Two readings of counterfactual conditionals

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Abstract

The existence of distinct 'ontic' and 'epistemic' readings of counterfactuals remains controversial, because its empirical basis is debated. I present new cross-linguistic evidence for this divide from the Bangla conditional connective *jodi*: unlike *if, jodi* licenses ontic inferences but excludes backtracking and other 'epistemic' inferences (Schulz, 2007), showing that these are genuinely distinct readings tracked by the grammar. This raises a compositional puzzle: what enables dual readings of counterfactuals in general, and what blocks one of them in *jodi*-counterfactuals? I argue that to derive the observed variation, the potential for dual readings must be located in the lexical semantics of the conditional connective: the two readings involve different selection functions in a Stalnakerian similarity semantics. The selection function is a contextual parameter, and natural language conditional connectives can constrain the range of its admissible values. I implement this by enriching Stalnaker (1976)'s system with causal structures (Pearl, 2009), deriving the desired range of inferences with little new formal machinery. Finally, I discuss some implications of *jodi*-counterfactuals for understanding the nature of the laws underlying ontic readings of counterfactuals.

Keywords: counterfactual conditionals, backtracking, causal models, Bangla, epistemic conditionals

1 Introduction

A core question that has steered the analysis of counterfactual conditionals, is what it means to make a counterfactual assumption. Intuitively, a counterfactual expresses that in some or all of the relevant scenarios where the antecedent is true, the consequent is true, too. The challenge is to articulate which scenarios are relevant, in light of the intuition that when the antecedent is in fact false, hypothesizing about scenarios where it is true requires giving up some of what is known to be the case, but not too much. One approach has been to examine what kinds of conclusions can be drawn from a given counterfactual assumption, and then work backwards to understand what must be held fixed, and what must be allowed to change, to derive that inference. This enterprise, based largely on *if*-counterfactuals in English, has led some researchers to propose that there are two distinct ways of making a counterfactual assumption, which differ in the information held fixed while choosing the relevant antecedent-scenarios, and lead to different possible conclusions. The most prominent example is Schulz (2007), who proposes a distinction between two interpretations of counterfactuals, which she

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labels 'ontic' and 'epistemic'. Following terminology in this and subsequent work, I adopt these labels for the relevant sets of readings.[1]

However, the empirical basis of this claim has been debated (Rott 1999, Veltman 2005, a.o.). I present new cross-linguistic evidence for such a divide from the Bangla conditional connective *jodi*. Unlike *if*, *jodi* licenses ontic inferences but systematically excludes all the inferences labeled as 'epistemic' by Schulz (2007). This supports the hypothesis that the two groups form linguistically-relevant natural classes that are tracked by the grammar.

I then argue that the contrast between *if* and *jodi* raises a compositional puzzle for existing analyses of counterfactual conditionals: what enables dual readings of counterfactuals in general, and what blocks one of these with *jodi*? Schulz's analysis attributes the readings to different interpretation functions at the sentential level, making cross-linguistic variation hard to account for without positing deep differences between English and Bangla. On the other hand, recent analyses of the lack of epistemic readings in a specific counterfactual construction (*if-not-for A, C*) rely on morphosyntactic and semantic properties that jodi does not share (Henderson, 2010; Ippolito, 2003).

I argue that to allow the right amount of variability, the potential for dual readings must be located in the lexical semantics of the conditional connective, along a parameter that is independently known to vary. In the account proposed here, the two sets of readings involve different selection functions in a Stalnakerian similarity semantics (Stalnaker, 1976). The selection function is a contextual parameter and natural language conditional connectives can lexically constrain the range of its admissible values. This preserves Schulz (2007)'s insight that the readings reflect different antecedent revisions while accommodating the observed variability within and across languages. The approach aligns with recent work showing lexically encoded variation among conditional connectives within and across languages (Kaufmann et al., 2024; Arita, 2009). I implement this by enriching Stalnaker (1976)'s system with a typology of selection functions. To preview, the contrast between *if* and *jodi* is as follows:

(1) $[\![if(A)(C)]\!]^{c,w} = 1$ iff $[\![B]\!]^{c,f(A,w)}=1$

(2) $[\![jodi(A)(C)]\!]^{c,w} = 1$ iff $\delta(f \in f_{causal})\& \ [\![B]\!]^{c,f(A,w)}=1$, where δ is the presupposition operator (Beaver and Krahmer, 2001).

The selection functions can now be defined in terms of any existing analyses of ontic and epistemic readings. I spell out a formulation of f_{causal} based on Pearl (2009)'s causal intervention semantics, which derives the right inferences for *jodi*.

Finally, by examining counterfactuals with overt doxastic modals in the consequent, I show how facts about *jodi* and new empirical observations about English *if-not-for* constructions can clarify the nature of the laws underlying ontic readings.

The paper is structured as follows. Section 2 introduces the core empirical data contrasting *jodi*- and *if*-counterfactuals with respect to the availability of backtracking readings (2.1)

[1]However, note that Schulz's work does not appeal to modal bases or flavors of modality in the Kratzerian sense, and I am similarly agnostic to whether the 'epistemic' readings involve epistemic modality. For the purposes of this paper, what matters is that the inferences under each label pattern together, suggesting that they share *some* property.

and evidence-source asymmetries (2.2). Section 3 summarizes the relevant morphosyntactic properties of *jodi* alongside key features of the Bangla tense-aspect system. In section 4, I outline the compositional puzzle raised by the contrast between *if* and *jodi* in light of 'negated counterfactuals' (NCs) (section 4.1). This leads to the main proposal in section 5, formalized in section 6. Finally, section 7 presents data on NCs and *jodi*-counterfactuals with overt deontic modals in the consequent, discussing their implications for the nature of the underlying causal dependencies.

2 Ontic and epistemic readings

The distinction between 'ontic' and 'epistemic' readings is based on the intuition that modals in natural language systematically admit two interpretations, one invoking facts of the world in some objective sense and the other invoking an agent's knowledge or beliefs. This has been proposed by Condoravdi (2002) for modal auxiliaries, and extended to indicative conditionals by Kaufmann (2005). Schulz (2007) intends for the two proposed readings of counterfactuals to relate to this broader divide. Setting aside the conceptual parallel, the formal correlate of the divide in her account concerns how the process of antecedent revision is modeled. Recall that in counterfactuals, while assuming a false hypothetical scenario, some things are held fixed. The proposed readings differ in what is held fixed: whether we prioritize holding the facts of the actual scenario fixed ('ontic'), or whether we prioritize holding certain dependencies (laws) fixed, even if this alters more facts about the actual scenario ('epistemic'). Schulz (2007) identifies a number of examples where the two options lead to diverging predictions about the truth of the resulting conditional. Recall that the association with the broader epistemic-ontic divide in modal language is a conceptual choice. What Schulz's account predicts over and above this is that counterfactual inferences fall into two distinct classes, each requiring a different mechanism of antecedent revision to yield a true reading.

However, the existence of these classes has been contentious because the empirical status of the relevant inferences with *if*-counterfactuals have been debated. Focusing on two of the examples identified by Schulz— 'backtracking' and 'evidence-source asymmetries'— I show that for each of these, *jodi* makes a distinction between the two possible readings: the ontic reading is permitted, but the epistemic reading is completely unavailable. This presents a contrast with *if*, for which both readings have been considered at least plausible, though to different degrees by various authors. The presence of a natural language expression that permits one inference but not the other is a strong argument for these being genuinely distinct readings that are tracked by the grammar. Although I focus on two, the patterns discussed below extend to all the examples identified by Schulz.

2.1 Backtracking

In contrast to ordinary 'forward-tracking' counterfactuals, which reason from cause to effect, backtracking counterfactuals involve reasoning from an effect to its cause.[2] An example of

[2]Backtracking has been variously understood in terms of temporal or causal ordering, which coincide on many of the classic examples. Since I ultimately adopt a causal approach here, I speak in terms of causal

the contrast is the following pair, where in the most natural context, we can assume that refusing to eat causes hunger, but not the converse:

(3) Law: *not-eating* $\rightarrow$ *hunger*. Context: the children refused to eat lunch earlier, and are now hungry.

a. *Forward-tracking:* If they had eaten lunch earlier, they would not have been hungry now.

b. *Backtracking:* If they had not been hungry now, they would (have to) have eaten lunch earlier.

While (3a) in uncontroversially true in this context, there is disagreement about whether the intended reading of a backtracking counterfactual like (3b) is really a legitimate reading of *if*-counterfactuals. Some authors have reported them to be deviant (Lewis, 1973), others have claimed that the desired interpretation is possible only with the additional modal 'have to' in the consequent (Arregui, 2005), and yet others have claimed that they are always available in principle, although less prominent than their forward-tracking counterpart, improving with contextual support and the addition of 'have to' (Henderson, 2014; Schulz, 2007).

Data from *jodi*-counterfactuals provide evidence that there is, in fact, a distinct backtracking reading for the *if*-counterfactuals above. This is because while the latter might be argued to be less prominent than the forward-tracking reading, its counterpart with *jodi* is simply unacceptable, regardless of contextual support:

(4) Law: *not-eating* $\rightarrow$ *hunger*. Context: the children refused to eat lunch earlier, and are now hungry

a. jodi ora lunch kheye thak-t-o, oder ekhon khide
   if they.CLF lunch eat.aux-IPFV.PST-3, they.GEN now hunger
   pe-t-o na
   get-IPFV.PST-3 NEG
   If they had eaten lunch, they would not be hungry now.

b. # jodi oder ekhon khide na pe-t-o, ora lunch
   # if they.GEN now hunger NEG get-IPFV.PST-3, they.CLF lunch
   kheye thak-t-o
   eat.aux-IPFV.PST-3
   Intended: If they had not been hungry now, they would have eaten lunch.

(4b) can only express the implausible meaning that the children's current hunger would somehow affect their past actions.

This pattern is not limited to temporally ordered antecedent and consequent facts: it persists even when both clauses are stative and co-temporal, highlighting that the relevant ban in *jodi* is against reversing causal dependencies (rather than temporal ordering). A modified version of the 'king Ludwig' example from Kratzer (1979) demonstrates this. Here,

ordering.

there is no temporal ordering, but the king's presence causally antecedes the flag being up. The resulting conditional patterns exactly like the example above:

(5) Law: $king \rightarrow flag$. Context: King Ludwig of Bavaria has a castle on an island. Whenever the king is in the castle, the royal flag is up. Right now, the king is not in the castle, and the flag is not up.

a. If the king was in the castle, the flag would be up.

b. If the flag was up, the king would (have to) be in the castle.

(6) Law: $king \rightarrow flag$. Context: same as above.

a. jodi raja bari-te thakto, pOtaka uRto
   if king house-LOC be.aux-IPFV.PST-3, flag fly.IPFV.PST-3
   If the king was at home, the flag would be up.

b. # jodi pOtaka uRto, raja bari-te thakto
   # if flag fly.IPFV.PST-3, king house-LOC be.aux-IPFV.PST-3
   Intended: If the flag was up, the king would be at home.

Once again, (6b) can only express the implausible meaning that the flag's position would cause the king to appear in the castle.

2.2 Evidence-source asymmetries

The backtracking examples above involve pairs of different conditionals in the same context—one in the flow of causality and one against. Another type of example that motivates the epistemic-ontic distinction in Schulz (2007) involves the same counterfactual in two minimally different contexts, one of which admits a true reading while the other does not. These contexts differ in whether a relevant fact is directly observed, or inferred from other facts via laws. I call these 'evidence-source asymmetries'. Schulz (2007) offers the following example (based on Veltman (2005)). First, consider the counterfactual below, for which there seems to be no true reading:

(7) Bed-ordinary: siblings a, b, and c share a room with a bed that is large enough to fit two. Every night, one of the kids sleeps on the floor. You go into the room and see that a is on the floor; b and c are on the bed.

If a had been on the bed, c would have been on the floor.

This is presumably because the best antecedent (a-bed) worlds include both b-floor and c-floor worlds, and therefore fail to entail c-floor. This is verified by the intuitive truth of *If a had been on the bed, b or c would have been on the floor*. But in the slightly altered context below, there is a true reading:[3]

[3] The reader can verify that this is not due to a difference in topic or Question Under Discussion (QUD; Roberts 2012) by leading with *c is on the floor, but...* for both, to ensure that c's position is what is under discussion in both cases. The difference in acceptability persists.

(8) Bed-invisible: siblings a, b, and c share a room with a bed that is large enough to fit two. c happens to be invisible. Every night, one of the kids sleeps on the floor. You go into the room and see a on the floor and b on the bed. You conclude that c is on the bed too.

If a had been on the bed, c would have been on the floor.

The only difference between the contexts is in the status of the consequent fact– while there is direct evidence for c's position in the first example (it is visible to the speaker), it is an inferred fact in the second. Schulz (2007) takes this as evidence that when c's position is inferred, altering this fact is less costly than altering b's position under some antecedent update, so that the closest a-bed worlds now entail c-floor. In her formal account, the epistemic update, but not the ontic update, is sensitive to evidence-source, predicting that only the former would produce a contrast in acceptability between (7) and 8. The ontic update, on the other hand, predicts both (7) and 8 to be false.

Once again, *jodi* systematically differs from *if*, in disallowing a true reading even in the altered context:

(9) a. Bed-ordinary: siblings a, b, c share a room with a bed large enough to fit two. Every night, one of the kids sleeps on the floor. You go into the room and see that a is on the floor; b and c are on the bed.

# jodi	a	khaT-e	hoto,	c	mejhe-te	hoto
# if	a	bed-LOC	be.IPFV.PST.3,	c	floor-LOC	be.IPFV.PST.3

Intended: If a was on the bed, c would have been on the floor.

b. Bed-invisible: siblings a, b, and c share a room with a bed that is large enough to fit two. c happens to be invisible. Every night, one of the kids sleeps on the floor. You go into the room and see a on the floor and b on the bed. You conclude that c is on the bed too.

# jodi	a	khaT-e	hoto,	c	mejhe-te	hoto
# if	a	bed-LOC	be.IPFV.PST.3,	c	floor-LOC	be.IPFV.PST.3

Intended: If a was on the bed, c would have been on the floor.

While Schulz (2007)'s formal account takes these evidence-source asymmetries to arise from the same antecedent revision operation as the backtracking readings in section 2.1, backtracking counterfactuals have generated a substantial body of research even outside the epistemic-ontic debate. Whether or not they involve the same revision operation, the data here shows that these inferences (i) pattern together under a connective in an unrelated language, suggesting that they have *some* property in common; (ii) are bonafide readings of *if*-counterfactuals that are distinct from their 'ontic' counterparts.

3 *jodi*

jodi is a two-place conditional connective which, like *if*, combines with two tensed clauses. Bangla has at least one other way of expressing counterfactual conditionals: the conditional participial *-le* (Guha, 2022; Bagchi, 2005). Since I am interested in the contrast between the connectives *if* and *jodi*, I focus on *jodi* constructions in this paper. As cross-linguistically common, counterfactual conditionals in Bangla involve specific tense-aspect morphology in both the antecedent and consequent (X-marking; von Fintel and Iatridou 2023; Iatridou 2000). Bangla has an inflectional system of tense-aspect marking with two distinct past-tense markers: perfective past (*-l-*), and imperfective past (*-t-*). The latter appears in both antecedent and consequent clauses of counterfactuals, as shown by the underlined parts below:

(10) Context: Whenever the king is in his castle, the royal flag is up (law: *king*→*flag*).

a. jodi raja bari-te thak-t-o, pOtaka uR-t-o
if king house-LOC be.aux-IPFV.PST-3, flag fly-IPFV.PST-3
If the king was at home, the flag would be up.

Finally, it is widely accepted *if*-counterfactuals implicate, but do not entail, the falsity of their antecedent. *jodi*-counterfactuals similarly signal that the antecedent is false. Like *if*, this is not an entailment, as shown by the fact that the connective can be used in a context where the status of the antecedent is under discussion, to express an informative modus tollens argument:

(11) A: Mini went to the store. B: No she didn't. A: Yes she did, since:

a. jodi o dokan-e na giye thak-t-o, tahole ekhon baRit-e thak-t-o
if she shop-LOC NEG go.aux-IPFV.PST-3, then now home-LOC be-IPFV.PST-3
If she had not gone to the store, she would be at home now (and she isn't).

4 A puzzle: compositionality and variation

Section 2 provided data to support earlier proposals that *if*-counterfactuals license (at least) two distinct readings. This raises the following question: what allows for dual readings of *if*, and what blocks one of these readings in a connective like *jodi*? The most extensive treatment of the two readings of *if* that I am aware of is Schulz (2007). Schulz attributes the two readings to different speech acts, formalized in her system as different interpretation functions at the sentential level. The focus of much of the work is to provide formally explicit definitions of these interpretation functions, treating them as instructions for updating an information state. Abstracting away from the implementation details, this understanding of the source of dual readings appears too broad. If the readings correspond to different speech acts, it is not clear why one of these should be unavailable in Bangla. This is especially so because the 'epistemic' interpretation function is proposed to correspond to the default mode of language use and involved in most declarative language. A conceptually simpler alternative is to locate the source of dual readings of counterfactuals in a part of the linguistic system that is independently known to be subject to variation.

Pertaining to the second part of the question, a recent line of work has been concerned with what might block epistemic readings in certain counterfactual conditionals. These involve so-called 'negated counterfactuals' (NCs; Henderson 2010). Below, I summarize the relevant empirical facts about NCs, showing that (i) they behave exactly like *jodi* vis-a-vis allowing ontic inferences while disallowing epistemic inferences, but (ii) *jodi* diverges from NCs in all the independent (morphosyntactic and semantic) properties that have been used to explain used to explain this absence of epistemic readings. This suggests that the unavailability of epistemic readings in counterfactuals cannot be exclusively tied to NC-specific features.

Together, these observations motivate the proposal in section 5 that the availability of dual readings must be located in the lexical semantics of the conditional connective.

4.1 Negated counterfactuals (NCs) vs *jodi*

An inferential profile very similar to *jodi* has been reported recently for another class of conditional connectives across multiple languages: 'negated counterfactuals', or NCs. In English, these involve a nominal or clausal gerund embedded under the expression *if not for*. The following is an example of an NC, along with its *if*-counterfactual counterpart:

(12) a. *NC:* If not for [Ali going to the store], we would not have salsa.
b. *if-counterfactual:* If Ali hadn't gone to the store, we would not have salsa.

Similar constructions are found in a number of languages, including Kakchikel (Mayan), Spanish, and Mandarin (Henderson, 2010; Nevins, 2002; Ippolito and Su, 2014; Yang, 2019).

Just like *jodi*, NCs encode a contrast between forward-tracking and backtracking readings, licensing the former but not the latter:

(13) Law: *not-eating* $\rightarrow$ *hunger*. Context: the children refused to eat lunch earlier, and are now hungry.
a. *Forward-tracking:* If not for them having refused lunch earlier, they would not be hungry now.
b. *Backtracking:* # If not for them being hungry now, they would (have to) have eaten lunch earlier.
Intended: If they had not been hungry now, they would (have to) have eaten lunch earlier.

Note that the backtracking inference remains unavailable even with the addition of *have to*, which has been noted to make backtracking readings more prominent in ordinary *if*-counterfactuals (Arregui, 2005; Schulz, 2007).

Moreover, just like *jodi*, NCs do not show evidence-source asymmetries— there is no true reading for the counterfactual below in either context:

(14) a. Bed-ordinary: siblings a, b, c share a room with a bed large enough to fit two. Every night, one of the kids sleeps on the floor. You go into the room and see that a is on the floor; b and c are on the bed.
If not for a being on the floor, c would be on the floor.

b. Bed-invisible: same as above, but c happens to be invisible. You see a on the floor and b on the bed. You conclude that c is on the bed too.
If not for a being on the floor, c would (have to) be on the floor.
Compare: If a has been on the bed, c would (have to) be on the floor.

NCs are morphosyntactically complex: across languages, these expressions involve a nominal embedded under negation. Unsurprisingly, existing analyses have attributed the inferential contrast between NCs and *if*-counterfactuals to these properties, either by directly invoking the syntactic properties of light negation (Ippolito and Su, 2014), or by arguing that negation triggers semantic effects that block the relevant readings. Proposals of the second kind are found in Henderson (2010, 2014), who links the morphosyntactic facts to an independent semantic property of NCs, namely that their antecedent is non-defeasibly counter-to-fact, and uses this to derive the lack of epistemic readings.

The example below demonstrates this semantic property, showing that NCs, unlike *if*, are unacceptable in contexts where the status of the antecedent is under discussion and therefore cannot express an informative modus tollens argument:

(15) A: Mini went to the store. B: No she didn't! A: Yes she did, since:
a. # If not for her having gone to the store, she would be at home now (and she isn't).
b. Compare: If she had not gone to the store, she would be at home now (and she isn't).

Finally, Yang (2019) derives the blocked backtracking readings from a proposed pragmatic property of NCs: their use is limited to 'explanation-seeking' contexts with a salient question of the form *Why* $\neg C$*?*, where C is the consequent.

The analyses above take for granted that both ontic and epistemic readings are in-principle available to the base connective (e.g. *if* in English), and are concerned with explaining how the additional material in NCs block the epistemic readings. Unlike NCs, *jodi* is a single lexical item. It neither involves overt negation nor, as section 3 shows, has the associated semantic property of entailing the falsity of its antecedent. Moreover, *jodi*-counterfactuals are not restricted to explanation-seeking contexts as defined in Yang (2019). Therefore, existing analyses of NCs cannot be imported directly to explain the *jodi* facts. Moreover, the absence of these properties in *jodi* suggests that these cannot constitute the only route to blocking epistemic readings in counterfactual constructions.

5 Proposal: selection functions

I propose that capturing the range of variation across counterfactual expressions requires a small tweak to Schulz (2007)'s core proposal: instead of assuming two globally available ways of interpreting sentences, we must locate the (un)availability of dual readings in the lexical semantics of conditional connectives, along a parameter subject to lexical variation.

Specifically, I take the two readings of counterfactuals to involve different selection functions in a Stalnakerian similarity semantics. The selection function in Stalnaker (1968) identifies, for a given base world w and antecedent A, the 'closest' A-world, where the consequent is then evaluated. I assume that this function is a contextual parameter, whose possible values can be lexically constrained by certain natural language connectives. Informally, the selection function in Stalnaker's account functions as a black box that outputs the right antecedent-world. I make a minimal extension by proposing that there are in fact multiple boxes, the inner workings of which may be spelled out in terms of existing analyses of the intended inference. This results in a modular account which can import existing formal models of ontic and epistemic inferences.

The type of variation proposed here is familiar from the Kratzerian analysis of modals: like modal flavors, selection functions come in different varieties, with the choice in any given instance of use being a function of the context. And like modal flavors, certain expressions constrain the range of values this contextual parameter can take. For example, English *might* expresses epistemic modality but cannot express root modalities, whereas *must* permits both flavors of modality. I propose that the difference between *jodi* and *if* is analogous, but involving selection functions rather than modal flavor.

This approach preserves Schulz (2007)'s insight that the two readings reflect different antecedent revisions, but also allows for the possibility of connectives like *jodi*. It predicts that the contrasts between *if*- and *jodi*-counterfactuals reflect a familiar source of variability in natural language rather than deep differences between English and Bangla. Moreover, it remains compatible with compositional analyses of negated counterfactuals, allowing other morphosyntactic material to interact with the lexical content of the base connective (which, in the case of *if*, permits both readings).

I implement this by enriching Stalnaker (1976)'s baseline system with a typology of selection functions and assuming that *jodi*, but not *if*, constrains the range of its possible values:

(16) $[\![if(A)(C)]\!]^{c,w} = 1$ iff $[\![B]\!]^{c,f(A,w)}$=1

(17) $[\![jodi(A)(C)]\!]^{c,w} = 1$ iff $\delta(f \in f_{causal})\&$ $[\![B]\!]^{c,f(A,w)}$=1, where δ is the presupposition operator (Beaver and Krahmer, 2001).

The set of selection functions is sorted into (at least) f_{causal} and $f_{epistemic}$, corresponding to the two antecedent revisions proposed in earlier work to derive ontic and epistemic readings respectively. Their exact formulation is not crucial to my proposal, provided each derives the appropriate inferences. I spell out a formulation of f_{causal} based on Schulz (2007)'s presentation of Pearl (2009)'s causal intervention semantics, which derives the right inferences for *jodi*.

The proposal builds on three independently motivated ideas: (i) similarity accounts posit selection function that map an evaluation world and antecedent to the closest antecedent-world via an ordering relation (Stalnaker, 1968); (ii) lexical items can invoke specific selection functions as part of their lexical semantics (e.g. see Cariani and Santorio 2018 on *will*); (iii) formally explicit accounts of the antecedent revisions underlying the two counterfactual readings already exist (Schulz 2007; Henderson 2014,a.o.). In addition to locating observed variability along a known parameter, this approach also aligns with recent work showing that conditional connectives can contribute lexically-specific presuppositions (Kaufmann et al., 2024), and broader cross-linguistic work showing lexical variation in conditional connectives within and across languages (Arita, 2009; Yeom, 2004).

6 Analysis

6.1 Setup

Let $\mathcal{P}$ be a set of proposition letters, and $\mathcal{L}$ its closure under conjunction and negation. For any $A, C \in \mathcal{L}$, $if(A)(C)$ and $jodi(A)(C)$ are sentences.

Sentences are evaluated in models. A model $\mathbb{M}$ is a tuple $< W, R, C >$, where W is a set of worlds. $R : W \rightarrow\ _p(W)$ is a reflexive accessibility relation, which determines for each world w $\in$ W the set of worlds w' that are visible from w.

Finally, C is a set of contexts c s.t. c = $\langle M_c, W_c, f \rangle$. M_c is a causal model for $\mathcal{P}$ (defined below), $W_c \subseteq W$ a set of worlds (the 'context set'). Informally: W_c gives the set of worlds that the conversational participants take as candidates for the actual world, and M_c represents the shared picture of causality against which the conditional is asserted. $f : \mathcal{L} \times W_C \rightarrow W$ is a selection function that maps a world w and a sentence A to a selected world w'. Intuitively, w' is the world that is 'closest' to w while making A true. The following constraints apply to f:

(18) Constraints on f
  a. Success: For all antecedents A and base worlds w, A must be true in $f(A, w)$.
  b. Strong Centering: For all antecedents A and base worlds w, if A is true in w, then $f(A, w) = w$.
  c. Absurdity: For all antecedents A and base worlds w, $f(A, w) = \lambda$ iff there is no world in R(w) at which A is true.

Absurdity using the biconditional is based on Mandelkern (2018)'s refinement of Stalnaker (1976)'s original constraint, and ensures that f can never select an A-world that is inaccessible from w.

So far, apart from the causal model in C, the system outlined above closely resembles Stalnaker (1976). To account for the empirical facts of interest, we now specify that f comes in different varieties, and enrich the structure of possible worlds by introducing causal structures (Pearl, 2009).

6.1.1 Causal structures

Following Schulz (2007)'s presentation of Pearl (2009)), a causal structure for $\mathcal{P}$ is a triple M = $\langle$B,E,F$\rangle$, such that $B \subseteq \mathcal{P}$ are background variables; $E = \mathcal{P}\ - B$ are endogenous variables; F is a function $F : E \rightarrow \mathcal{L}$ that is rooted in B. Rootedness is defined as follows:

(19) **Definition: rootedness** (Schulz, 2007, p. 141-142)
Let $\mathcal{P}$ be a finite set of proposition letters and $\mathcal{L}$ the language obtained when closing

P under negation and conjunction. Let M = ⟨B,E,F⟩ be a causal structure. We introduce a binary relation R_F on the set of atomic formula $\mathcal{P}$. $R_F(X, Y)$ holds if X occurs in $F(Y)$. Let R_F^T be the transitive closure of R_F. The R_F minimal of $Y \in \mathcal{P}$, $Min_{R_F}(Y)$, is defined as follows: $Min_{R_F}(Y) = \{X \in \mathcal{P} | \ R_F^T(X, Y) \ \& \ \neg Z \in \mathcal{P} : R_F^T(Z, X)\}$. We say that F is *rooted* in B if R_F^T is acyclic and $\forall Y \in \mathcal{P} - B$: $Min_{R_F}(Y) \subseteq B$.

Rootedness ensures that given an endogenous variable, all the variables associated with it by F, if not themselves background variables, can be traced through their F-relations back to background variables. This results in causal relations that are not cyclic: knowing the values of the background variables determines the truth value of every endogenous variable.

We now expand on what worlds are: each $w \in W$ is a tuple $< M_w, I_w >$, where M_w is a causal model for $\mathcal{P}$ and I_w an interpretation function for its background variables: I : B $\to \{0, 1\}$. Recall that a context c is a tuple $\langle W_c, M_c \rangle$. We stipulate that for all $w \in W_c$, $M_w = M_c$. That is, the context provides the initial causal structure for each world in the context set. Let us now turn to the truth conditions of simple simple sentences, and then conditionals.

6.1.2 Truth

Truth for simple sentences at a world is derived recursively as follows. For arbitrary $X, Y \in \mathcal{P}$, a context c, and a world $w \in W_c$ s.t. $w =< M, I >$; $M =< B, E, F >$:

(20) a. $[\![X]\!]^{c,w}$ = I(X), if $X \in B$
b. $[\![X]\!]^{c,w}$ = F(X), if $X \in E$
c. $[\![\neg X]\!]^{c,w} = 1$ iff $[\![X]\!]^{c,w} = 0$
d. $[\![X \wedge Y]\!]^{c,w} = 1$ iff $[\![X]\!]^{c,w} = 1$ and $[\![Y]\!]^{c,w} = 1$

Following Stalnaker (1976), the truth of a conditional at a world, and at a context, are defined as follows:

(21) For a context $c =< M_c, W_c, f >$ and world $w \in W_c$:
a. $[\![if(A)(B)]\!]^{c,w} = 1$ iff $[\![B]\!]^{c,f(A,w)} = 1$
b. $[\![if(A)(B)]\!]^{c} = 1$ iff for all $w \in W_c$, $[\![if(A)(B)]\!]^{c,w} = 1$

6.1.3 Unpacking *f*

To derive the right truth conditionals for ontic conditionals, we define one variety of selection function, f_{causal}, as encoding a Pearl (2009)-style causal intervention semantics.

(22) **Selection function for ontic counterfactuals**
Let $w =< M_w, I_w >$, where M_w is a causal model $< B, E, F >$ for $\mathcal{P}$, A a sentence of $\mathcal{L}$, and f a causal selection function ($f \in f_{causal}$). $f(A, w) =< M_{w-A}, I_w >$, where M_{w-A} = ⟨B,E,F'⟩, s.t. for all $X \in E$,
a. $F'(X) = F(X)$ if X does not occur in A
b. $F'(X) = \top$ if X is among the positive literals of A

c. $F'(X) = \perp$ if X is among the negative literals of A

While *if* is unselective for the variety of selection function, *jodi* carries a presupposition that encodes selectivity: a context c = $< W_c, M_c, f >$ is an admissible context for *jodi* only if $f \in f_{causal}$.

(23) Contrast between *if* and *jodi*:

a. $[\![if(A)(C)]\!]^{c,w} = 1$ iff $[\![B]\!]^{c,f(A,w)}$=1

b. $[\![jodi(A)(C)]\!]^{c,w} = 1$ iff $\delta(f \in f_{causal})$& $[\![B]\!]^{c,f(A,w)}$=1

6.2 Deriving the inferences with *jodi*-counterfactuals

6.2.1 Ontic conditionals

These are predicted true with *jodi*. Suppose the flag is up (*flag*) whenever the king is in the castle (*king*), and we want to evaluate the following: *jodi (king)(flag)*. This corresponds to the conditional in example (6a). Assume a context c where we have no prior beliefs about the antecedent (neither *king* nor $\neg$*king* is entailed by the context set W_c), and we take the presence of the flag to be causally determined by the presence of the king.

c = $\langle W_c, M_c \rangle$, where $M_c =< B, E, F >$. Since the conditional can only manipulate the variables in E, we assume a dummy background variable U as a causal ancestor of *king*. This does not affect the results (see Schulz (2007) for discussion). We can therefore expand M_c as follows:

$B = \{U\}, E = \{king, flag\}$, $F(king) = U, F(flag) = king$.

Since we assume nothing about the antecedent, the context set intuitively admits two kinds of worlds: those where *king* is true, and those where *king* is false. Accordingly, assume that $W_c = \{w1, w2\}$ such that

$w_1 =< M_{w1}, I_{w1} >$ where $M_{w1} = M_c; I_{w1} = \{U \rightarrow 1\}$

$w_2 =< M_{w2}, I_{w2} >$ where $M_{w2} = M_c; I_{w2} = \{U \rightarrow 0\}$

(24) $[\![jodi(king)(flag)]\!]^c = 1$

a. iff $\forall w \in W_c$, $[\![jodi(king)(f)]\!]^{c,w} = 1$

b. iff $\forall w \in W_c$, $\delta(f \in f_{causal})$& $[\![flag]\!]^{c,f(king,w)}$=1

Assuming that c is an admissible context for the sentence, we know:

(25) $f(king, w) =< M_{w-king}, I_w >$, where $M_{w-king} = \langle$B,E,F'$\rangle$, s.t. for all $X \in E$,

a. $F'(X) = F(X)$ if X does not occur in *king*

b. $F'(X) = \top$ if X is among the positive literals of *king*

c. $F'(X) = \perp$ if X is among the negative literals of *king*

Consider at each world in W_c:

(26) w1: $M_{w1-king} =< B, E, F' >$, where $F'(king) = \top, F'(flag) = F(flag) = king$

a. $[\![jodi(king)(flag)]\!]^{c,w_1} = 1$ iff $[\![flag]\!]^{c,<M_{w1-king}, I_{w1}>} = 1$

b. iff $[\![F'(flag)]\!]^{c,<M_{w1-king}, I_{w1}>} = 1$

c. iff $[\![king]\!]^{c,<M_{w1-king},I_{w1}>} = 1$

d. iff $[\![\top\,]\!]^{c,<M_{w1-king},I_{w1}>} = 1$

(27) w2: $M_{w2-king} =< B, E, F''$, where $F''(king) = \top, F''(flag) = F(king) = king$

a. $[\![jodi(king)(flag)]\!]^{c,w_2} = 1$ iff $[\![flag]\!]^{c,<M_{w2-king},I_{w2}>} = 1$

b. iff $[\![F''(flag)]\!]^{c,<M_{w2-king},I_{w2}>} = 1$

c. iff $[\![king]\!]^{c,<M_{w2-king},I_{w2}>} = 1$

d. iff $[\![\top]\!]^{c,<M_{w2-king},I_{w2}>} = 1$

(28) since for all $w \in W_c$, $[\![jodi(king)(flag)]\!]^{c,w} = 1$, $[\![jodi(king)(flag)]\!]^{c} = 1$

The conditional is true in c. It is clear that this would remain the case even if we restricted our attention to just w1 or w2 (i.e. considered a context where the antecedent was assumed to be false, or assumed to be true).

6.2.2 Backtracking conditionals

These are predicted false with *jodi*. Suppose the flag is up (*flag*) whenever the king is in the castle (*king*), and we want to evaluate the following: *jodi(king)(flag)*, as in example (6b). Assume a context c where we have no prior beliefs about the antecedent (neither *king* nor $\neg king$ is entailed by the context set W_c), and we take the presence of the flag to be causally determined by the presence of the king.

c = $\langle W_c, M_c\rangle$, where $M_c =< B, E, F >$; $B = \{king\}, E = \{flag\}$, $F(flag) = king$ (since the antecedent is already in E, a dummy background variable is not required here.)

Again, the context set intuitively admits two kinds of worlds: those where *flag* is true, and those where *flag* is false. Since the interpretation can only specify the value of the background variables, this is ensured by assuming $W_c = \{w1, w2\}$ s.t.:
$w_1 =< M_{w1}, I_{w1} >$ where $M_{w1} = M_c; I_{w1} = \{king \to 1\}$
$w_2 =< M_{w2}, I_{w2} >$ where $M_{w2} = M_c; I_{w2} = \{king \to 0\}$

(29) $[\![jodi(flag)(king)]\!]^{c} = 1$

a. iff for all $w \in W_c$, $[\![jodi(flag)(king)]\!]^{c,w} = 1$

b. iff for all $w \in W_c$, $\delta(f \in f_{causal})$& $[\![king]\!]^{c,f(flag,w)}$=1

Assuming that c is an admissible context for the sentence, we know:

(30) $f(flag, w) =< M_{w-flag}, I_w >$, where $M_{w-flag} = \langle$B,E,F'$\rangle$, s.t. for all $X \in E$,

a. $F'(X) = F(X)$ if X does not occur in *flag*

b. $F'(X) = \top$ if X is among the positive literals of *flag*

c. $F'(X) =\perp$ if X is among the negative literals of *flag*

Consider each world in W_c:

(31) w1: $M_{w1-flag} =< B, E, F' >$, where $F'(king) = F(king) = 1, F'(flag) = \top$

a. $[\![jodi(flag)(king)]\!]^{c,w_1} = 1$ iff $[\![king]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$

b. iff $[\![F'(king)]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$

(32) w2: $M_{w2-flag} =< B, E, F''$, where $F''(king) = F(king) = 0, F''(flag) = \top$

a. $[\![jodi(flag)(king)]\!]^{c,w_2} = 1$ iff $[\![king]\!]^{c,<M_{w2-flag},I_{w2}>} = 1$

b. iff $[\![F''(king)]\!]^{c,<M_{w2-flag},I_{w2}>} = 1$

c. but, $[\![F''(king)]\!]^{c,<M_{w2-flag},I_{w2}>} \neq 1$

(33) since $\neg(\forall w \in W_c,\ [\![jodi(flag)(king)]\!]^{c,w} = 1)$, $[\![jodi(flag)(king)]\!]^{c} \neq 1$

The conditional is false in c. This would remain the case even if we restricted our attention to just w2 (i.e. considered a context where the antecedent was assumed to be false). However, if we restricted our attention to w1 (considered a context where the antecedent was assumed to be true), the backtracking counterfactual would be true. This shows that when the antecedent is causally downstream, intervention has no effect, as expected: the consequent remains true if it was already true in the evaluation world, and remains false if it was false in the evaluation world.

6.2.3 Evidence-source asymmetries

Assume a situation corresponding to example (9) where a is on the floor, b and c are on the bed. However, to avoid notational confusion, let us rename our third sibling q. Translating ‘a is on the bed’ as a, ‘a is on the floor’ as $\neg a$, and so on for each kid.

We want to evaluate the following: $jodi(a)(\neg q)$. This is predicted to be false with *jodi*, just as with *if*. Since nothing in our current definition of f_{causal} makes reference to whether a fact is directly observed or merely inferred, the difference between the contexts in (9a; bed-ordinary) and (9b; bed-invisible) is not expected to affect the truth of the conditional. Therefore, we only need to make sure that the conditional comes out false in this system.

As before, assume an evaluation context c $= < W_c, M_c >$. We define M_c such that there are no salient causal connections between the positions of the different kids. For reasons that will be clear soon, we assume that all three variables are endogenous, and posit dummy background variables U_1, U_2, U_3 as their causal parents. We expand c as follows:

(34) c $= < W_c, M_c >$, where $M_c =< B, E, F >; B = \{U_1, U_2, U_3\}; E = \{a, b, q\}; F(a) = U_1, F(b) = U_2, F(q) = U_3$

The context set consists of one world, which specifies the position of each kid. Since a,b, and q are endogenous variables, this is done by manipulating the values of their causal parents. $W_c = \{w\}$, s.t. :

$w =< M_w, I_w >$ where $M_w = M_c; I_w = \{U_1 \to 0, U_2 \to 1, U_3 \to 1\}$

(35) $[\![jodi(a)(\neg\ \text{q})\ ]\!]^{c} = 1$

a. iff for all $w \in W_c$, $[\![jodi(a)(\neg\ \text{q})\ ]\!]^{c,w} = 1$

b. iff for all $w \in W_c$, $\delta(f \in f_{causal})\&\ [\![\neg q\ ]\!]^{c,f(a,w)}$=1

Assuming that c is an admissible context for the sentence, we know:

(36) $f(a, w) =< M_{w-a}, I_w >$, where $M_{w-a} = \langle$B,E,F'$\rangle$, s.t. for all $X \in E$,

a. $F'(X) = F(X)$ if X does not occur in a

b. $F'(X) = \top$ if X is among the positive literals of a

c. $F'(X) = \perp$ if X is among the negative literals of a

Evaluating at each world in W_c:

(37) w: $M_{w-a} =< B, E, F' >$, where $F'(a) = \top, F'(b) = F(b) = U_2 = 1, F'(q) = F(q) = U_3 = 1$

a. $[\![jodi(\text{a})(\neg q\ ]\!]^{c,w} = 1$ iff $[\![\neg q\ ]\!]^{c,<M_{w-a},I_w>} = 1$

b. iff $[\![\text{q}]\!]^{c,<M_{w-a},I_w>} = 0$

c. iff $[\![F'(q)]\!]^{c,<M_{w-a},I_w>} = 0$

d. But, $[\![F'(q)]\!]^{c,<M_{w-a},I_w>} = 1$

e. $\implies [\![jodi(\text{a})(\neg q)\ ]\!]^{c,w} \neq 1$

(38) since $\neg(\forall w \in W_c, [\![jodi(\text{a})(\neg q)\ ]\!]^{c,w} = 1), [\![jodi(\text{a})(\neg q)\ ]\!]^{c} \neq 1$

We have the required result, since the conditional is correctly predicated to be false. But this is intuitively the wrong reason for falsity. The antecedent update moves a to the bed, and since there is no causal connection between the variables, the other kids remain on the bed in the best antecedent world selected by f, failing to entail the consequent. However, the intuition in Veltman (2005)'s original example and Schulz (2007)'s discussion of it, is that the counterfactual fails to be true because the best a-bed worlds contain both b-floor and q-floor worlds, and therefore fail to entail q-floor. This is supported by the truth of the following counterfactual in the same context: *If a was on the bed, b or q would be on the floor.* The facts are identical for *jodi*, as the following is judged true:

(39) jodi a khaT-e hoto, b ba q mejhe-te hoto
if a bed-LOC be.IPFV.PST.3, b or q floor-LOC be.IPFV.PST.3
If a was on the bed, b or q would be on the floor.

This shows that when the antecedent update is run, we retain the fact that there can be at most two kids on the bed at any given time. To account for these facts, we need to ensure that the intervention with a does not lead us to consider worlds where there are more than two kids on the bed, even if this requires altering the values of b or q.

Intuitively, the restriction on the number of kids on the bed represents an outer limit on our reasoning– worlds outside it are simply not considered. I take this to be enforced through the accessibility relation, such that any worlds where there are more than two kids on the bed are not accessible through R. Recall that the Absurdity constraint on f (18) already posits that f cannot select worlds that are inaccessible via R : f must select an accessible antecedent-world, and when there are no accessible antecedent-worlds, f must select the absurd world λ. Below, I implement this within our definition of f_{causal}.

f creates an ordering over worlds, and selects the best world in that ordering. For f_{causal} as defined in terms of Pearl (2009), the best world is that which is obtained by performing the most local intervention with the antecedent. However, we require this world to be accessible via R. If that is not the case, we go down the ordering and select the best *accessible* world. This might necessitate an intervention that is less local, i.e. changes more facts. To implement this, we implicitly add more material to the antecedent, and run a Pearl-style intervention with the resulting sentence. Specifically, the material we add must ensure that the new world meets the criterion for accessibility via R.

Let X represent the fact that there are at most two kids on the bed: $X = (a \wedge b \wedge \neg q) \vee (a \wedge \neg b \wedge q) \vee (\neg a \wedge b \wedge q)$. We make two assumptions about the accessibility relation R:

1. For any $w \in W_c$ and $w' \in W$, $w' \in R(w)$ only if $[\![X]\!]^{c,w'}$=1.

2. For all $w, w' \in W$ s.t. $w =<< B, E, F >, I_w >$ and $w' =<< B', E', F' >, I_{w'} >$, $R(w)(w') \Longrightarrow B = B', E = E'$.
   That is, all worlds accessible from w via R are such that the partition of $\mathcal{P}$ into background and dependent variables remains invariant. This is not the only option, as one might imagine an accessibility relation that cares only about what facts are true at a world without any regard for their position in the causal structure. However, we adopt this for simplicity here.

To ensure that the antecedent update cannot result in worlds that are not accessible via R, we add X to the antecedent formula, and run the update with the resulting formula. Consider again the admissible context c, repeated below:

(40) c $= < W_c, M_c >$, where $M_c =< B, E, F >; B = \{U_1, U_2, U_3\}; E = \{a, b, q\}; F(a) = U_1, F(b) = U_2, F(q) = U_3$

(41) $W_c = \{w\}; w =< M_w, I_w >$ where $M_w = M_c; I_w = \{U_1 \rightarrow 0, U_2 \rightarrow 1, U_3 \rightarrow 1\}$

We know, $[\![jodi(a)(\neg \text{ q})]\!]^c = 1$ iff for all $w \in W_c$, $\delta(f \in f_{causal})$& $[\![\neg q]\!]^{c,f(a,w)}$=1

(42) Adding X to the antecedent, we get:
  a. $f(a, w) =< M_{w-\underline{a \wedge X}}, I_w >$
  b. $A \wedge X = a \wedge ((a \wedge b \wedge \neg q) \vee (a \wedge \neg b \wedge q) \vee (\neg a \wedge b \wedge q)) = (a \wedge b \wedge \neg q) \vee (a \wedge \neg b \wedge q)$
  c. so, $f(a, w) =< M_{w-((a \wedge b \wedge \neg c) \vee (a \wedge \neg b \wedge c))}, I_w >$

In Pearl (2009)'s baseline system, the only possible antecedents are literals and their conjunctions (Schulz, 2007). Therefore, there is no direct way to update a causal model with a disjunction. I propose that a formula of the form $[\![\text{C}]\!]^{M_{w-(A \vee B)}, I_w}$ is evaluated as follows:[4]

(43) $[\![\text{C}]\!]^{M_{w-(A \vee B)}, I_w} = 1$ iff $[\![\text{C}]\!]^{M_{w-A}, I_w} = 1$ and $[\![\text{C}]\!]^{M_{w-B}, I_w} = 1$

Intuitively, this parallels the treatment of a counterfactual of the form $if(A \vee B)(C)$ as the conjunction of the counterfactuals $if(A)(C)$ and $if(B)(C)$: we run the update separately for each disjunct, and the counterfactual is true iff both updates entail the consequent. Evaluating at w:

(44) $[\![jodi(\text{a})(\neg q)]\!]^{c,w} = 1$

[4] To avoid clutter, I drop the context parameter outside the double bracket when there is no room for confusion.

a. iff $[\![\neg q\ ]\!]^{M_{w-((a\wedge b\wedge\neg q)\vee(a\wedge\neg b\wedge q))},I_w} = 1$

b. iff $[\![\neg q\ ]\!]^{M_{w-(a\wedge b\wedge\neg q)},I_w} = 1$ and $[\![\neg q\ ]\!]^{M_{w-(a\wedge\neg b\wedge q)},I_w} = 1$ (from 43)

c. iff $[\![\mathrm{q}]\!]^{M_{w-(a\wedge b\wedge\neg q)},I_w} = 0$ and $[\![\ \mathrm{q}]\!]^{M_{w-(a\wedge\neg b\wedge q)},I_w} = 0$

d. $M_{w-(a\wedge b\wedge\neg q)} = < B, E, F' >$, where $F'(a) = \top, F'(b) = \top, F'(q) =\perp$

e. $M_{w-(a\wedge\neg b\wedge q)} = < B, E, F' >$, where $F'(a) = \top, F'(b) =\perp, F'(q) = \top$

f. $\Longrightarrow [\![\neg q\ ]\!]^{M_{w-((a\wedge b\wedge\neg q)\vee(a\wedge\neg b\wedge q))},I_w} = 1$ iff $[\![\perp\ ]\!]^{M_{w-(a\wedge b\wedge\neg q)},I_w} = 0$ and $[\![\top]\!]^{M_{w-(a\wedge\neg b\wedge q)},I_w}$ $= 0$

g. $\therefore [\![\neg q\ ]\!]^{M_{w-((a\wedge b\wedge\neg q)\vee(a\wedge\neg b\wedge q))},I_w} \neq 1$

(45) since $\neg(\forall w \in W_c,\ [\![jodi(\mathrm{a})(\neg q)\ ]\!]^{c,w} = 1)$, $[\![jodi(\mathrm{a})(\neg q)\ ]\!]^{c} \neq 1$

This derives that the counterfactual is false, for the 'right' reason: the best antecedent-worlds (all of which retain two kids on the bed) fail to entail q-bed. This can be confirmed by verifying that with these truth conditions, the counterfactual $if(a)(\neg b\ or\ \neg q)$ comes out true.

7 Nature of laws

7.1 Believe-counterfactuals and nature of causal dependencies

The previous sections have shown that *jodi* allows classic ontic inferences and disallows epistemic ones. This is moreover mirrored by 'not'-counterfactuals (NCs) across languages. Given these baseline patterns, these restricted counterfactual expressions enable us to probe the nature of the dependencies underlying ontic counterfactuals: assuming that *jodi* and NCs encode intervention in causal structures, what should these causal structures look like beyond the simple examples discussed above? I highlight a specific empirical fact about *jodi* that raises relevant questions. This pattern also extends to NCs, but as far as I am aware, none of the existing analyses of NCs discuss it.

While backtracking and evidence-source asymmetries are blocked with *jodi* and NCs, it is not impossible to express the intended meanings corresponding to these blocked inferences. An overt epistemic or doxastic modal in the consequent allows this.[5]

(46) Context: whenever the king is in the castle, the flag is up (same as 6).

a. jodi pOtaka uRto, tahole <u>bujhtam</u> je raja bari-te ache
if flag fly.IPFV.PST-3, then conclude.IPFV.PST.1 that king house-LOC, be.PRS.3
If the flag was up, we would conclude that the king is at home.

b. If not for the flag not being up, we would <u>conclude/believe</u> that the king is in the castle.

(47) Context: the children refused to eat lunch earlier and are now hungry (same as 4).

[5] I use 'epistemic' and 'doxastic' interchangeably here, to refer to a non-root modality that represents what an agent takes to be true.

a. jodi oder khide na pe-t-o, tahole <u>bujh-t-am</u>
if they.GEN hunger NEG get-IPFV.PST-3, then understand-IPFV.PST-1
lunch khey-ech-$\Phi - e$
lunch eat-PRF-PRS-3
If they were not hungry now, we would conclude that they have eaten lunch

b. If not for them being hungry now, we would <u>think/believe/conclude</u> that they have eaten lunch

(48) Evidence-source (Context: same as 9b)

a. jodi a khaT-e hoto, ami <u>bhabtam</u> je c mejhe-te ache
if a bed-LOC be.IPFV.PST.3, I think.IPFV.PST.1 that c floor-LOC be.PRS.3
If a was on the bed, I would think that c is on the floor.

b. If not for a being on the floor, I would <u>think/believe/conclude</u> that c is on the floor.

These 'believe-counterfactuals' differ minimally from the disallowed epistemic readings in (6b,4b,9b), are subject to the same contextual constraints, and mutually paraphrasable, suggesting similar truth and felicity conditions. They only differ in optionally allowing the consequent to be indexed to someone other than the speaker (*If not for x, <u>she</u> would believe that y*). In this case, the relevant laws and evidence-source are those of the attitude holder rather than the speaker. What explains the difference in acceptability between these believe-counterfactuals and the canonical epistemic readings in section 2 under *jodi* and NCs, in spite of invoking the same laws and evidence-source asymmetries?

If we accept that *jodi* and NCs are restricted to ontic inferences, which can be formalized via causal intervention, then believe-counterfactuals suggest that the relevant picture of causal dependencies must be such that our belief in a cause is treated as a downstream variable of (witnessing) its effect (for example, $king \to flag \to believe(king)$). This would correctly predict that only reasoning from *flag* to *king* involves backtracking (and is therefore unacceptable). Reasoning from *flag* to *believe(king)*, under this picture of causal laws, does not involve backtracking. Below, I sketch a minimal extension of the account along these lines that derives these facts for *jodi*.

7.2 Deriving believe-counterfactuals

I propose that for the purposes of the linguistic system, believe-counterfactuals are treated as forward-tracking readings involving our beliefs about certain facts given their position in a causal model. To express this, and allow facts about our beliefs to participate in causal relations, we extend the set of propositional letters:

(49) **Extended language:** Let $\mathcal{P}$ be a set of proposition letters and $\mathcal{P}^+$ extend it such that for all $\phi \in \mathcal{P}$, $b.\phi$ and $b.\neg\phi$ are sentences, read as *believe* ϕ and *believe* $\neg\phi$ respectively. $\mathcal{L}$ is the closure of $\mathcal{P}^+$ under conjunction and negation. Finally: for $A, C \in \mathcal{L}$, $if(A)(C)$ and $jodi(A)(C)$ are sentences.

No other changes are required, except that we now consider causal models for $\mathcal{P}^+$ rather than $\mathcal{P}$.

Consider the counterfactual in (46), translated as $jodi(flag)(b.king)$. Assume a context where we have no prior beliefs about the antecedent, and take the presence of the flag to be causally determined by the presence of the king. In addition, assume two variables *b.king, b.flag* representing our belief in the king's presence and the flag's being up respectively. We will consider a context where the presence or absence of the flag is always known to us, by assuming a causal law that determines *b.flag* based on *flag*:

c $= \langle W_c, M_c \rangle$; $M_c =< B, E, F >$, where $B = \{king\}, E = \{flag, b.flag, b.king\}$; $F(flag) = king, F(b.flag) = flag, F(b.king) = b.flag$.

Since we assume nothing about the antecedent, the context set intuitively admits two kinds of worlds: those where *flag* is true, and those where *flag* is false. To ensure this, assume that $W_c = \{w1, w2\}$ s.t.:
$w_1 =< M_{w1}, I_{w1} >$ where $M_{w1} = M_c; I_{w1} = \{king \to 1\}$
$w_2 =< M_{w2}, I_{w2} >$ where $M_{w2} = M_c; I_{w2} = \{king \to 0\}$

$[\![jodi(flag)(b.king)]\!]^c = 1$ iff for all $w \in W_c$, $\delta(f \in f_{causal})$& $[\![b.king]\!]^{c,f(flag,w)}$=1

Assuming that c is an admissible context for the sentence, we know:

(50) $f(flag, w) =< M_{w-flag}, I_w >$, where $M_{w-flag} = \langle$B,E,F'$\rangle$, s.t. for all $X \in E$,
  a. $F'(X) = F(X)$ if X does not occur in *flag*
  b. $F'(X) = \top$ if X is among the positive literals of *flag*
  c. $F'(X) =\perp$ if X is among the negative literals of *flag*

Consider each world in W_c:

(51) w1: $M_{w1-flag} =< B, E, F' >$, where $F'(flag) = \top, F'(b.flag) = flag, F'(b.king) = b.flag$
  a. $[\![jodi(flag)(b.king)]\!]^{c,<M_{w1},I_{w1}>} = 1$ iff $[\![b.king]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$
  b. iff $[\![F'(b.king)]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$
  c. iff $[\![F'(flag)]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$
  d. iff $[\![\top]\!]^{c,<M_{w1-flag},I_{w1}>} = 1$

(52) w2: $M_{w2-flag} =< B, E, F''$, where $F''(flag) = \top, F''(b.flag) = flag, F''(b.king) = b.flag$
  a. $[\![jodi(flag)(b.king)]\!]^{c,<M_{w2},I_{w2}>} = 1$ iff $[\![b.king]\!]^{M_{w2-flag},I_{w2}} = 1$
  b. iff $[\![F''(b.king)]\!]^{c,<M_{w2-flag},I_{w2}>} = 1$
  c. iff $[\![F'(flag)]\!]^{c,<M_{w2-flag},I_{w2}>} = 1$
  d. iff $[\![\top]\!]^{c,<M_{w2-flag},I_{w2}>} = 1$

(53) since for all $w \in W_c$, $[\![jodi(flag)(b.king)]\!]^{c,w} = 1$, $[\![jodi(flag)(b.king)]\!]^c = 1$

The conditional is true in c. Once again, it is clear that this would remain the case no matter our starting assumption about the truth of the antecedent.

8 Conclusion

I have argued in favor of proposals positing distinct 'ontic' and 'epistemic' readings of *if*-counterfactuals based on new data from the Bangla conditional connective *jodi*, which shows that these two classes of inferences pattern differently under an unrelated connective. While *jodi* freely licenses ontic, it systematically excludes precisely those readings that have been labeled as 'epistemic' in Schulz (2007). This suggests that the inferences form linguistically-relevant natural classes that are tracked by the grammar. This raises two questions: what is the source of the dual readings of counterfactuals, and why is one of them unavailable with *jodi*?

An existing account of the first question in Schulz (2007) is not easily reconciled with the newly observed cross-linguistic variation. On the other hand, some recent accounts of blocked epistemic readings, based on 'negated counterfactuals' (NCs; Henderson 2010; Ippolito 2003; Yang 2019), rely on morphosyntatic properties that are not shared by *jodi*. I argued that to derive the observed variation, the potential for dual readings must be located in the lexical semantics of the conditional connective. The readings differ in which facts are held fixed during antecedent revision, corresponding to different selection functions in a Stalnakerian similarity semantics. *jodi*, but not *if*, constrains the range of its admissible values through presupposition.

To implement this, I enriched Stalnaker (1976)'s system with a typology of selection functions that includes at least f_{causal} and $f_{epistemic}$, corresponding to distinct antecedent revisions proposed for for ontic and epistemic inferences in earlier work. I then defined f_{causal} using Pearl (2009)'s causal intervention semantics, which derives the right inferences for *jodi*. Finally, I discussed a new data-point showing that counterfactuals with overt doxastic modals in the consequent, which are near-paraphrases of the disallowed epistemic readings, are nonetheless acceptable with both *jodi* and NCs, suggesting that the relevant causal dependencies underlying these constructions involve facts pertaining to our beliefs.

Beyond introducing new empirical data from Bangla to address a longstanding debate about dual readings of counterfactuals, the close parallel between *jodi* and NCs suggests that similar inferential profiles can arise from distinct sources (e.g. lexical constraints vs added morphosyntactic material), raising questions about the compositional implementation of dual readings. Finally, it is well-known that ontic inferences of *if*-counterfactuals are much more prominent than epistemic inferences. *jodi* and NCs show that natural languages may in fact have specialized devices to express the former, to the exclusion of the latter. This prompts us to ask why such an asymmetry should exist in the encoding of counterfactual reasoning in natural language. More broadly, the results support a view on which observed variability in the interpretation of conditionals is located in the lexical semantics of conditional connectives, aligning with recent cross-linguistic work (Arita, 2009; Yeom, 2004; Kaufmann et al., 2024).

Abbreviations

1 first person

3	third person
CLF	classifier
GEN	genitive
IPFV	imperfective
LOC	locative
NEG	negative
PRF	perfect
PRS	present
PST	past

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