must-p* indeed entails p, or whether it has a weaker meaning. In defense of the former view, see von Fintel & Gillies (2010, 2021); in defense of the latter view, see Lassiter (2014, 2016) and Goodhue (2017), building on part on arguments made by Karttunen (1972) and Kratzer (1991). For those convinced by the latter view, that the strong semantics for *must* in (57) derives the undesirable result in (59) would just provide further support for a weaker semantics for *must*. Those convinced of the former view, however, have proposed that the intuitive weakness of *must*-claims is due not to their logical strength, but to their carrying an evidential meaning supplementing the classic semantics in (57).

To be concrete, von Fintel & Gillies (2010) propose that *must* presupposes that its prejacent is not entailed by the 'kernel' representing what is known by direct observation (or whatever may count as direct evidence in the context). If this is the case, then the *prima facie* undesirability of treating the update potential of *must-p* as the same as the update potential of its prejacent would be defused: *must-p* would be differentiated from its prejacent by way of its evidential presupposition. If one were so inclined, one could develop a model of the NSF in which the notion of an epistemic state were extended to include a kernel K, and derive an update potential for *must-p* on which it may manipulate K_c. I leave such an extension as an exercise to the reader.

In the following section, I show what the ordering version of the NSF derives for the ordering semantics of *must*, which delivers a weaker meaning for *must*-claims.

5.2   THE ORDERING SEMANTICS

On the ordering semantics, *must*, as the dual of *might*, quantifies universally over the same set of BESTworlds that *might* quantifies over existentially:

(60)   HUMAN NECESITY:
$$[\![\text{must}]\!]^i = \lambda p.\lambda w.[\forall w' : w' \in \text{BEST}_{b_i,o_i}]p(w') = 1$$

That is to say: *must-p* is true, on the ordering semantics, iff every world that is most compatible with the live possibilities given the information parameter is a p-world.

Meta-intensionalizing a sentence of the form *must-p* gives us the following:

(61) $MI(\text{must-}p)$
$= \{\ i : [\forall w : w \in b_i][\![\text{must-}p]\!]^i(w) = 1\ \}$
$= \{\ i : [\forall w : w \in b_i][\forall w' : w' \in \text{BEST}_{b_i,o_i}]p(w') = 1\ \}$
$= \{\ i : [\forall w' : w' \in \text{BEST}_{b_i,o_i}]p(w') = 1\ \}$

That is to say: the meta-intensionalized denotation of *must-p*, given the ordering semantics, is the set of all epistemic states whose BESTworlds are all p-worlds.

The general formalization of NSF update in (15) specifies that the update potential of any assertion in c of a sentence s is that an s-commensurate and s-conservative function be applied to c. In the case of the meta-intensionalized denotation in (61), we need a function that

will render any *must-p*-compatible context a member of that set (*must-p*-commensurativity) without guaranteeing that every context thus modified will entail anything not already entailed by *must-p* (*must-p*-conservativity). The function with these properties is that function which adds p to a context's ordering source, and removes from that ordering source all propositions disjoint with p.

As a preliminary, note that any context whose context set contains at least one p-world is *must-p*-compatible. By the definition of refinement in (46) and the definition of BEST in (44), any such context has a refinement in which all its BESTworlds are p-worlds: that refinement such that the ordering source is the singleton set $\{p\}$. So we restrict our attention to such contexts in the following.

Consider the first portion of this update function: the addition of p to the ordering source. Any update function that does not add p to the ordering source of the context being updated cannot be *must-p*-commensurate. To see this, consider the following scenario:

(62) $c_1 = \langle b_{c_1}, o_{c_1} \rangle$
      $p = \{w_1, w_2\}$
      $b_{c_1} = \{w_1, w_2, w_3\}$
      $o_{c_1} = \varnothing$
      $\text{BEST}_{b_{c_1}, o_{c_1}} = \{w_1, w_2, w_3\}$

In this scenario, c_1 is *must-p*-compatible, by virtue of having p-worlds in its context set. Removing w_3 from the context set would result in a context that entails *must-p*, but it would also entail p, which is not entailed by *must-p* (on the ordering semantics), thereby violating *must-p*-conservativity. The only other path available is to add a proposition to the ordering source, and that proposition must be p, as the addition of any other proposition would likewise violate *must-p*-conservativity. Therefore, any *must-p*-commensurate update operation must involve adding p to the ordering source.

But that alone is not enough. Consider the following scenario:

(63) $c_2 = \langle b_{c_2}, o_{c_2} \rangle$
      $p = \{w_1, w_2\}$
      $q = \{w_3\}$
      $b_{c_2} = \{w_1, w_2, w_3\}$
      $o_{c_2} = \{q\}$
      $\text{BEST}_{b_{c_2}, o_{c_2}} = \{w_3\}$

In this scenario, c_2 is *must-p*-compatible, by virtue of having p-worlds in its context set. But simply adding p to the ordering source will not deliver a new context relative to which all BESTworlds are p-worlds. By virtue of the presence of the p-disjoint proposition q in the ordering source, the non-p-world w_3 will remain in the set of BESTworlds, as there is no world in a proper superset of the ordering propositions it is a member of. The disjoint proposition q must therefore be removed from the ordering source in order to guarantee that all BESTworlds are p-worlds. This is the case for all and only p-disjoint propositions in the

ordering source for any *must-p*-compatible context. Ordering propositions overlapping at least partially with p are unproblematic; by virtue of their overlap with p, only worlds in their intersection with p are possible BESTworlds, as their non-p-worlds will be in a proper subset of the ordering propositions that their p-worlds are members of.

This reasoning delivers the following update potential for *must-p*, given the ordering semantics:

(64)   UPDATE POTENTIAL FOR *MUST-p* (ordering version):
       For any c:
       $$c[\text{must-}p] = \begin{cases} \langle b_c, (o_c + p) \cap \{i : i \cap p \neq \varnothing\}\rangle \text{ if } b_c \cap p \neq \varnothing \\ \langle \varnothing, o_c\rangle \text{ otherwise} \end{cases}$$

That is to say: the update potential the NSF derives for *must-p*, given the ordering semantics, is that it results in a context such that every live possibility is compatible with p. Put differently: it proposes that p be taken to be a live possibility (if it wasn't already), and that all possibilities disjoint with p no longer be taken to be live possibilities (if they were before).

APPENDIX B: RELATIONAL SEMANTICS

The proposal in the main text of the paper makes use of a domain semantics for epistemic modals, in the style of Yalcin (2007), rather than a relational semantics for epistemic modals, in the style of Kratzer (1977). Nothing crucial relies on this: as long as one assumes that epistemic states are CLOSED, the two implementations of modal semantics deliver equivalent results (see Ninan 2016 for an argument that the two implementations are expressively equivalent more generally).

In this technical appendix, I simply show that this is true. Here's a relational implementation of both the simple quantificational semantics and the ordering semantics, and a derivation of update potentials for both that are identical to those encountered in the main text.

5.3   RELATIONAL SIMPLE QUANTIFICATIONAL SEMANTICS

(65) $[\![\text{might}]\!]^i = \lambda p.\lambda w.[\exists w' : w' \in f_i(w)]p(w') = 1$
       (adapted from Kratzer 1977)

On this semantics, a *might*-claim is true in a world w relative to a contextually-determined body of information i iff there is at least one world w' epistemically accessible from w via the epistemic accessibility function f_i determined by i such that the prejacent proposition is true in w'.

Epistemic accessibility functions map from a world to the set of worlds that are epistemically accessible from that world. In addition to the ordinary properties of epistemic functions, I assume, following Gillies (2004), von Fintel & Gillies (2010), that epistemic accessibility functions are CLOSED:

(66) EPISTEMIC CLOSURE
The domain of epistemic accessibility functions is D_f.
$$f \in D_f \rightarrow [\forall w : w \in W][\forall w' : w' \in f(w)]f(w') = f(w)$$

In the relational semantics for epistemic modals given in (65), the epistemic accessibility function f_i is determined by the information parameter i. The context determines the value of f_i as the epistemic accessibility function associated with the relevant holder of i in the context of utterance. This means that f_i must be a function that returns i as the set of worlds epistemically accessible from any world in i.

(67) For any epistemic state i, D_{f_i} is that subset of D_f such that
$$[\forall f : f \in D_{f_i}][\forall w : w \in i]f(w) = i$$

Why should this be so? All that is necessary to see this is to note that i represents an epistemic state held in the world of evaluation. If we assume solipsistic contextualism this is obviously true: i is the epistemic state of the speaker in the world of utterance. That is to say, i is the set of all worlds accessible to the speaker in the world of evaluation. Because epistemic accessibility is reflexive by definition, i must contain the world of evaluation. So f_i must map from the world of evaluation to i. The rest follows from epistemic closure.

Strictly speaking, the above only says that i *constrains* the identity of f_i. We could make stronger assumptions about the relation between i and f_i, but we need not for our purposes here.

Given this assumption about the relation between i and f_i, meta-intensionalizing a *might*-claim given the semantics in (65) delivers the following result:

(68) a. $[\![\text{might-}p]\!]^i = \lambda w.[\exists w' : w' \in f_i(w)]p(w') = 1$
  b. $MI(\text{might-}p)$
    $= \{i : [\forall w : w \in i][\![\text{might-}p]\!]^i(w) = 1$
    $= \{i : [\forall w : w \in i][\exists w' : w' \in f_i(w)]p(w') = 1$

This is simply the set of all states containing at least one p-world:

(69) a. For any i such that $i \cap p \neq \varnothing$:
    $[\forall w : w \in i][\exists w' : w' \in f_i(w)]p(w') = 1$

    Proof:
    $i \cap p \neq \varnothing$ PREMISE
    $w \in i \rightarrow f_i(w) = i$ (67)
    $[\forall w : w \in i]f_i(w) \cap p \neq \varnothing$ $\therefore$
  b. For any i such that $i \cap p = \varnothing$:
    $[\forall w : w \in i]\neg[\exists w' : w' \in f_i(w)]p(w') = 1$

    Proof:
    $i \cap p = \varnothing$ PREMISE

$$w \in i \rightarrow f_i(w) = i \qquad (67)$$
$$[\forall w : w \in i] f_i(w) \cap p = \varnothing \qquad \therefore$$

c. For any s of the form *might-p*, $MI(s) = \{\ i : i \cap p \neq \varnothing\ \}$

Proof:
$$i \in MI(\text{might-}p) \leftrightarrow [\forall w : w \in i][\exists w' : w' \in f_i(w)]p(w') = 1 \qquad (68b)$$
$$[\forall w : w \in i][\exists w' : w' \in f_i(w)]p(w') = 1 \leftrightarrow i \cap p \neq \varnothing \qquad (69a), (69b)$$
$$MI(\text{might-}p) = \{\ i : i \cap p \neq \varnothing\ \} \qquad \therefore$$

In other words: a relational semantics delivers the same result as a domain semantics for the meta-intensionalized denotation of a *might*-claim, provided that epistemic accessibility is closed.

5.4 RELATIONAL ORDERING SEMANTICS

On the ordering semantics, an epistemic state i is an ordered pair $\langle b_i, o_i \rangle$. (See §4 for details.) On a relational version of the ordering semantics, the information parameter determines both an epistemic accessibility function f_i and an ordering function g_i, which maps from worlds to sets of propositions.

(70) $\llbracket might \rrbracket^i = \lambda p.\lambda w.[\exists w' : w' \in \text{BEST}_{f_i(w), g_i(w)}]p(w') = 1$

Closure works the same as above for epistemic accessibility relations: for each world $w \in b_i$, $f_i(w) = b_i$. We can extend the notion of closure to ordering relations as well. Just as the set of epistemically accessible worlds is constant across b_i, the set of ordering propositions is constant across b_i as well.

(71) For any epistemic state i, D_{g_i} is that subset of D_g such that
$$[\forall g : g \in D_{g_i}][\forall w : w \in b_i]g(w) = o_i$$

Meta-intensionalizing a *might*-claim on the ordering semantics has the following result:

(72) a. $\llbracket \text{might-}p \rrbracket^i = \lambda w.[\exists w' : w' \in \text{BEST}_{f_i(w), g_i(w)}]p(w') = 1$
   b. $MI(\text{might-}p)$
$$= \{\ i : [\forall w : w \in b_i]\llbracket \text{might-}p \rrbracket^i(w) = 1\ \}$$
$$= \{\ i : [\forall w : w \in b_i][\exists w' : w' \in \text{BEST}_{f_i(w), g_i(w)}]p(w) = 1\ \}$$

With the assumption of closure in hand, for any $w \in b_i$, $f_i(w) = b_i$, and $g_i(w) = o_i$. Therefore, the set above is equivalent to the following:

(73) $\{\ i : [\forall w : w \in b_i][\exists w' : w' \in \text{BEST}_{b_i, o_i}]dead'(j)(w) = 1\ \}$

That is to say, meta-intensionalizing *might-p* on the relational implementation of the ordering semantics returns the set of all epistemic states whose ordering source picks out at least one p-world from its modal base as a BESTworld. In other words, a relational ordering semantics

delivers the same result as a domain ordering semantics for the meta-intensionalized denotation of a *might*-claim, provided that epistemic accessibility (including ordering functions) is closed.