

# Factual Conditionals and Hypothetical Commitments

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# Abstract

A very general intuition about conditionals is that they ask us to consider their consequents in light of their antecedents. Different theories cash out this intuition in different ways, but one common assumption is that an agent parsing a conditional must consider only the ways in which the antecedent affects the information and issues present in discourse. In this thesis, I argue that one must also consider the conventional discourse effects brought about by its antecedent.

My central argument comes from the contrast between ‘if so’ and ‘if yes’. While the former can occur felicitously as a response either to a question or to an assertion, the latter can only occur in response to a question. This restriction cannot arise from constraints on informational or inquisitive content, since ‘so’ and ‘yes’ have the same content when they are anaphoric to the same proposition. Rather, it must arise from the fact that ‘yes’ commits its speaker to its anaphoric antecedent on the basis of their private inquisitive-evidentiary state (i.e. it creates a *self-sourced commitment*), while ‘so’ creates a commitment based exclusively on testimony (i.e. a *dependent commitment*). Therefore, this contrast motivates a treatment of conditionals which is sensitive to these kinds of discourse-level distinctions.

To explain this data, I propose a stack-based analysis of conditionals in which an ‘if so’ conditional creates a temporary hypothetical context where the speaker has a dependent commitment, while ‘if yes’ creates a hypothetical context where the speaker has a self-sourced commitment. I show that this analysis can help us make sense of *factual conditionals*, an otherwise mysterious class of conditionals whose antecedents echo a previous utterance.

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All errors are the fault of one person and one person only. Don't pretend you don't know who you are.

# Notational and Terminological Conventions

In this thesis, I use standard notation and terminology wherever possible and provide explicit definitions wherever there is no standard to rely on. However, there are several notational and terminological conventions which it might help my reader to know. These are listed below.

- I use lowercase letters  $p, q, r$  to denote *atomic formulas*.
- I use lowercase letters  $s, t, u$  to denote *classical propositions*, which I also refer to as *information states*.
- I use capital letters  $P, Q, R$  to denote *inquisitive propositions*.
- I use potentially subscripted  $w$ 's, to denote *possible worlds*.
- *Stacks* can be notated as a single tuple  $\langle a, b, c, d, \dots \rangle$  or as nested tuples  $\langle a, \langle b, \langle c, \langle d, \dots \rangle \rangle \rangle \rangle$ . I use the former convention by default but occasionally use the latter where it keeps notation simpler.
- Where not otherwise specified, the term *proposition* refers to an inquisitive proposition and not a classical proposition.
- Since this thesis concerns both anaphora and conditionals, the term “antecedent” on its own can cause confusion. Where possible, I will specify *anaphoric antecedent* or *antecedent of a conditional*.
- In the text, I say that  $\varphi$  *entails*  $\psi$  when  $\llbracket \varphi \rrbracket \subseteq \llbracket \psi \rrbracket$  and also that  $P$  *entails*  $Q$  when  $P \subseteq Q$ . These notions are adopted from  $\text{InqB}$  and are therefore only defined on contents. There is currently no suitable notion of entailment for the full language of the stack model.

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# 1. Introduction

A very general intuition about conditionals is that they ask us to consider their consequents in light of their antecedents. This intuition is found explicitly in accounts that build on the Ramsey Test, but is also subtly present in most other frameworks. But what does it mean to consider the consequent in light of the antecedent? A common view holds that it is fundamentally about informational content. To evaluate a conditional, you add the informational content of the antecedent to your background information and then check if the resulting body of information implies the informational content of the consequent. This view is made as a simplifying assumption in much of the literature, but it is easy to see that it is not the whole story. For instance, consider the consequents of the conditionals shown in (1).

- (1) a. If Saúl comes to the party, will it be fun? (conditional question)
- b. If Ian is here, bring him to me! (conditional imperative)

Each of these examples shows that conditionals can care about something more than raw informational content. Rather, they must be sensitive to inquisitive content and imperative content. This fact has been the focus of a lot of recent work, such as Isaacs and Rawlins (2008) and Kaufmann and Schwager (2009). Moreover, closer examination of other examples shows that conditionals can be sensitive to non-informational content not just in their consequents but also in their antecedents. For instance, Alonso-Ovalle (2009) and Ciardelli (2016) among others have shown that the antecedents of conditionals like the one in (2a) must have the same content as an alternative question in order to explain the validity of the inference from (2a) to (2b) and (2c).

- (2) a. If Saúl or Morwenna comes to the party, it will be fun.
- b.  $\rightsquigarrow$  If Saúl comes to the party, it will be fun.
- c.  $\rightsquigarrow$  If Morwenna comes to the party, it will be fun

In a nutshell, recent work on conditionals has shown that they manipulate kinds of content other than just informational content. However, expressions of natural language can do more than just convey content. Many of them bring about *discourse effects* which are at least in some cases conventional and thus potentially attributable to the semantic component of the grammar. To see how this is so, consider the following example adapted from Gunlogson (2008).

- (3) Dean: Today is Zhuoye's birthday.
- a. Saúl: Yes, I knew that!
  - b. Saúl: #Oh, I knew that!
  - c. Saúl: #Yes, I didn't know that!
  - d. Saúl: Oh, I didn't know that!

Example (3) shows that 'oh' and 'yes' are sensitive to different kinds of discourse commitments. While 'yes' commits Saúl to its antecedent proposition on the basis of his own evidence, 'oh!' commits him to its antecedent proposition on the basis of him taking Dean's word for it. Crucially, this is not a difference in content. In both cases, Saúl accepts a commitment to the content of Dean's utterance. The difference lies only in what *kind* of commitment Saúl accepts.

In this thesis, I argue that considering the consequent in light of the antecedent is not just a matter of content but in fact a matter of sum total discourse effects. Our central data will involve contrasts like the one between (4) and (5).

- (4) CONTEXT: A and B are discussing a recently passed law. B has heard conflicting reports about the content of this law, but knows that unconstitutional laws are always repealed in this country.
- a. A: Does this law run afoul of the sixth amendment?  
B: If **so**, then it will be repealed!
  - b. A: This law runs afoul of the sixth amendment!  
B: If **so**, then it will be repealed!
- (5)
- a. A: Does this law run afoul of the sixth amendment?  
B: If **yes**, then it will be repealed!
  - b. A: This law runs afoul of the sixth amendment!  
B: #If **yes**, then it will be repealed!

In (4) we see that we can use an ‘if so’ conditional as a reply either to a question or to an assertion. On the other hand, (5) shows that an ‘if yes’ conditional can only be used as a reply to a question. Since ‘so’ and ‘yes’ have the same content in each of these four sentences, this contrast shows that the difference in acceptability arises solely from conventional discourse effects and not from differences in content. Ergo, conditionals must be sensitive to discourse effects and not just content.

## 2. Background

This chapter gives an overview of the main ideas on which the present work builds. In Section 2.1, I give a brief introduction to *inquisitive semantics*, a framework which will provide our notion of semantic content. In Section 2.2, I present the model of conversational scorekeeping proposed by Farkas and Bruce (2010) and elaborated by Roelofsen and Farkas (2015), which allows us to track fine-grained discourse information. Finally, in Section 2.3, I introduce the *stack model* of Kaufmann (2000) and Hara and Sano (2017), a slightly unusual framework for analyzing conditionals which interfaces very nicely with the other frameworks I adopt. These sections are written in a modular manner, so a reader who is already familiar with the ideas presented in one can easily skip to the next.

### 2.1 Inquisitive semantics

In this thesis, my notion of content will be that supplied by *inquisitive semantics*. Inquisitive semantics is a formal framework which integrates informational and inquisitive aspects of meaning into a single notion of propositionhood. In particular, it associates sentences with semantic objects which capture both the information they convey and the issues they raise. For my purposes in this thesis, the essential notion from this framework is that of an *inquisitive proposition*, defined in Definition 1.

**Definition 1** (Inquisitive propositions).

- An *information state* (alternately a *classical proposition*) is a set of possible worlds.
- An *inquisitive proposition* is a nonempty downward closed set of information states.

Inquisitive propositions encode informational content via the region of logical space which their information states cover. For instance, consider a simple

inquisitive proposition which contains only a singleton information state  $\{w\}$  and the empty set  $\emptyset$ . This inquisitive proposition conveys the information that the actual world must be  $w$ . In this respect, inquisitive propositions aren't very different from classical propositions, which also convey information by carving out a region of logical space. However, inquisitive propositions differ from classical ones in that they also convey inquisitive content by offering different avenues which one can take in refining their information. These avenues are provided by the maximal information states of an inquisitive proposition, which we call its *alternatives*. An inquisitive proposition can be thought of as raising the issue of which of its alternatives contains the actual world.

**Definition 2** (Alternatives). Let  $P$  be an inquisitive proposition. Then  $s$  is an *alternative* of  $P$  iff  $s$  is a maximal element of  $P$ .

To see how inquisitive propositions work, let's look at two brief examples. Consider the inquisitive proposition  $P$  which contains two singleton information states  $\{w_1\}$  and  $\{w_2\}$ , as well as the empty set  $\emptyset$ .  $P$  conveys the information that the actual world must either be  $w_1$  or  $w_2$ , but it also raises the issue of which of those two ways the world actually is. Contrast this with the inquisitive proposition  $Q$  which consists of the information state  $\{w_1, w_2\}$  and all of its subsets. This inquisitive proposition conveys the same informational content as  $P$ , but it differs in its inquisitive content. Since  $Q$  contains only a single maximal information state, it offers only a single avenue for refining its information, and therefore doesn't raise any non-trivial issues. We can isolate the informational content of an inquisitive proposition by pooling its constituent information states as shown below.

**Definition 3** (Informational content).

- The *informational content* of an inquisitive proposition  $P$  is  $\text{info}(P) = \{w \mid w \in t \text{ for some } t \in P\}$ .
- We will sometimes overload notation by writing  $\text{info}(\varphi)$  where we technically mean  $\text{info}(\llbracket\varphi\rrbracket)$ .

We will make use of inquisitive propositions in order to interpret a basic propositional language  $\mathcal{L}$ .

**Definition 4** (The basic propositional language  $\mathcal{L}$ ).

$$\varphi ::= p \mid \neg\varphi \mid \varphi \wedge \varphi \mid \varphi \vee \varphi$$

Since the set of inquisitive propositions ordered by the subset relation forms a Heyting algebra, we can use the inventory of basic algebraic operations as the basis of our semantics. For instance, for every proposition  $P$  we have a relative pseudocomplement  $P^*$  which amounts to  $\{s \subseteq W \mid s \cap t = \emptyset \text{ for all } t \in \llbracket \varphi \rrbracket\}$ . Similarly, for any propositions  $P$  and  $Q$  we have a meet and a join which amount to  $P \cap Q$  and  $P \cup Q$  respectively. Thus, following the model of Ciardelli et al. (2017), we can assign inquisitive propositions to formulas of  $\mathcal{L}$  as shown in Definition 5.

**Definition 5** (Semantics of propositional InqB). Given a model  $\mathfrak{M} = \langle W, V \rangle$  where  $W$  is a set of possible worlds and  $V$  is a valuation function:

- $\llbracket p \rrbracket = \{s \subseteq W \mid \forall w \in s, V(w, p) = 1\}$
- $\llbracket \neg \varphi \rrbracket = \llbracket \varphi \rrbracket^* = \{s \subseteq W \mid s \cap t = \emptyset \text{ for all } t \in \llbracket \varphi \rrbracket\}$
- $\llbracket \varphi \wedge \psi \rrbracket = \llbracket \varphi \rrbracket \cap \llbracket \psi \rrbracket$
- $\llbracket \varphi \vee \psi \rrbracket = \llbracket \varphi \rrbracket \cup \llbracket \psi \rrbracket$

We will also use the operators  $!$  and  $?$  as abbreviations in the manner shown in Definition 6.

**Definition 6** (Abbreviations for InqB).

- $!\varphi \equiv \neg \neg \varphi$
- $?\varphi \equiv \varphi \vee \neg \varphi$

Conceptually, the  $!$ -operator can be thought of as cancelling the issues raised by whatever it applies to while leaving its informational content untouched. For any formula  $\varphi$ , the inquisitive proposition  $\llbracket !\varphi \rrbracket$  expresses the same information as  $\llbracket \varphi \rrbracket$ , but it may differ in that it raises no nontrivial issues. For example, if  $\llbracket \varphi \rrbracket$  is the inquisitive proposition  $P$  from a few paragraphs ago, then  $\llbracket !\varphi \rrbracket$  is the inquisitive proposition  $Q$  from that same paragraph.

The  $?$ -operator trivializes the information expressed by whatever it applies to, while converting information states which would establish that its issues are unresolvable into states which resolve it. This is very abstract, so let's consider another example. Imagine that logical space consists of four possible worlds,  $w_1$ ,  $w_2$ ,  $w_3$ , and  $w_4$ , and consider a formula  $\varphi$  such that  $\llbracket \varphi \rrbracket$  contains  $\{w_1\}$ ,  $\{w_2\}$ , and of course  $\emptyset$ . This proposition conveys that the actual world is either  $w_1$  or  $w_2$  and raises the issue of which of those worlds it actually is. Therefore, the issue it raises would not be resolved if we learned

that the actual world is in the information state  $\{w_3, w_4\}$ . Rather, learning this would show that the issue raised by our toy proposition is unresolvable. As a result, the proposition  $[[?\varphi]]$  contains all the states of  $[[\varphi]]$ , along with  $\{w_3, w_4\}$  and all of its subsets.<sup>1</sup>

In this section, I have laid out the essentials of what inquisitive propositions are, how they encode both issues and information, and how we can use them to interpret a basic propositional language. This is enough to give us the notion of content that I will use in the coming sections. There is much more that can be said about inquisitive semantics, but for that I refer readers to Ciardelli et al. (2017).

## 2.2 Scorekeeping commitments

In discourse, we keep track of various pieces of information which define the current state of the conversation. For instance, if two people are talking, and one believes they are discussing Lay’s brand potato chips while the other believes they are discussing a person named Laïs, there is a sense in which they are not having the same conversation. That is because knowing what you are discussing is one essential piece of knowing what conversation you’re having.

Since Lewis (1979), various systems have been proposed to model how agents represent and update a conversational *scoreboard* of discourse information. In this section, I present the basics of the commitment-based discourse model proposed by Farkas and Bruce (2010) and subsequently extended by Roelofsen and Farkas (2015). While there are alternatives to this system, I adopt it in the forthcoming chapters for two reasons. First, it interfaces very nicely with inquisitive semantics, both in its conceptual spirit and in its technical details. Second, it provides elegant accounts for phenomena such as polarity particles and propositional anaphora which will play a large role in later chapters.

### 2.2.1 Scorekeeping

At its core, a discourse context is just a list of the information which you know when you know the actual state of a conversation at a given point in

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<sup>1</sup>The idea here that the  $?$ -operator should preserve as much of its complement’s inquisitiveness as possible while trivializing its informational content. It cannot perfectly preserve inquisitive content, since trivializing informational content necessarily alters inquisitive content.

time. In the model of Roelofsen and Farkas (2015), we take this list to be as shown in Definition 7.

**Definition 7.** A context  $C$  is a tuple  $\langle \text{participants}, \text{table}, \text{drefs}, \text{commitments} \rangle$  where:

- **participants** is a set of discourse participants.
- **commitments** is a function mapping each  $a \in \text{participants}$  to the set of classical propositions to which  $a$  is committed.
- **table** is a stack of inquisitive propositions which have been offered as proposals.
- **drefs** is a stack of pairs of classical propositions which are available as propositional discourse referents.

The rationale for the set **participants** is easy to see. Knowing which discourse context you are in requires knowing who is a member of the conversation. While participants may come and go from a conversation, Roelofsen and Farkas (2015) assume that linguistic utterances alone cannot update this particular aspect of our discourse contexts.

The function **commitments** models the fact that the informational content of an agent’s assertion doesn’t just disappear into the ether, but rather remains in memory, where it contributes to a (partial and potentially fictive) picture of its speaker’s private evidentiary state. For instance, if someone says ‘Ian just shaved his beard entirely off’, it would be infelicitous for them to immediately afterwards say ‘Ian has a beard’. Someone who makes both of these utterances is either not speaking in good faith or else has a contradictory state of mind. Hence to keep a conversational record of what agents have publicly signaled about their private mental states, we need a function like **commitments** which is updated by any information-carrying utterance.<sup>2</sup>

The **table**, on the other hand, models the fact that utterances in dialogue can be seen as proposals for the other participants to refine their informational commitments in particular ways. For instance, if someone says ‘Ian is drunk’ this utterance can be seen as a proposal for everyone else in the conversation to accept the information that Ian is drunk. On the other hand, if someone asks the polar question ‘Is Ian drunk?’ their utterance can be

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<sup>2</sup>Roelofsen and Farkas (2015) crucially understand commitments as attitudes taken towards pieces of information, but not to issues. We will reconsider this assumption in Chapter 3.

seen as a proposal for everyone to refine their informational commitments by either accepting that Ian is drunk or by accepting that he is not. We model this by including a table as part of our discourse contexts which serves as a repository for the inquisitive and informational content of each utterance which is made.

Finally, Roelofsen and Farkas’s (2015) system includes the stack *drefs* to model the fact that later utterances can often target earlier ones via propositional anaphora. This stack differs from the table in several crucial ways. First, the items it lists are classical propositions (i.e. information states) rather than inquisitive propositions. This is because the referents of propositional anaphors seem to be the possibilities made salient by an antecedent inquisitive proposition rather than the inquisitive proposition itself. For instance, consider the dialogue in (1).

- (1) A: Is Saúl coming to the party?  
 B: Yes!

In this example, B’s utterance of the polarity particle ‘yes’ does not endorse A’s question, but rather the positive answer to it. Thus, no inquisitiveness seems to rear its head as far as these kinds of dialogues go, and so classical propositions will suffice in our effort to explain them.<sup>3</sup>

A second novelty of the way Roelofsen and Farkas (2015) define *drefs* is that it is not merely a list of classical propositions, but is rather a tuple of pairs of sets of classical propositions. Thus, an example of a set *drefs* could be something like  $\langle\langle\{s, t\}, \{r\}\rangle, \langle\{m\}, \emptyset\rangle, \langle\emptyset, \{n\}\rangle\rangle$ . This extra structure allows us to track both the salience of a given classical propositional discourse referent and its *polarity*. A discourse referent is more salient than another to the extent that it lives in a pair further to the left. Thus, in this example, *s*, *t*, and *r* are equally salient, but are all more salient than *m*, which is more salient than *n*. The polarity of a classical proposition can be thought of as the quality which makes it feel positive or negative, and is captured in the structure of *drefs* by whether it is an element of the right or left set inside a pair. Thus, in our example, *s*, *t*, and *m* have positive polarity, while *r* and *n* all have negative polarity.

To see why we must track the polarity of highlighted classical propositions, consider the two possible dialogues in (2).

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<sup>3</sup>There is also a less salient reading of this example where B signals that they approve of A’s question. Roelofsen and Farkas do not capture this reading, but one could potentially capture it by having *drefs* contain pairs of inquisitive propositions and claiming that interrogatives highlight both themselves and the inquisitive proposition whose informational content is their positive answer and which raises no nontrivial issues.

- (2) a. A: Is Saúl not coming to the party?  
 B: No, he isn't coming.
- b. A: Is Saúl not coming to the party?  
 B: No, he IS coming.

In this example, we see that B can use the word ‘no’ to mean two exactly opposite things. How can this be? Roelofsen and Farkas (2015) explain this fact by arguing that ‘yes’ and ‘no’ are ambiguous between one meaning which (dis)agrees with the informational content of a highlighted proposition and another which (dis)agrees with its polarity. For instance, ‘no’ can either confirm a highlighted proposition of negative polarity as in (2a) or deny a highlighted proposition as of any polarity as in (2b). On the other hand, the particle ‘yes’ can either confirm a highlighted proposition of any polarity or deny a negatively highlighted proposition. In order to cash this analysis out formally, we need a way of scorekeeping propositional discourse referents along with their highlights, which is exactly what `drefs` does.

In order to specify exactly which classical propositions a formula of `InqB` highlights and what polarity each highlighted proposition has, Roelofsen and Farkas posit a function  $\llbracket \cdot \rrbracket^\pm$  which is defined recursively as shown in Definition 8. An utterance of  $\varphi$  updates `drefs` by adding  $\llbracket \varphi \rrbracket^\pm$  as its new leftmost element.

**Definition 8** (Highlights for `InqB`).

- $\llbracket p \rrbracket^\pm = \langle \{\text{info}(\llbracket p \rrbracket)\}, \emptyset \rangle$
- $\llbracket \neg \varphi \rrbracket^\pm = \langle \emptyset, \{\cup \llbracket \varphi \rrbracket^\pm\} \rangle$
- $\llbracket \varphi \vee \psi \rrbracket^\pm = \llbracket \varphi \rrbracket^\pm \cup \llbracket \psi \rrbracket^\pm$
- $\llbracket !\varphi \rrbracket^\pm = \llbracket ?\varphi \rrbracket^\pm = \begin{cases} \langle \emptyset, \{\alpha\} \rangle & \text{if } \llbracket \varphi \rrbracket^\pm = \langle \emptyset, \{\alpha\} \rangle \\ \langle \{\cup \llbracket \varphi \rrbracket^\pm\}, \emptyset \rangle & \text{otherwise} \end{cases}$

In this section, I have provided the basic formalisms we will need to understand discourse contexts. In particular, I introduced a system which provides an off-the-shelf analysis for polarity particles such as ‘yes’ and ‘no’. In the next section, we will look a little more closely at commitments.

### 2.2.2 Commitments

In the previous subsection, we saw a model of discourse where all commitments are of the same kind. In that model, you’re either committed to a

classical proposition  $s$  or you're not, and there's nothing more to say about it. However, Gunlogson (2008) shows that commitments are not all of the same kind. For example, consider the examples in (3).

- (3) a. Dean: Today is Zhuoye's birthday.  
Saúl: Yes, I knew that!
- b. Dean: Today is Zhuoye's birthday.  
Saúl: Oh, I didn't know that!

In each of these examples, Saúl accepts a commitment to the content of Dean's assertion. Yet, he signals something different about the basis for his commitment in each of these examples. In (3a), Saúl commits on the basis of his own independent evidence, whereas in (3b) he commits because he is willing to take Dean's word for it. This distinction is expressed not simply in his explicit descriptions of his prior knowledge, but is in fact grammaticalized as part of the meaning of the response particles 'yes' and 'oh'. To see that this is so, consider the infelicitous alternative responses in (4).

- (4) a. Saúl: #Oh, I knew that!  
b. Saúl: #Yes, I didn't know that!

From examples like this, Gunlogson argues that 'oh' and 'yes' can serve as diagnostics for two distinct kinds of commitments. First, we have *self-sourced commitments* which are made on the basis of first-hand experience. Then we also have *dependent commitments* which are made on the basis of another agent's testimony. To explain this distinction, Gunlogson argues that we scorekeep these kinds of commitments separately. Thus, in her model, a commitment structure for an agent doesn't just track a single list of commitments but rather tracks a list of total commitments as well as a list of self-sourced commitments.

Gunlogson makes two crucial assumptions about how commitments are sourced. First, she assumes that an agent is only a source for a classical proposition relative to a particular conversation. If Lizzy informs me that Austin is the capital of Texas and I report this fact to Floris in a later conversation, my commitment to this fact is a dependent one in my conversation with Lizzy, but is self-sourced in my conversation with Floris. This is despite the fact that my evidence for this proposition has not changed. Second, Gunlogson proposes the *Source Principle* which states that if anybody in a conversation is committed to a proposition, then somebody in the conversation must be committed to it as source. Thus, in Gunlogson's system,

we can never have a conversation where everybody accepts a proposition dependently.

## 2.3 The stack approach to conditionals

In this section, I present the *stack model* of conditionals, which was originally proposed by Kaufmann (2000). This model diverges from other approaches to conditionals in that it assimilates them to a more general notion of hypothetical discourse. However, in doing so it provides elegant analyses of phenomena such as modal subordination (Kaufmann, 2000) and conditional questions (Isaacs and Rawlins, 2008; Hara and Sano, 2017).

The essence of the stack model can be summarized in two claims. First, an ‘if’-clause creates a hypothetical context which lingers until it is *popped*. Second, utterances which are made before the hypothetical context is popped update it while also *percolating* some information from it down to other contexts. To see how this works formally, we will start with Definition 9.<sup>4</sup>

**Definition 9** (Scorekeeping in the stack model).

- An *inquisitive context* is an inquisitive proposition  $C$ .
- A *macro-context*  $\tau$  is a stack (i.e. a tuple) of inquisitive contexts  $\langle C_0, \dots, C_n \rangle$ .

The top context  $C_0$  of a macro-context is called the *active context*, while the bottom state  $C_n$  is called the *main context*. The active context contains the information and issues which are live in the present moment of the conversation, while the main context contains only the actual and enduring information. For instance, if we have supposed that it is raining outside, this information is present in  $C_0$  but not in  $C_n$ .

The inquisitive stack approach adopts  $\text{InqB}$  to supply its notion of content. However, for the system to do anything interesting it needs to be made

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<sup>4</sup>In my presentation of the stack model, I follow the version proposed by Hara and Sano (2017). The various formulations of the stack model differ most substantively in what they take contexts to consist of. Kaufmann (2000) takes them to be classical Stalnakerian (1978) context sets, while Isaacs and Rawlins (2008) take them to be equivalence relations on classical context sets, and Hara and Sano (2017) take them to be inquisitive context sets. I follow Hara and Sano since their approach replicates Kaufmann’s crucial results and expands upon the results of Isaacs and Rawlins. As we will see in later chapters, the insights of the stack model can in theory be extended to richer notions of what a context is.

dynamic. Thus, we will define updates using simple intersection.<sup>5</sup>

**Definition 10** (Intersective update).  $C[\varphi] = C \cap \llbracket \varphi \rrbracket$

Plugging this definition into our semantics for  $\text{InqB}$  from Definition 5 spawns the intersective inquisitive update semantics  $\text{InqU}$  as defined in Definition 11.

**Definition 11** (Semantics of  $\text{InqU}$ ).

- $C[p] = \{t \in C \mid \forall w \in t, V(w, p) = 1\}$
- $C[\neg\varphi] = C[\neg\varphi] = C \cap (C[\varphi])^* = \{s \in C \mid s \cap t = \emptyset \text{ for all } t \in \llbracket \varphi \rrbracket\}$
- $C[\varphi \wedge \psi] = C[\varphi] \cap C[\psi]$
- $C[\varphi \vee \psi] = C[\varphi] \cup C[\psi]$
- $C[?\varphi] = C[\varphi \vee \neg\varphi]$
- $C[!\varphi] = C[\neg\neg\varphi]$

The next notion we will need in order to see how the stack model works as a theory of conditionals is that of *percolation*. The idea behind percolation is that learning in one context can tell you something about a different one. For instance, imagine that I haven't decided whether I am going to host a party tonight but you believe that I have and therefore RSVP. In this case, my learning that you will come to the party in the fictitious context where a party is certain to happen tells me something in the actual context, namely that I should expect your presence in the case that the party does occur. The formal definition of percolation is given in Definition 12.

**Definition 12** (Percolation). The result of percolating  $\varphi \in \mathcal{L}$  from  $C'$  to  $C$  is the context  $C[C' \uparrow \varphi]$ , which is defined as follows:

$$C[C' \uparrow \varphi] = \{s \in C \mid \text{for all } t \subseteq s, t \not\subseteq C' \text{ or } t \in C'[\varphi]\}$$

This definition tells us that learning in  $C$  that  $\varphi$  has been learned in  $C'$  involves eliminating from  $C$  any superset of an information state which is in  $C'$  but which would not survive update of  $C'$  with  $\varphi$ . This is perhaps a little bit confusing, so let's consider an example. Imagine that  $C$  consists of  $\{w_1, w_2, w_3\}$  (along with all of its subsets) and imagine that  $C'$  consists

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<sup>5</sup>In the original non-inquisitive version of the stack model, Kaufmann used non-intersective definitions for conjunction and possibility modals, following the model of Groenendijk et al. (1996).

of  $\{w_1, w_2\}$  (along with all of its subsets). Let's say the atom  $p$  denotes a proposition which holds at  $w_1$  and  $w_3$  but not at  $w_2$ . This means that  $C'[p]$  contains  $\{w_1\}$  along with the emptyset  $\emptyset$ , and so  $\{w_1, w_2\}$  and  $\{w_2\}$  are the only information states which are in  $C'$  but not  $C'[p]$ . Thus, to calculate  $C[C' \uparrow p]$ , we simply remove any information state from  $C$  which is a superset of one of those information states. Thus,  $C[C' \uparrow p]$  consists of  $\{w_1, w_3\}$  and all of its subsets.

This completes our system for updating inquisitive contexts. However, the stack model goes further than just updates on inquisitive contexts. What is interesting and unusual about the stack model is that it provides a system for updating macro-contexts. These updates are defined as follows:

**Definition 13.** Given a macro-context  $\tau = \langle C_0, \dots, C_n \rangle$  we have that for any  $\varphi \in \mathcal{L}$ :

- $\tau + \text{UPDATE } \varphi = \langle C_i[C_0 \uparrow \varphi] \rangle_{0 \leq i \leq n}$
- $\tau + \text{IF } \varphi = \langle C_0[\varphi], C_0, \dots, C_n \rangle$
- $\tau + \text{POP} = \begin{cases} \langle C_1, \dots, C_n \rangle & \text{if } n > 0 \\ \tau & \text{if } n = 0 \end{cases}$

Let's walk through each of these update rules one at a time. Updating a macro-context with a formula of the form  $\text{UPDATE } \varphi$  involves updating each context in that macro-context with the fact that its active context has been updated with  $\varphi$ . The effect this has on the lower contexts is just what we went through before, but the effect on the active context might look surprising. Why do we update  $C_0$  with  $C_0 \uparrow \varphi$  instead of updating it with  $\varphi$  directly? The answer to this question is that we in fact *do* update in that way. Since  $C[C \uparrow \varphi] = C[\varphi]$ , these two updates are equivalent, so we can just use the compressed definition given above.<sup>6</sup>

Updating a macro-context with a formula of the form  $\text{IF } \varphi$  creates a new active context, identical to the previous active context except that it has been updated with  $\varphi$ . Thus, 'if'-clauses can be seen as adding a hypothetical assumption, while preserving the previous active context in memory for when the hypothetical assumption is discarded. In order to discard hypothetical assumptions, we use the popping operator, which removes the active context

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<sup>6</sup>To see why, consider the context  $C[C \uparrow \varphi]$ , which is defined as  $\{s \in C \mid \text{for all } t \subseteq s, \text{ we have } t \notin C \text{ or } t \in C[\varphi]\}$ . The downward closure and nonemptiness requirements tell us that we can ignore the first disjunct in this definition, meaning that this set amounts to  $\{s \in C \mid \text{for all } t \subseteq s, t \in C[\varphi]\}$  or in other words,  $C[\varphi]$ .

of a macro-context unless doing so would leave the macro-context empty, in which case it does nothing.

When the stack model was first introduced by Kaufmann (2000), its original purpose was to explain cases of *modal subordination* such as (5).

- (5) a. If Shannon visits Amsterdam, she'll have a good time. She'll see lots of canals.  
b.  $\not\rightarrow$  Shannon will see lots of canals whether or not she visits Amsterdam.

In this example, we see that the assertion that Shannon will see lots of canals can be interpreted under the assumption that she will visit Amsterdam, even when it is not syntactically part of the conditional which introduces that assumption. This modally subordinated reading is difficult to capture in standard theories of conditionals, but falls out easily if (5) is analyzed in the stack model using the sequence of updates shown in (6).

$$(6) \quad \tau + \text{IF } \varphi + \psi + \chi$$

Moreover, the non-modally subordinated reading can be captured by popping the stack between the final two updates.

$$(7) \quad \tau + \text{IF } \varphi + \psi + \text{POP} + \chi$$

A second argument for the stack model is based on conditional questions (Isaacs and Rawlins, 2008). One puzzling feature of conditional questions is that they can be answered as if the ‘if’-clause wasn’t there. For instance, consider the dialogue in (8).

- (8) A: If Shannon visits Amsterdam, will she enjoy it?  
B: Yes, she will!

In this example, B’s response does not mean that Shannon will have a good time regardless of whether she visits Amsterdam. Rather, it means that she will have a good time specifically under the assumption that she visits Amsterdam. This fact is easy to explain in the stack model. The antecedent of A’s conditional question sets up a hypothetical context in which it is established that Shannon visits Amsterdam. Then, in this derived context, A asks whether she is going to have a good time, and B answers that she will. On the other hand, in a story without a stack-like mechanism, this would be difficult to explain, since we would need to rely on ad hoc mechanisms, for instance by positing a covert ‘if’-clause in B’s response.

Thus, this simple incarnation of the stack model can capture some very subtle linguistic phenomena. In the next chapter, I will propose a richer version which can push it even further.

## 3. A stack model with fine-grained discourse contexts

In Chapter 2, I showed how the standard stack model operates when we assume that contexts consist only of information about what the world is like, so far as the discourse participants know. However, I also showed that there are good reasons to think that contexts contain many other kinds of information about the current state of the conversation. In this section, I present a version of the stack model which operates on fine-grained discourse contexts.

We will build this system up in three levels. First, we will have the *level of content*, in which formulas which express propositions are associated with those propositions via the familiar inquisitive interpretation function  $[[\cdot]]$ . Next, at the *level of context*, we will expand our language and introduce a new interpretation function  $[\cdot]$  which will interpret the resulting formulas as updates on individual discourse contexts. Finally, at the *level of context management*, we will interpret our formulas as updates on a stack of contexts using the interpretation function  $+$ . I will assume that formulas at the level of context management serve as an intermediate formal language for English, though I will not give a systematic translation.

### 3.1 The level of content

At the level of content, we model the information that an expression contributes and the issues that it raises. In the present framework, not all linguistic expressions can be understood entirely in terms of their content. For instance, as we saw in the previous chapter, the expressions ‘yes’ and ‘oh’ carry the same content when they are anaphoric to the same antecedent proposition, but they create different kinds of commitments to that content. Thus, at this level we work with a simple propositional language  $\mathcal{L}_0$  which contains only expressions which can be understood in terms of their propo-

sitional content. These end up corresponding to the formulas of the basic propositional language.

**Definition 14** (The content-level language  $\mathcal{L}_0$ ).

$$\varphi ::= p \mid \neg\varphi \mid \varphi \wedge \varphi \mid \varphi \vee \varphi \mid$$

We interpret this language using the semantics provided by **InqB**. This system is presented and discussed in Section 2.1 but I repeat the essential definitions here for the sake of clarity and for the self-containedness of this chapter.

**Definition 15** (Semantics of propositional **InqB**). Given a model  $\mathfrak{M} = \langle W, V \rangle$  where  $W$  is a set of possible worlds and  $V$  is a valuation function:

- $\llbracket p \rrbracket = \{t \subseteq W \mid \forall w \in t, V(w, P) = 1\}$
- $\llbracket \neg\varphi \rrbracket = \llbracket \varphi \rrbracket^* = \{s \subseteq W \mid s \cap t = \emptyset \text{ for all } t \in \llbracket \varphi \rrbracket\}$
- $\llbracket \varphi \wedge \psi \rrbracket = \llbracket \varphi \rrbracket \cap \llbracket \psi \rrbracket$
- $\llbracket \varphi \vee \psi \rrbracket = \llbracket \varphi \rrbracket \cup \llbracket \psi \rrbracket$

**Definition 16** (Abbreviations for **InqB**).

- $!\varphi \equiv \neg\neg\varphi$
- $?\varphi \equiv \varphi \vee \neg\varphi$

With these definitions in hand, we have everything we need to move on to the level of context.

## 3.2 The level of context

At the level of context, we represent the ability of an utterance to update a discourse context. For present purposes, we will consider three kinds of effects an utterance can have on a context. First, an utterance presents a proposal to update the information in the common ground, potentially offering different avenues for doing so. Second, it may introduce new discourse referents. Finally, a speaker may use it to signal one of several public attitudes towards a piece of content. Thus, we will need to track these kinds of information in our contexts and interpret formulas of our context-level language  $\mathcal{L}_1$  so that they bring about these sorts of effects.

In Section 3.2.1, we will define contexts in a way which follows earlier work, but includes a much richer and more general notion of what it means to express a public attitude towards some content. Then in Section 3.2.2 we will define a language which updates contexts so understood.

### 3.2.1 Contexts

Discourse contexts in our system resemble those of Roelofsen and Farkas (2015) in that they include the set `participants` and the two stacks `table` and `drefs`. However, we will replace their bare-bones commitment sets with a richer system which tracks more fine-grained information about the public attitudes each agent has signaled. We will therefore replace their function `commitments` with a new one called `attitudes`.

One way in which `attitudes` differs from `commitments` is that it tracks not only what agents commit to but also what they *object* to and what they *refuse*. By an objection, I mean a public expression of the fact that a proposition is at odds with an agent’s private frame of mind. The notion of an objection should not be confused with that of a refusal, which can be thought of as a public signal of an agent’s unwillingness to accept a commitment. These notions are distinct in two ways. First, as we will see in Chapter 4, one can object to a proposition and still commit to it, whereas a refusal functions as an anti-commitment. Second, refusing a proposition does not necessarily signal anything about one’s mental state beyond that one is choosing to not accept a commitment.

A second way in which `attitudes` differs from `commitments` is that it divides commitments between those which are *self-sourced* and those which are *dependent*. In making this distinction, I follow Gunlogson’s (2008) lead, but I depart from her specific conception of what a dependent commitment means. In her system, a person making a dependent commitment commits on the basis of the testimony of another participant in the conversation. However, the dialogue in (1) shows that this is not quite right.

- (1) A: Is *Escaping the Delta* any good?  
B: I don’t know. I never read it. But I guess you trust Jonathan and he once said that it’s the best book ever written about music.  
A: Oh! I had no idea it was that good!

In this example, B declines to take a stand on whether or not this book is any good, but passes along the recommendation of a third party not involved in the present conversation. A is then able to form a dependent commitment on this basis. Thus, the lesson of this example is that one can commit dependently to a proposition which no agent in the present conversation is committed to.<sup>1</sup>

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<sup>1</sup>A proponent of Gunlogson’s definition could claim that B’s utterance creates a conversational fiction that John is a participant in the present context. However, it would be much simpler to just loosen the strictures of the definition in the manner I have suggested.

One reply to this data point might be that A is in fact committing as source using B’s testimony as the relevant first-hand evidence. However, if we apply Gunlogson’s yes vs. oh diagnostic, we see that A’s commitment in (1) patterns with dependent commitments rather than with self-sourced commitments.

- (2) A: Is *Escaping the Delta* any good?  
B: I don’t know. I never read it. But I guess you trust Jonathan and he once said that it’s the best book ever written about music.  
A: #Yes! I had no idea it was that good! I’ll have to read it then!

Thus, we will define our inventory of public attitudes as shown in Definition 17.<sup>2</sup>

**Definition 17** (Public attitudes).

- A *commitment* is a public display of one’s acceptance of a proposition.
  - A *self-sourced commitment* is a commitment made on the basis of one’s private mental state.
  - A *dependent commitment* is a commitment made on the basis of testimonial evidence.
- An *objection* is a public display of the fact that a proposition is at odds with one’s private mental state.
- A *refusal* is a public display of one’s unwillingness to accept a proposition.

In the above discussion, I defined commitments, objections, and refusals as different kinds of public attitudes, but I did not take a stance on what exactly the objects of these attitudes are. In all earlier work that I am aware of, commitments have been understood as attitudes towards information, i.e. towards classical propositions. However, dialogues like those in (3) show that agents can signal the exact same attitudes towards issues.

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<sup>2</sup>In the present system, we track only four kinds of public attitudes. Of course, actual conversational scorekeeping probably involves tracking other kinds as well. Yet we might expect certain constraints on which kinds of attitudes can be grammaticalized. For instance, it seems unlikely that any language would conventionalize discourse effects relating to participants’ precise credence levels, since it would be impossible for actual human agents to coordinate their understandings of the context. An interesting question for future work might concern what other kinds of attitudes are grammaticalized by languages and what constraints might limit the observed inventory.

- (3) a. A: Wait, so is Morwenna coming to the party?  
 B: Right, exactly! That’s what I can’t figure out. (self-sourced)
- b. A: Wait, so is Morwenna coming to the party?  
 B: Oh! That’s an interesting question! (dependent)
- c. A: Why isn’t Michael coming to the party?  
 B: Oh Lord. If you have to know, . . . (objection)
- d. A: Why isn’t Michael coming to the party?  
 B: Nuh-uh. Don’t go there. (refusal)

Moreover, allowing attitudes towards issues makes sense from a conceptual perspective. In theories of conversational scorekeeping, commitment slates are devices for capturing the fact that when someone makes an assertion, they signal that the information it conveys follows from their private evidentiary state. But when someone asks a question, they similarly signal that the issues it raises follow from their private inquisitive state. Thus, we need some formal device to capture what the act of asking or reacting to a question signals about an agent. Since inquisitive semantics gives a notion of proposition-hood which contains both information conveyed and issues raised, treating the objects of our public attitudes as inquisitive propositions is a parsimonious way to go.

As a consequence of this shift to attitudes being inquisitive, we will need to redefine our system of highlights so that highlighted propositions are inquisitive too. Otherwise, particles such as ‘yes’ would affirm classical propositions rather than inquisitive ones, and thus be unable to update our inquisitive attitude states. To make this adjustment without substantively changing the predictions of the theory, I propose that where an utterance highlighted a classical proposition  $P$  in the system of Roelofsen and Farkas (2015), it will highlight the power set of  $P$  in ours. Since the power set of  $P$  conveys the same information as  $P$  but raises only the trivial issue, this technical change will not introduce any unwanted pieces of meaning.

This proposal is shown formally in Definition 18. Note, however, that there is one other alteration I make in this definition. Since the data we will work with in Chapter 4 only concerns positive polarity particles, I ignore the separation of highlights by polarity. This is purely a simplifying assumption and can be easily discarded if one wants to apply this framework to the sorts of phenomena that demand separating highlights by polarity.

**Definition 18** (Inquisitive highlights for  $\text{InqB}$  without polarity). Given a

model  $\mathfrak{M} = \langle W, V \rangle$  where  $W$  is a set of possible worlds and  $V$  is a valuation function:

- $\llbracket p \rrbracket^h = \{\llbracket p \rrbracket\}$
- $\llbracket \neg\varphi \rrbracket^h = \{\mathcal{P}(W)(W - \cup\llbracket \varphi \rrbracket^h)\}$
- $\llbracket \varphi \vee \psi \rrbracket^h = \llbracket \varphi \rrbracket^h \cup \llbracket \psi \rrbracket^h$
- $\llbracket !\varphi \rrbracket^h = \llbracket ?\varphi \rrbracket^h = \{\mathcal{P}(\cup\llbracket \varphi \rrbracket^h)\}$

Our final departure from ?? lies in the structure we use to track attitudes. Most approaches to speaker commitments posit that speakers simply maintain a list of the propositions each agent has committed to, and then derive a *commitment set* as the intersection of all these propositions. I will deviate from this approach in two ways. First, since the list does no explanatory work for the phenomena covered in this thesis, we will skip it and define an *attitude set* directly. Second, the way an attitude set is formed from speakers' utterances does not always rely on intersection.

To see how this is so, observe that commitments and objections/refusals are mirror images of each other in the sense that commitment attitudes are closed under entailment, while objection and refusal attitudes are closed under converse-entailment.<sup>3</sup> We can see this most clearly in the contrast between self-sourced commitments and objections. If your state of mind motivates you to accept  $p \wedge q$ , it also motivates you to accept  $p$ , but crucially may or may not motivate you to accept  $p \wedge q \wedge r$ . On the other hand, if your state of mind is at odds with  $p \wedge q$ , it is also at odds with  $p \wedge q \wedge r$ , but could be entirely compatible with  $p$ . (To see that the same holds for inquisitive content, just consider the case of  $?(p \wedge q)$ .) Thus, while a self-sourced commitment set can be defined as the strongest proposition a rational agent must accept given what they have publicly signaled, an objection set should be defined as the weakest proposition a rational agent must object to given what they have publicly signaled. As such, commitment states are updated by intersection, while objection and refusal states are updated with union.

Given what we now know about public attitudes, we can define an agent's *attitude structure* as follows.

**Definition 19** (Attitude structure). An *attitude structure* for an agent  $a$  is a tuple  $\langle \text{SS}_a, \text{DS}_a, \text{OS}_a, \text{RS}_a \rangle$  where:

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<sup>3</sup>Recall that I say that a proposition  $P$  entails  $Q$  when  $P \subseteq Q$ .

- $SS_a$  is the strongest proposition to which  $a$  commits as source.
- $DS_a$  is the strongest proposition to which  $a$  commits dependently.
- $OS_a$  is the weakest proposition to which  $a$  objects.
- $RS_a$  is the weakest proposition which  $a$  refuses.

Here,  $SS$  can be read as the “self-sourced state”, while  $DS$  can be read as the “dependent state”. Similarly,  $OS$  can be read as the “objection state” and  $RS$  can be read as the “refused state”. With these notions in hand, we can now define our fine-grained discourse contexts as follows.

**Definition 20.** A context  $C$  is a tuple  $\langle \text{participants}, \text{table}, \text{drefs}, \text{attitudes} \rangle$  where:

- **participants** is a set of discourse participants.
- **table** is a stack of inquisitive propositions representing the proposals that have been made so far.
- **drefs** is a stack of sets of inquisitive propositions available as discourse referents.
- **attitudes** is a function mapping each  $a \in \text{participants}$  to  $a$ ’s attitude structure.

What we have said so far allows more contexts than one actually finds in the wild. We will examine this issue in more detail in Section 4.2.2, but for now we will introduce the following two restrictions on what counts as an admissible context.

**Definition 21** (Don’t Accept the Absurd). A context  $C$  is only well-formed if for every  $a \in \text{participants}$ , we have that:

$$SS_a \cap DS_a \neq \{\emptyset\}$$

**Definition 22** (Don’t Dismiss the Trivial). A context  $C$  is only well-formed if for every  $a \in \text{participants}$ , we have that:

$$OS_a \neq \mathcal{P}(W) \text{ and } RS_a \neq \mathcal{P}(W)$$

These principles capture the fact that one’s commitments are expected to be logically consistent and that one can neither refuse nor object to the trivial proposition  $\mathcal{P}(W)$ . Of course, these two principles aren’t very strong. In particular, they don’t say anything about which public attitudes an agent may hold simultaneously. More on that later.

### 3.2.2 Updates

Now that I have established what discourse contexts are like in this system, I will introduce a formal language which updates them. This language  $\mathcal{L}_1$  will differ from our content-level language  $\mathcal{L}_0$  in several crucial respects. First,  $\mathcal{L}_1$  will need some additional formulas corresponding to natural language expressions which can only be understood in terms of the context-level discourse moves they encode. Second, we will need to account for the fact that English expressions corresponding to formulas of  $\mathcal{L}_0$  are systematically ambiguous between a self-sourced and a dependent meaning, as shown in the dialogue in (4).

- (4) A: Guess what? Thijs came to the party! (self-sourced)  
 B: Wow! Thijs came to the party. I wish I'd been there. (dependent)

The contrast between these dialogues shows that the sentence “Thijs came to the party” can create either a self-sourced or a dependent commitment to its content. Thus, we cannot simply treat our context-level language as an extension of our content-level language if we want a well-defined semantics. To capture this ambiguity we will require that formulas of  $\mathcal{L}_0$  be marked with either the self-sourced operator S or the dependent operator D in order to become formulas of  $\mathcal{L}_1$ . This move may appear unmotivated, since the S and D operators are not visible in the surface-level structure in English. However, the distinction these operators encode bears a striking resemblance to that of evidential markers which exist in many of the world’s languages. Thus, it is not unreasonable to assume that English has the same features but simply does not spell them out on every verb.<sup>4</sup>

Thus, our context-level language  $\mathcal{L}_1$  will include propositional expressions based on those of  $\mathcal{L}_0$ , along with an inventory of *attitude constants* and the *polarity particles* YES and NO. A definition of this language is given below. Crucially, notice that this definition is not recursive.

**Definition 23** (The context-level language  $\mathcal{L}_1$ ). For  $\psi \in \mathcal{L}_0$ , we have:

$$\varphi ::= S\psi \mid D\psi \mid \text{S-ACCEPT} \mid \text{D-ACCEPT} \mid \text{OBJECT} \mid \text{REFUSE} \mid \text{YES} \mid \text{NO}$$

<sup>4</sup>One objection to this claim might be that languages with evidential marking often make distinctions finer than those we see here, for instance distinguishing self-sourced commitments that arise from sensory evidence from those which come from inference. An answer to this objection would be that close examination of English conversational behavior might reveal sensitivity to these kinds of distinctions, but it is also possible that languages differ in the attitudes they scorekeep.

To interpret this language, we will define a context-level interpretation function  $[\cdot]$ , but once again there is a bit of a wrinkle we need to work out first. This wrinkle arises from the fact that the speaker’s identity determines the effect of their utterance on the context. For instance, when Lange Frans utters “the lasagna is in the oven” he commits himself to the lasagna being in the oven; when Taylor Swift utters this sentence, she is the one who accepts the commitment.

One way of capturing this fact would be to revise the syntax of our language so that each formula is indexed to a particular participant. However, this distinction is not grammatically marked in any language I am familiar with, and moreover would be redundant to mark in the grammar since the identity of the speaker is normally recoverable from numerous other conversational cues. Thus, I propose instead that this distinction should be made using a context-level interpretation function  $[\cdot]$  which assigns an update potential on contexts to each pair of a formula  $\varphi$  and a conversational participant  $a$ . In general, we will notate the speaker argument as a superscript like so:  $[\cdot]^a$ .

**Definition 24** (Context-Level Interpretation). Fix a set **participants**. Then for any  $C$  based on **participants** and any  $a \in \mathbf{participants}$  we have the following update rules.

- If  $\varphi = \text{S}\psi$  for some  $\psi \in \mathcal{L}_0$ , then  $C[\varphi]^a = C'$  where  $C'$  differs from  $C$  only in that:
  - $\text{ss}_a^{C'} = \text{ss}_a^C \cap \llbracket \psi \rrbracket$
  - $\text{table}^{C'} = \langle \llbracket \psi \rrbracket, \text{table}^C \rangle$
  - $\text{drefs}^{C'} = \langle \llbracket \psi \rrbracket^h, \text{drefs}^C \rangle$
- If  $\varphi = \text{D}\psi$  for some  $\psi \in \mathcal{L}_0$ , then  $C[\varphi]^a = C'$  where  $C'$  differs from  $C$  only in that:
  - $\text{ds}_a^{C'} = \text{ds}_a^C \cap \llbracket \psi \rrbracket$
  - $\text{table}^{C'} = \langle \llbracket \psi \rrbracket, \text{table}^C \rangle$
  - $\text{drefs}^{C'} = \langle \llbracket \psi \rrbracket^h, \text{drefs}^C \rangle$
- $C[\text{S-ACCEPT}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{ss}_a^{C'} = \text{ss}_a^C \cap P$  where  $P$  is the top element of **table** in  $C$
- $C[\text{D-ACCEPT}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{ds}_a^{C'} = \text{ds}_a^C \cap P$  where  $P$  is the top element of **table** in  $C$

- $C[\text{OBJECT}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{os}_a^{C'} = \text{os}_a^C \cup P$  where  $P$  is the top element of table in  $C$
- $C[\text{REFUSE}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{rs}_a^{C'} = \text{rs}_a^C \cup P$  where  $P$  is the top element of table in  $C$
- $C[\text{YES}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{ss}_a^{C'} = \text{ss}_a^C \cap P$  where  $P$  is the sole element of the top set of drefs in  $C$ ; defined only if there is a unique such  $P$
- $C[\text{NO}]^a = C'$  where  $C'$  differs from  $C$  only in that  $\text{ss}_a^{C'} = \text{ss}_a^C \cap \{s \subseteq W \mid s \cap t = \emptyset \text{ for all } t \in P\}$  where  $P$  is the sole element of the top set of drefs in  $C$ ; defined only if there is a unique such  $P$

These semantic clauses are simpler than they look. Updating with a formula of the form  $S\varphi$  places its content on the table, makes its highlighted discourse referents available for later propositional anaphora, and commits the speaker to its content as source. A formula of the form  $D\varphi$  does the same thing, except that it commits the speaker dependently. The various attitude constants (S-ACCEPT, etc.) create the appropriate attitude towards whatever proposal is currently on the table.

The polarity particle YES is like the attitude constant S-ACCEPT in that it creates a self-sourced commitment, but differs in that the object of that commitment is the most salient discourse referent rather than the most salient proposal on the table. In many cases, this difference will be invisible, but it is conceptually significant and rears its head in certain examples. For instance, in response to a polar question, S-ACCEPT signals that its speaker entertains the issue raised by the question, while YES signals that the speaker can vouch for the positive answer to the question. The polarity particle NO does not share an analogous relationship with the attitude constant REFUSE, since the former expression creates a self-sourced commitment to the negation of the most salient discourse referent, while the latter creates an anti-commitment to the most salient proposal.<sup>5</sup>

One crucial technical detail of these definitions is that while an agent accepting a commitment to a proposition  $P$  *intersects* it with their commitment state, an agent objecting to or refusing  $P$  *joins* it to the appropriate attitude state. To see why this is necessary, recall from Definition 19 that a commitment state is the strongest proposition that an agent can commit to,

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<sup>5</sup>In English, these polarity particles also have readings which are at least superficially similar to S-ACCEPT and REFUSE. I leave the question of how to capture these readings for another day.

while an objection or refusal state is the weakest proposition which the agent objects to or refuses. Thus, making a new commitment requires strengthening one’s commitment state, while making a new objection or refusal requires weakening the corresponding state.<sup>6</sup>

A practical question worth pondering is how English speakers disambiguate between homophonous expressions which correspond to  $S\varphi$  and  $D\varphi$ . A clue to the answer lies in the fact that B’s response in example (4) from above sounds extremely awkward if we remove all the material which explicitly reveals B’s prior ignorance of Thijs having been at the party.

- (5) A: Guess what? Thijs came to the party!  
 B: ?Thijs came to the party.

In this example, it sounds like B is trying to inform A of something which it is common knowledge that A already knows. Thus, the lesson of this example is that agents have a very strong preference for treating utterances as self-sourced, all things being equal. What it means for all things to fail to be equal is a question I will leave for future work. In my examples, I will make it clear when an agent commits dependently by using expressions such as ‘oh’ or ‘wow’.

A related practical question is how an agent can tell which attitudes other agents have signaled towards their initiatives. For instance, it is rarely the case that an initiative is followed by every single agent in the conversation responding with ‘exactly!’, ‘oh!’, or some other expression corresponding to an attitude constant. And yet, we generally have a pretty clear picture of what attitudes everyone in a conversation has taken towards what we have said. Since this problem concerns rational behavior and the present work is focused merely on the logical component of the grammar, I will leave a full answer to future work. However, we will adopt a few reasonable assumptions which will allow this system to make concrete predictions. First, I assume

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<sup>6</sup>At first glance, this update process might seem both too weak and too strong. For instance, suppose an agent  $a$  has refused two atomic formulas  $p$  and  $q$ . In this case,  $RS_a$  will be the inquisitive proposition  $\llbracket p \rrbracket \cup \llbracket q \rrbracket$  which can be glossed as the question “Is  $p$  true or is  $q$  true?” This might seem weird. Why would refusing to accept multiple pieces of information be the same as refusing to entertain an issue? Moreover, shouldn’t refusing these two formulas mean refusing  $\llbracket !(p \vee q) \rrbracket$ , i.e. the statement “Either  $p$  is true or  $q$  is true”?

If we think carefully, we see that these concerns have answers. If you aren’t prepared to accept any answer to a question, then you regard it as unanswerable and therefore cannot publicly entertain it in good faith. On the other hand, one can commit to either  $p$  or  $q$  being true, but be unwilling to commit to more than that. Thus, this update procedure seems to be the correct one, odd though it may look at first glance.

that agents' understanding of each others' acceptances and objections is governed by the principle in Definition 25.

**Definition 25** (Resolve Immediately). Every proposal is immediately followed by all other agents accepting, refusing, or objecting to it.

This principle allows agents to expect immediate reactions to their utterances, narrowing the range of cues they must look for to figure out what is going on. Second, I assume that speakers have a bias towards interpreting other agents as committing dependently to their initiatives, all else being equal. Once again, I will leave open the question of how things can fail to be equal.

On its surface, the system outlined in this section might seem to differ radically from more traditional systems in dynamic semantics, where formulas update a Stalnakerian (1978) *context set* rather than our fine-grained discourse contexts. However, there is actually a tight link between the present system and that earlier work. To see how, first observe that we can derive an inquisitive context set from the agents' individual commitments.

**Definition 26** (Context set). For any context  $C$ , we have:

- $\sigma^C = \{s \subseteq W \mid \forall a \in \text{participants}^C, s \in \text{ss}_a^C \cap \text{DS}_a^C\}$

If an utterance is accepted by all other participants, then its content is intersected with the context set. Therefore, the present system can be seen as a generalization of an inquisitive update semantics based on intersective update such as  $\text{InqU}$  as presented in Definition 11 of the previous chapter.

**Fact 1.** Let  $C$  be a discourse context whose participants are  $a_1 \dots a_n$ . Then for any  $\varphi \in \mathcal{L}_0$ , we have that for  $C' = C[\text{S}\varphi]^{a_1}[\text{AGREE}]^{a_2} \dots [\text{AGREE}]^{a_n}$ :

$$\sigma^{C'} = \sigma^C[\varphi]^{\text{InqU}}$$

*Proof.* Fix a context  $C$  and a formula  $\varphi \in \mathcal{L}_0$ . Since  $\text{attitudes}^{C'}$  differs from  $\text{attitudes}^C$  only in that  $\text{ss}_{a_1}^{C'} = \text{ss}_{a_1}^C \cap \llbracket \varphi \rrbracket$  and  $\text{DS}_{a_i}^{C'} = \text{DS}_{a_i}^C \cap \llbracket \varphi \rrbracket$  for  $1 < i \leq n$ , it follows that  $\sigma^{C'} = \sigma^C \cap \llbracket \varphi \rrbracket$ . By the definition of intersective update, we know that  $\sigma^C \cap \llbracket \varphi \rrbracket = \sigma^C[\varphi]^{\text{InqU}}$ , and so we conclude that  $\sigma^{C'} = \sigma^C[\varphi]^{\text{InqU}}$ .  $\square$

Fact 1 shows that the present system subsumes that of Hara and Sano (2017), and thus brings along all of its desirable results. However, the implications of

this fact go beyond the present system, since versions of this fact should apply to any dynamic semantics which updates individual commitments rather than just a context set. For instance, if we adopt a notion of content where formulas are interpreted as classical propositions with respect to an information parameter, then a commitment-based system would similarly deliver a standard update semantics such as that of Veltman (1996). Thus, the ideas in this section should be seen as extensions of standard thinking about context updates and not as a radical departure.

We will close this section by introducing a notion which is not conceptually interesting at this present level but which must be defined here in order for us to push our analysis further one level up. This is our notion of percolation. Here we will define percolation in such a way that it adds a new proposition to an agent's commitments. In practice, this update will typically be trivial on all but one of the commitment sets, but we define it as an update on all four for the sake of uniformity. To give us percolation, we will extend our language  $\mathcal{L}_1$  to the language  $\mathcal{L}_{1\frac{1}{2}}$ . As with  $\mathcal{L}_1$ , this definition is not recursive.

**Definition 27** (The extended context level language  $\mathcal{L}_{1\frac{1}{2}}$ ). For  $\psi \in \mathcal{L}_1$  and a context  $C$ , we have:

$$\varphi ::= \psi \mid C \uparrow \psi$$

In this definition, the symbol  $C$  should be understood as referring to a context  $C$ . Thus, a formula of the form  $C \uparrow \varphi$  should be read as conveying the news that  $C$  has been updated with  $\varphi$ . We interpret these formulas as shown below.

**Definition 28** (Percolation). The result of percolating  $\varphi \in \mathcal{L}_1$  from  $C'$  to  $C$  is the context  $C[C' \uparrow \varphi]^a$ , which is identical to  $C$  except that:

1.  $ss_a^{C[C' \uparrow \varphi]^a} = ss_a^C \cap \{s \in ss_a^C \mid \forall t \subseteq s, t \notin ss_a^{C'} \text{ or } t \in ss_a^{C'[\varphi]^a}\}$
2.  $ds_a^{C[C' \uparrow \varphi]^a} = ds_a^C \cap \{s \in ds_a^C \mid \forall t \subseteq s, t \notin ds_a^{C'} \text{ or } t \in ds_a^{C'[\varphi]^a}\}$
3.  $os_a^{C[C' \uparrow \varphi]^a} = os_a^C \cup \{s \in os_a^C \mid \forall t \subseteq s, t \notin os_a^{C'} \text{ or } t \in os_a^{C'[\varphi]^a}\}$
4.  $rs_a^{C[C' \uparrow \varphi]^a} = rs_a^C \cup \{s \in rs_a^C \mid \forall t \subseteq s, t \notin rs_a^{C'} \text{ or } t \in rs_a^{C'[\varphi]^a}\}$

This definition is a generalization of the context set-level definition of percolation to individual agents' attitude states. The only interesting departure is that we update an objection set and refusal set by weakening it, for reasons discussed in detail above.

### 3.3 The level of context management

At the level of context management, we model the effects that an utterance may have not just on a single context, but on a stack of contexts. We will consider this level to exhaust the space of discourse effects which can be brought about by natural language utterances (though see Hara (2012) on unconditionals).

Our context management-level  $\mathcal{L}_2$  language will be an expansion of  $\mathcal{L}_1$  with ‘if’-clauses as well as a popping operator. There are two important things to notice about this definition. First, as with our definition of  $\mathcal{L}_1$ , this definition is not recursive. Second, note that our language at this level is *not* an expansion of  $\mathcal{L}_{1\frac{1}{2}}$ . This is because learning in a state about another state is an exclusively context-level notion.

**Definition 29** (The context management-level language  $\mathcal{L}_2$ ). For  $\psi \in \mathcal{L}_1$ , we have:

$$\varphi ::= \psi \mid \text{if } \psi \mid \text{POP}$$

We interpret formulas of  $\mathcal{L}_2$  as updates on *macro-contexts*, understood as stacks of discourse contexts.

**Definition 30 (Macro-Contexts.)**. • A *macro-context*  $\tau$  is a tuple of contexts  $\langle C_0, \dots, C_n \rangle$ .

- The *active* or *top context*  $C_0$  contains current but potentially temporary information.
- The *main* or *bottom context*  $C_n$  contains enduring information.

At this level, our interpretation function  $+$  assigns *macro-context change potentials* to pairs of participants and formulas of  $\mathcal{L}_2$ . For formulas of  $\mathcal{L}_2$  which are also formulas of  $\mathcal{L}_1$ , we update the macro-context by updating the active context with  $\varphi$  and then percolating this information to all the contexts below it in the stack.<sup>7</sup> A formula of the form IF  $\varphi$  pushes a new hypothetical context which is identical to the previous active context except that it has been updated with  $\varphi$ . Finally, the POP operator removes the

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<sup>7</sup>This is superficially different from the system of Hara and Sano (2017), where the analogous update is defined as  $\langle C_k[C_0 \uparrow \varphi] \rangle_{0 < k \leq n}$ . This difference is superficial because in their system, their update rule would be equivalent to mine. However, my approach demands the definition given above because it does not validate the equivalence  $C[\varphi] = C[C \uparrow \varphi]$ , owing to the fact that updates to **drefs** and **table** do not percolate.

active context unless doing so would deliver an empty stack (in which case it idles).

**Definition 31** (Context Management-Level Interpretation). Fix a set **participants**. Then for any  $\tau = \langle C_0, \dots, C_n \rangle$  where each context is based on **participants** and for any  $a \in \mathbf{participants}$  we have the following update rules, where  $\varphi \in \mathcal{L}_1$ .

- $\tau +^a \varphi = \langle C_0[\varphi], C_k[C_0 \uparrow \varphi] \rangle_{0 < k \leq n}$
- $\tau +^a \text{if } \varphi = \langle C_0[\varphi], C_0, \dots, C_n \rangle$
- $\tau +^a \text{POP} = \begin{cases} \langle C_1, \dots, C_n \rangle & \text{if } n > 0 \\ \tau & \text{if } n = 0 \end{cases}$

In this system, one cannot accept, refuse, or object to an effort to push or pop a context. Rather, these effects on stacks are brought about directly by their speakers. When one wants to resist a context management-level discourse move, one must either reintroduce a popped assumption or else pop the stack to remove a hypothetical assumption one does not want to make.

### 3.4 Commentary

The general picture painted in this section is that natural language utterances can be understood in terms of a logical language whose formulas denote updates on stacks of discourse contexts. Some such utterances can also be understood in terms of their effects on single contexts or even in terms of their inquisitive content. Others, however, can only be understood at the macro-context level.

This system will do most of its work in Chapter 4 but we can already see some of its advantages. Notably, it can serve as a framework for thinking about how conditionals manipulate the availability of propositional discourse referents. For instance, one result that follows directly from the architecture of the framework is that the availability of a discourse referent is determined by the current active context. We can see this prediction is borne out from examples like (6).

- (6) A: If Morwenna comes to the party, will Dean come too?  
 B: Yes. #But of course, she's probably not coming, so most likely no.

In this dialogue, A's conditional creates a hypothetical context in which the most salient propositional discourse referent is the possibility that Dean will come to the party. B can target this propositional discourse referent with the polarity particle 'yes' as long as the context remains the same. However, as soon as B uses an 'of course' phrase to pop the top context, this discourse referent becomes unavailable.

Note that the problem here is not about proximity or intervening material. Consider a similar alternative utterance that doesn't induce popping:

- (7) A: If Morwenna comes to the party, will Dean come too?  
B: Hmmm. He's not totally recovered from the flu and he has a lot of work to do, so most likely no.

Here quite a bit of material intervenes between A's introduction of this discourse referent and B's particle that targets it. However, because B does not pop the stack, A's discourse referent remains available. Thus, this approach is well-motivated both conceptually and by some basic empirical data. In the next chapter, we will consider some much more complex data and show that this system can do the necessary heavy lifting.

## 4. Factual Conditionals

In this chapter, I show that by adopting the stack model with fine-grained discourse contexts, we can solve several major puzzles involving the semantics of *factual conditionals* (henceforth *FC*'s). *FC*'s are conditionals like the one which B utters in (1).<sup>1</sup>

- (1) A: I'm hungry.  
B: If you're hungry, go eat something.

One can generally recognize a *FC* by the fact that its antecedent echoes an earlier utterance. However, this characteristic correlates with a surprising variety of syntactic properties. For instance, antecedents of *FC*'s cannot scope under negation, as shown in the fact that while (2a) can occur in response to someone asserting that there is a lot of pressure on John, (2b) cannot (Iatridou, 1991).

- (2) a. John won't finish on time if there's a lot of pressure on him, since he responds poorly to pressure. (FC or non-FC)  
b. John won't finish on time if there's a lot of pressure on him, but rather if he has space to think. (only non-FC)

Moreover, when a single conditional contains both a *FC* 'if'-clause and a non-*FC* 'if'-clause, the two are subject to certain restrictions on their relative order as shown in (3) (adapted from Haegeman and Wekker 1984).

- (3) a. A: Saúl is coming to the party!  
B: The party will be fun if Saúl coming, if there's enough beer.  
b. A: Saúl is coming to the party!  
B: \*The party will be fun if there's enough beer, if Saúl is coming.

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<sup>1</sup>Haegeman (2003) and Mayol and Castroviejo (2017) use the alternative term *premise conditionals*.

The literature also identifies and discusses a number of unique semantic and discourse-level properties of FC's, yet to my knowledge there has been no proposed explanation for them. This is surprising since many of these properties are extremely puzzling from the perspective of previous work on conditionals. For instance, take the fact that FC's antecedents typically echo an earlier utterance. Previous analyses of conditionals diverge widely, but one reoccurring theme is that the antecedent of a conditional provides content which we must somehow take into account while considering the consequent. However, in the case of a FC, it seems like the content of the antecedent has already been supplied by the utterance which it echoes. Thus, on the surface it might seem that FC's diverge from the semantics of other conditionals in a deep way. However, in this chapter I will argue otherwise. Specifically, I will argue that a FC is just a conditional whose antecedent creates a hypothetical dependent commitment.

## 4.1 Five questions about FC's

In this section, I present five major questions regarding the semantics and discourse effects of FC's. Answers to these questions will serve as our desiderata in the remainder of this chapter. These questions are distinct, but not entirely independent.

### 4.1.1 Question #1: What does the antecedent of a FC do?

Our first question concerns the semantic job performed by the antecedent of a FC. Iatridou (1991) argues that the antecedent of a FC should be seen as something analogous to an appositive, supplying relevant information to motivate or accompany the consequent. She argues this on the basis of pairs of dialogues like the one in (4), adapted from Haegeman and Wekker (1984). The dialogue in (4a) shows that the role of an 'if'-clause for an ordinary conditional can be understood as specifying the circumstances in which the consequent is true. However, examples such as (4) seem to show that the same cannot be said of a FC's antecedent.<sup>2</sup>

- (4) a. A: If Grzegorz comes to visit, he will bring goat cheese.  
B: Sorry, I missed that. Under what circumstances will he bring

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<sup>2</sup>Iatridou (1991) also cites a number of syntactic parallels between factual conditionals 'if'-clauses and appositive relative clauses. Given that there has been no work on how stack-based meanings would be composed, I shy away from syntactic patterns here, except where they are useful as diagnostics for FChood.

goat cheese?  
A: If he comes to visit.

- b. B: Grzegorz is coming over!  
A: Oh! If Grzegorz comes over, he will bring goat cheese.  
B: Sorry, I missed that. Under what circumstances is Grzegorz gonna bring goat cheese?  
A: #If he comes to visit.

Another suggestion Iatridou makes in passing is that a FC's 'if'-clause can sometimes be understood as supplying "some reason for the content of the assertion". However, (5) shows that we at least cannot take this suggestion literally.

- (5) B: Grzegorz is coming over!  
A: Oh! If Grzegorz comes over, he will bring goat cheese.  
B: Sorry, I missed that. Why is Grzegorz bringing goat cheese?  
A: #If he comes to visit.

One possible reaction is that the 'if'-clause is actually doing very little, merely supplying some information which is relevant to the consequent. However, as shown in (6), not all tangentially related consequents can go with any given antecedent.

- (6) A: Grzegorz is coming over!  
B: #If Grzegorz is coming over, he loves playing chess.

In this example, Grzegorz's love of chess could be relevant to his coming over for any variety of reasons. (Perhaps he is likely to bring his chess set or to want to play a game.) Yet this is not sufficient to license B's utterance. Thus, it seems like the antecedent is doing *something*. But what is it doing? This is our first major puzzle.

#### 4.1.2 Question #2: What is the discourse function of a FC?

Since FC's typically echo an earlier utterance, one of the major questions we should ask is what a FC says about that utterance. Thus, our second major puzzle concerns the discourse move performed or suggested by a FC. One obvious possibility is that they express skepticism about the earlier utterance. This seems to be the case in examples like those shown in (7).

- (7) a. A: This is a consular ship!

- B: If this is a consular ship, where is the ambassador?
- b. A: I'm sober!  
B: If you're sober, I'm a monkey's uncle.
- c. A: I'm gonna send you my paper tomorrow.  
B: If you send me your paper tomorrow, I will be very pleased.

These examples suggest that FC's perform the discourse move I have defined as REFUSE. On the other hand, there are other examples of FC's which do not appear to reject the assertion that their antecedent echoes. For instance, consider the dialogue in (8).

- (8) A: It's Zhuoye's birthday today!  
B: Oh! If it's Zhuoye's birthday, I better start baking him a cake!  
*(B hurries off to bake a cake)*

In this example, B responds to A's assertion with a FC, but behaves in a way which is hard to understand unless B accepts A's assertion. Thus, this example would be hard to square with the idea that FC's perform a refusal. Thus, to give an analysis of FC's that explains these examples, we need to either find an alternative explanation either for the skepticism expressed by the FC's in (7) or for B's action in (8). In Section 4.3, I will argue for the latter option.

### 4.1.3 Question #3: Why are FC's felicitous?

A third issue we will investigate in this chapter is why many factual conditionals seem to violate a requirement obeyed by all other kinds of conditionals. This requirement is that the antecedent of a conditional must introduce a new assumption rather than reflect something which has already been introduced into the discourse. We can see this restriction at play in simple examples like (9) below.

- (9) #It's Zhuoye's birthday today! And if it's Zhuoye's birthday today, I better start baking a cake.

In this example, we see that a perfectly good conditional is ruined by the fact that the speaker has previously asserted its antecedent. We see a similar effect at work in (10), where A's use of a conditional betrays their ignorance about the truth of its antecedent.

- (10) A: If the exam is tomorrow, I'm gonna fail.  
B: The exam *is* tomorrow. Did you seriously not know that?

The exact principle responsible for this effect will look different from framework to framework, but in the stack model we can phrase it as shown below.<sup>3</sup>

**Definition 32** (No Vacuous Moves). An utterance is infelicitous if it results in an identical active context.

This principle is evidenced by examples like (9) and (10), but it also makes sense in light of very general pragmatic considerations. Why would one choose to utter an 'if'-clause when their epistemic state would license them to use the stronger 'since'-clause?

To see how factual conditionals seem to violate *No Vacuous Moves*, recall the dialogue in (8). In this example, B appears to accept A's assertion, and yet is able to use it as the antecedent of a felicitous conditional. Thus, to explain this pattern, a semantic account of FC's must either (i) deny the principle of *No Vacuous Moves* and provide an alternative explanation for the infelicity of (9) and (10) or else (ii) find some respect in which antecedents of factual conditionals create a fresh active context. In Section 4.3, I will take the latter route.

#### 4.1.4 Question #4: What mechanism links a FC to earlier discourse?

One of the defining characteristics of a FC is that its antecedent is in some sense linked to an earlier utterance. However, it is not clear exactly what that link consists of. In many examples, we see that the antecedent of a FC echoes the exact words of the previous utterance. However, as (11) shows, a FC need not be literally echoic in this sense.

- (11) A: I hate medical school.  
B: If you're so unhappy with what you're studying, why don't you switch to something else, for instance logic?

Moreover, as (12) shows, they also need not echo the exact content of an earlier utterance.<sup>4</sup>

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<sup>3</sup>This principle is slightly stronger than the one of the same name proposed by Hara (2012) for different reasons. That principle banned vacuous updates on macro-contexts but allowed updates which created duplicate copies of the active context, which is exactly what we want to block in the case of (9).

<sup>4</sup>At this point, a skeptical reader may wonder why I suggest revising this generalization rather than concluding that B's utterance in (11) is not a bona fide factual conditional. The

- (12) A: I'm going to be working every single day until Monday.  
B: If you're not even taking Friday off, you're crazy.

In this example, B's conditional functions as a factual conditional even though its antecedent is merely entailed by A's utterance. What mechanism in the grammar is sensitive to this kind of link between a FC and earlier discourse?

#### 4.1.5 Question #5: Why can't the speaker of a FC have independent evidence for its antecedent?

Iatridou (1991) argues that FC's are infelicitous in contexts where the speaker has direct evidence for the antecedent. This restriction can be seen at work in examples like (13).

- (13) CONTEXT: A and B are sitting in a room, facing a window through which both can see that it is raining.  
A: It's raining!  
B: #If it's raining, I'd rather stay inside.

Iatridou also argues for this generalization on the basis of the contrast shown in (14). Here, the default assumption is that one knows one's own feelings is enough to render (14b) infelicitous.

- (14) a. If I am so sick, why am I leaving the hospital?  
b. #If I feel so sick, why am I leaving the hospital?

Notice, however, that (14) can actually be felicitous in a context where it is in question whether the speaker knows or is accurately reporting their own mental state.

- (15) A: You're feeling sick.  
B: No I'm not!  
A: I'm a Betazoid. I'm telepathic. I can tell what you're feeling.  
B: Oh yeah? Well, if I feel so sick, why am I leaving the hospital?

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tacit assumption in this section is that the examples discussed form a natural class, united by the characteristics discussed here as well the syntactic patterns discussed by Iatridou and Haegeman. Thus, presented with counterexamples to an apparent generalization about factual conditionals, one can always respond that the putative counterexample is not a true factual conditional. But then we would expect the counterexample to not display the other behaviors associated with factual conditionals. A skeptical reader can easily verify that all the examples in this section do indeed pattern with FC's and not with other kinds of conditionals.

Thus, Iatridou’s generalization about speaker knowledge seems to be very robust. But why should it be the case? Why would this kind of restriction covary with the others that we have seen in this section? This is our fifth and final puzzle.

## 4.2 ‘If yes’ and ‘If so’

To address the general questions about factual conditionals presented in Section 4.1, we will first focus on a smaller problem. The solution to this smaller problem will narrow the space of possible solutions to the general problems, leading us towards what I argue to be the correct ones.

### 4.2.1 The puzzle

The present puzzle concerns the contrast between (16) and (17).

(16) CONTEXT: A and B are discussing a recently passed law. B has heard conflicting reports about the content of this law, but knows that unconstitutional laws are always repealed in this country.

- a. A: Does this law run afoul of the sixth amendment?  
B: If **so**, then it will be repealed!
- b. A: This law runs afoul of the sixth amendment!  
B: If **so**, then it will be repealed!

This example shows that the polarity particle ‘so’, when embedded in the antecedent of a conditional, can pick up a proposition highlighted either by a question or by an assertion. As shown in (17), ‘yes’ is much more restricted.<sup>5</sup>

- (17) a. A: Does this law run afoul of the sixth amendment?  
B: If **yes**, then it will be repealed!
- b. A: This law runs afoul of the sixth amendment!  
B: #If **yes**, then it will be repealed!

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<sup>5</sup>Krifka (2013) marks ‘if yes’ conditionals with a question mark, indicating that they are less than fully acceptable. This appears to accord with the intuitions of some native speakers but not others. However, even for native speakers who do not entirely accept examples like (18a), examples like (18b) are dramatically worse.

An immediate reaction to this data might be that this has nothing to do with conditionals and that ‘yes’ can only pick up an anaphoric antecedent highlighted by a question. However, as (18) shows, this is not a restriction that ‘yes’ obeys in matrix clauses.

- (18) a. A: Does this law run afoul of the sixth amendment?  
B: **Yes**, it does.
- b. A: This law runs afoul of the sixth amendment!  
B: **Yes**, it does.

Thus, this pattern seems to be a product of (i) some property of ‘if’-clauses conspiring with (ii) some property which distinguishes questions from assertions in a manner which is sensitive to (iii) some property which distinguishes ‘yes’ and ‘so’. But what properties might those be and how do they conspire to produce the pattern in the data?

An appealing option is as follows. Because of the principle of *No Vacuous Moves* given in Definition 32, an utterance of ‘if  $\varphi$ ’ will convey that the effects of  $\varphi$  are not already present in discourse. Then, because plain declaratives highlight their own content whereas polar questions merely highlight their positive answers, an utterance of the form ‘if yes/so’ will signal different attitudes towards the previous utterance depending on whether it is a question or an assertion. In response to a question, such an utterance will signal that the speaker accepts the issue but wants to refine it rather than resolve it, whereas in response to an assertion, it will signal something less than full uptake of the information conveyed. Thus, ‘less than full uptake’ seems to be the crucial notion here and a solution to this puzzle seems to be a matter of finding a contrast between ‘yes’ and ‘so’ which is sensitive to it in these kinds of constructions.

Some immediate evidence in favor of this approach comes from the fact that we can replicate the pattern in (17) and (18) when embedding ‘so’ and ‘yes’ under the adverb ‘possibly’. This fact favors our approach since ‘possibly’ signals ambivalence to its prejacent.<sup>6</sup>

- (19) a. DETECTIVE A: Is the suspect in Stockholm?

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<sup>6</sup>We can also replicate this pattern with other adverbs of possibility such as ‘perhaps’ and ‘maybe’, so long as they are stressed. The fact that stress must occur on the adverb rather than the polarity particle might seem to work against the argument made above. However, when stress occurs on the polarity particle, the most natural reading is one which conveys that the highlighted proposition is irrelevant rather than uncertain. Thus, the necessity of stressing the adverb in fact supports the argument given above.

- DETECTIVE B: Possibly **so**, but we can always enlist the Stockholm police.
- b. DETECTIVE A: The suspect is in Stockholm.  
DETECTIVE B: Possibly **so**, but we can always enlist the Stockholm police.
- (20) a. DETECTIVE A: Is the suspect in Stockholm?  
DETECTIVE B: Possibly **yes**, but we can always enlist the Stockholm police.
- b. DETECTIVE A: The suspect is in Stockholm.  
DETECTIVE B: #Possibly **yes**, but we can always enlist the Stockholm police

Therefore, this is the approach that we will take.

#### 4.2.2 Coherence of commitments

In order to complete our explanation of the contrast between (17) and (18), we need to find a property distinguishing ‘yes’ from ‘so’ which interacts with the kinds of distinctions discussed above. And indeed, there is a very obvious candidate: the kind of commitments the two particles are capable of creating. Since ‘yes’ produces a self-sourced commitment, *No Vacuous Moves* tells us that ‘if yes’ conveys that the speaker does not have a self-sourced commitment in the main context. On the other hand, since ‘so’ does not put any restriction on what kind of commitment it creates, ‘if so’ can either convey that the speaker lacks a self-sourced commitment or that they lack a dependent commitment in the main context.<sup>7</sup> These are the properties that we will work with in our eventual explanation, but they are not sufficient to explain the data on their own. In order to put them to work, I will introduce some well-motivated principles governing attitudes and in particular the interrelation between them.

Our first constraint will govern the interrelation between objections and self-sourced commitments. The intuition we want to capture with this prin-

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<sup>7</sup>Recent literature such as Needham (2012) has drawn on the restricted distribution of ‘so’ to argue that its semantics directly encodes the requirement that the speaker has no commitment to its anaphoric antecedent in the context of utterance. If we adopted such an analysis, the only details of my account to change would be the exact mechanism by which ‘if so’ conveys a lack of a commitment in the main context.

ciple is that one cannot hold both an objection attitude and a self-sourced commitment attitude simultaneously towards the same proposition. To see why this is motivated, recall that an agent can only make a self-sourced commitment in good faith if it accurately represents the information they have strong evidence for and the issues that they genuinely entertain. Thus, if an agent does not obey this principle, they are either publicly signaling an incoherent state of mind or bad faith. Either is sufficient to derail a conversation.

To see how we can capture this fact formally, recall from Definition 19 that  $SS_a$  is the strongest proposition  $a$  commits to as source and that  $OS_a$  is the weakest proposition  $a$  objects to. Thus, if  $a$ 's internal state licenses acceptance of  $SS_a$ , it must license all (and only) propositions weaker than  $SS_a$ . Similarly, if  $a$ 's internal state leads them to object to  $OS_a$ , they must object to all (and only) propositions stronger than  $OS_a$ . Thus, our intuition tells us that no proposition should be weaker than  $SS_a$  but stronger than  $OS_a$ . Or in other words:

**Definition 33** (Coherence of Self-Sourced Commitments and Objections).

$$SS_a \not\subseteq OS_a$$

Crucially, there is no corresponding principle requiring coherence of *dependent* commitments with objections. This makes sense intuitively, since objections are signals of one's internal state, and dependent commitments can be made independently of one's internal state. However, there is also empirical evidence suggesting that the verbal actions I have taken to correspond to dependent commitments are compatible with those I have taken to correspond to objections. Such evidence is shown in (21).

- (21) A: There's a Bagels and Beans location at Waterloo-plein.  
 B: I'm skeptical, but okay.

Our second principle will govern the interrelation between commitments and refusals. Since refusals are defined as the attitude one signals when one refuses to commit to a piece of content, we require them to be incompatible with both self-sourced and dependent commitments. Since the refusal attitude is closed under converse-entailment like the objection attitude, we can capture this intuition formally as shown below.

**Definition 34** (Coherence of Commitments and Refusals).

$$SS_a \cap DS_a \not\subseteq RS_a$$

Our third principle will govern the interrelation between self-sourced and dependent commitments. At first glance, it might seem that we want to do something analogous to what we did above and require the two attitudes to be disjoint. However, such a principle would be too strong. While the pairs of attitudes discussed above are all mutually exclusive, self-sourced commitment and dependent commitment are not. For instance, notice that both kinds of commitment attitudes are closed under entailment. If you commit to  $P$ , then you also commit yourself to any proposition weaker than  $P$ , regardless of the source of your commitment. This means that some propositions must be entailed by both attitude states— if nothing else, then at least the tautology  $\mathcal{P}(W)$ . As a result, we cannot expect the two attitudes to be disjoint.

It is also tempting to forbid some kind of entailment relation between the states  $SS_a$  and  $DS_a$ , since it seems as though self-sourced commitments supersede dependent ones. However, once again, such a principle would be too strong. For instance, imagine that you are having a conversation with A, who is a narcissist and keeps talking about things he has seen and done without letting you get a word in. In this conversation, A will make no dependent commitments, but will make quite a few self-sourced ones. As a result, we will have that  $SS_A \subseteq DS_A$ . On the other hand, you are likely to be in the reverse situation, meaning that  $DS_{you} \subseteq SS_{you}$ . Since this scenario seems like a well-formed (if regrettable) conversation, it doesn't seem like we can ban any particular entailment relation between self sourced sets and dependent sets.

However, there is a sense in which we expect self-sourced commitments to supersede dependent ones. For instance, consider the dialogue shown below in (22).

- (22) A: Look! There's a hedgehog in the kitchen!  
 B: (*looks and sees hedgehog*) #Okay, I'll take your word for it!

In this dialogue, B's response is very strange. Why would someone choose to commit based on testimony when firsthand evidence was available? This example shows that the restriction we are looking for does not concern the properties of agents' commitment states, but rather the permissible actions they may take to update them. Specifically, we want to capture that someone who *can* commit as source *must* commit as source. Of course, since this principle concerns the relation between private and public attitudes while our own system concerns only public attitudes, this intuition is not something

we can directly require of our system.<sup>8</sup>

Instead, we must posit principles regarding the discourse moves which would reveal a violation of this principle. Here are two such principles. First, if an agent is already committed to a proposition as source and later commits dependently, this would be a patent violation of our intuition. This is shown in Definition 35.

**Definition 35** (Self-Sourced Precludes Dependent). If  $SS_a \subseteq P$ , then it is infelicitous for  $a$  to commit to  $P$  dependently.

Similarly, if an agent is already committed to a proposition dependently and later commits as source, that shows that their earlier commitment was not made on the basis of the strongest possible evidence. Thus, we have the additional principle in Definition 36.<sup>9</sup>

**Definition 36** (Dependent Precludes Self-Sourced). If  $DS_a \subseteq P$ , then it is infelicitous for  $a$  to commit to  $P$  as source.

Finally, in order to give these principles some teeth, we will assume that by default, attitudes on the conversational scoreboard stay there. This is not to say that agents cannot change their minds about their attitudes. Of course, one can walk back a commitment or rethink a refusal. However,

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<sup>8</sup>These principles could be subsumed under general rational principles in an extension of this system which includes representations of agents' actual epistemic-inquisitive states. However, it is not clear that this would be the correct way to go. One could view the principles I have posited as generalizations about rational behavior, but one could also take them to be hardwired principles in the grammar. To investigate this issue, one could look for abnormal situations in which a rational agent would have reason to violate one of these principles.

<sup>9</sup>These two principles together entail that commitments can only be created, but cannot be shifted back and forth between the two subtypes. Or in other words, a discourse move cannot update  $SS_a$  or  $DS_a$  unless it updates  $SS_a \cap DS_a$ . This way of looking at the above principles is interesting since it looks suspiciously similar to what *No Vacuous Moves* would predict if applied to an agent's sum total commitments. Thus, one might wonder whether we can in fact reduce these two principles to *NVM*. The obvious way of doing so would be to revise our earlier notion of a context so that agents only have a single commitment state. However, it is difficult to see how this could be accomplished in a way which allows us to separate self-sourced and dependent commitments without falling back to something equivalent to the present system.

A more promising avenue would be to redefine dependent states so that they include only content exclusively provided by testimony. On this story, accepting a self-sourced commitment to a proposition  $P$  would have to be accomplished by intersecting  $SS$  with the relative pseudo-complement of  $P$  and  $DS$  (and analogously for updates on  $DS$ ). I do not pursue this idea because it is unnecessarily complicated for our present purposes, but it could be an interesting avenue for future work.

doing so requires a revision, which must be explicitly signaled, for instance with special language as shown in (23).

- (23) a. A: There’s a Bagels and Beans location at Waterlooplein.  
B: I’m not so sure about that.  
A: No really, there is one.  
B: #Yes, there is one.
- b. A: There’s a Bagels and Beans location at Waterlooplein.  
B: I’m not so sure about that.  
A: No really, there is one.  
B: Oh wait, I’m mixing up Waterlooplein and Gruttoplein! Yes, you’re right, of course there is one at Waterlooplein.

In this thesis, I am not concerned with any empirical phenomena which require revision, so I will not introduce a revision mechanism into the formal system. The important point for us is merely that revision is only possible in the presence of extra marking. This marking can come in the form of a retraction of commitment using phrases such as “oh well actually” or “nevermind”, but can also be grammatically marked, for instance with X-Marking.<sup>10</sup>

Crucially, as shown in (24), X-Marking is impossible on the antecedent of an ‘if yes’-conditional.

- (24) A: Krsto didn’t come with us for lunch at Bagels and Beans.  
B: #Right, but if yes, he would have found it delicious.

This restriction is most likely for syntactic reasons. Since ‘yes’ is substitutable for an entire sentence, it seems to occupy a syntactic position larger than that which can be selected for by a head bearing X-Marking. This fact will play a crucial role in explaining the pattern exhibited in (17) and (18), as we will see in the next section.

### 4.2.3 Catching the data

To see how this system captures the data, let’s consider the most challenging example first, namely the dialogue where B’s conditional is infelicitous. This example is repeated below as (25).

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<sup>10</sup>Following recent literature, I use the term *X-Marking* introduced by Iatridou and von Stechow as a replacement for the traditional but enormously misleading terms *subjunctive marking* and *counterfactual marking*.

(25) CONTEXT: A and B are discussing a recently passed law, but neither has yet made any public commitments about it. B has heard conflicting reports about the content of this law, but knows that unconstitutional laws are always repealed in this country.

A: This law runs afoul of the sixth amendment!

B: #If yes, then it will be repealed!

My explanation for this infelicity can be stated informally as follows. In this dialogue, A proposes to update the common ground with the information that this law runs afoul of the sixth amendment. B responds with a conditional, but by the principle of *Resolve Immediately* given in Definition 25, this conditional must be understood as following an implicit adoption of some sort of attitude towards A’s information. Crucially, that attitude is inherited in the hypothetical context created by ‘if’, where it clashes with the self-sourced commitment created by ‘yes’, thus resulting in infelicity. The principles we introduced in the previous section guarantee this clash, no matter which specific attitude B signals.

In the next several paragraphs, we will go through the formal details of how my system from Chapter 3 derives this result. In my system, the utterances in this dialogue are understood as formulas of  $\mathcal{L}_2$ , which update a macro-context  $\tau$ . For simplicity, we will assume that  $\tau$  is just the singleton macro-context  $\langle C \rangle$ , but it should be easy to check that nothing substantive changes if we take a more complex example. In this system, A’s utterance translates to the formula  $sp$ , which updates  $\tau$  to the macro-context  $\tau +^A sp = \langle C[sp]^A \rangle$  where  $C[sp]^A$  is identical to  $C$  except that  $\mathbf{table}^{C[sp]^A} = \langle \llbracket p \rrbracket, \mathbf{table}^C \rangle$ ,  $\mathbf{drefs}^{C[sp]^A} = \langle \{\llbracket p \rrbracket\}, \mathbf{drefs}^C \rangle$ , and  $\mathbf{ss}_A^{C[sp]^A} = \mathbf{ss}_A^C \cap \llbracket p \rrbracket$ .

By the principle of *Resolve Immediately*, B’s subsequent discourse move is not that brought about by their conditional, but is rather an implicit reaction to A’s proposal. In other words, B’s conditional does not update the macro-context  $\langle C[sp]^A \rangle$  but rather the macro-context  $\langle C[sp]^A[\varphi]^B \rangle$  where  $\varphi$  is one of the attitude constants S-ACCEPT, D-ACCEPT, REFUSE, or OBJECT. Thus, the result of B’s conditional is the macro-context  $\langle C[sp]^A[\varphi]^B \rangle +^B \text{IF YES}$ , or in other words  $\langle C[sp]^A[\varphi]^B[\text{YES}]^B, C[sp]^A[\varphi]^B \rangle$ .

Now, no matter which attitude constant we take  $\varphi$  to be, we will find that it sets up B’s conditional for infelicity. For instance, if  $\varphi = \text{S-ACCEPT}$ , then B’s utterance of ‘if yes’ will violate *No Vacuous Moves*. To see why, first observe that since A’s utterance of  $sp$  placed  $\{\llbracket p \rrbracket\}$  on the top of the stack  $\mathbf{drefs}$ , the polarity particle YES will take  $\llbracket p \rrbracket$  as its anaphoric antecedent. This means that  $C[sp]^A[\text{S-ACCEPT}]^B[\text{YES}]^B$  will differ from  $C[sp]^A[\text{S-ACCEPT}]^B$

only in that  $SS_B^{C[sp]^A[S-ACCEPT]^B[YES]^B} = SS_B^{C[sp]^A[S-ACCEPT]^B} \cap \llbracket p \rrbracket$ . However, we also know that  $SS_B^{C[sp]^A[S-ACCEPT]^A} = SS_B^{C[sp]^A} \cap \llbracket p \rrbracket$ , so updating with YES will be a vacuous discourse move and therefore unlawful.

Similarly, if  $\varphi = D-ACCEPT$ , then B's conditional violates *Dependent Precludes Self-Sourced* from Definition 36. To see how this is so, observe that D-ACCEPT creates a dependent commitment to  $p$  for B which means that  $DS_B^{C[sp]^A[D-ACCEPT]^B} = DS_B^{C[sp]^A} \cap \llbracket p \rrbracket$ . This in turn means that  $DS_B^{C[sp]^A[D-ACCEPT]^B} \subseteq \llbracket p \rrbracket$ , and so trying to add a self-sourced commitment to  $p$  in this context would be an infelicitous action by the principle of *Dependent Precludes Self-Sourced*.

Next, if  $\varphi = OBJECT$ , then  $OS_B^{C[sp]^A[OBJECT]^B} = OS_B^{C[sp]^A} \cup \llbracket p \rrbracket$  and so we have that  $\llbracket p \rrbracket \subseteq OS_B^{C[sp]^A[OBJECT]^B[YES]^B}$ . However, since we know that  $SS_B^{C[sp]^A[OBJECT]^B[YES]^B} \subseteq \llbracket p \rrbracket$ , this means that  $SS_B^{C[sp]^A[OBJECT]^B[YES]^B} \subseteq \llbracket p \rrbracket \subseteq OS_B^{C[sp]^A[OBJECT]^B[YES]^B} \subseteq \llbracket p \rrbracket$ , which is ruled out by *Coherence of Self-Sourced Commitments and Objections* as shown in Definition 33. Finally, if  $\varphi = REFUSE$ , then an analogous argument shows that B's conditional will run afoul of *Coherence of Commitments and Refusals* as defined in Definition 34. Thus, for any choice of a discourse move  $\varphi$ , we run afoul of some constraint. Hence, we predict B's conditional in (25) as infelicitous.

Why does analogous reasoning not block the parallel example with 'so' instead of 'yes'?

- (26) A: This law runs afoul of the sixth amendment!  
 B: If so, then it will be repealed!

My story about (26) begins the same way as my story about (25). A's utterance updates  $\langle C \rangle$  to  $\langle C[sp]^A \rangle$  and then B's implicit reaction updates that macro-context, returning  $\langle C[sp]^A[\varphi]^B \rangle$ , where  $\varphi$  is some attitude constant. Things change in that this time, B's conditional antecedent creates a hypothetical *dependent* commitment to  $p$  instead of a self-sourced one, taking us to the macro-context  $\langle C[sp]^A[\varphi]^B[SO]^B, C[sp]^A[\varphi]^B \rangle$ .

This difference is significant since dependent commitments are less picky about what other attitudes they coexist with. The attitude constant  $\varphi$  cannot be S-ACCEPT due to *Self-Sourced Precludes Dependent*. Nor can it be D-ACCEPT due to *No Vacuous Moves*. It cannot be REFUSE due to *Coherence of Commitments and Refusals*. It can, however be OBJECT, since agents can bear both an objection attitude and a dependent commitment to the same proposition. Thus, there is an acceptable parse of this dialogue,

namely one in which B signals that they have reasons to doubt A’s claim but uses a hypothetical dependent commitment to go on and consider the implications it would have if true.

Why does this not affect B’s conditional when it occurs as a response to a question?

- (27) a. A: Does this law run afoul of the sixth amendment?  
 B: If yes, then it will be repealed!
- b. A: Does this law run afoul of the sixth amendment?  
 B: If so, then it will be repealed!

Once again, in these dialogues, A’s utterance makes a proposal which B must implicitly react to before going on to create a hypothetical context by uttering IF YES. However, in these examples, A’s utterance is of a very different nature than in those we considered before, since it translates as  $s?p$  rather than as  $sp$ . This is a significant difference for our purposes since this formula will update  $\langle C \rangle$  to  $\langle C[s?p]^A \rangle$ , where  $[[?p]]$  is the most salient proposition in  $\text{table}^{C[s?p]^A}$ , but  $[[p]]$  is the most salient discourse referent in  $\text{drefs}^{C[s?p]^A}$ . Since the most salient discourse referent is not also the most salient proposal, when B signals an attitude towards A’s proposal, they accept a weaker commitment than they do in their hypothetical context. As such, B can enter into the utterance of the conditional with a commitment slate that has no bearing on  $p$ , at which point nothing blocks their hypothetical commitment from being either self-sourced or dependent.

### 4.3 Back to factual conditionals in general

In this section, I show that we can use what we have learned about ‘if so’ conditionals in order to answer the questions about factual conditionals which I raised in Section 4.1. The reason we can do this is simple. An ‘if so’ conditional functions as a FC when it occurs in response to an assertion. This much is suggested by the general rule of thumb I gave for identifying FC’s, but closer examination confirms that they indeed act as a natural class with other known instances of FC’s. For instance, consider the dialogue in (28) below, which is analogous to (2) from earlier.

- (28) A: John’s under a lot of pressure these days.  
 B: #John won’t finish on time if so, but rather if he has space to

think.

This example shows that when an ‘if so’ conditional occurs in response to an assertion, it must scope above negation, just like the antecedent of a FC. Similarly, as shown in (3), an ‘if so’ conditional that occurs in response to an assertion is subject to the same order restrictions as the ‘if’-clause of a FC.

- (29) a. A: Saúl is coming to the party!  
B: The party will be fun if so, if there’s enough beer.
- b. A: Saúl is coming to the party!  
B: \*The party will be fun if there’s enough beer, if so.

Thus, we can use the analysis that we were forced into by what we know about the kinds of commitments ‘yes’ and ‘so’ create in order to tell us about FC’s in general.<sup>11</sup>

#### 4.3.1 The job of a FC’s antecedent

Recall that our first question about FC’s regarded the job that their antecedents perform. If we use ‘if so’ as our guide, then the answer to this question is that the antecedent of a FC creates a hypothetical dependent commitment. This means that the relation between the antecedent and consequent of a FC is just the same as with any other conditional. The antecedent introduces a hypothetical discourse move whose consequences can be explored by the consequent.

This leaves the question of why, as Haegeman and Wekker (1984) and Iatridou (1991) argue, it seems like the antecedent of a FC does not specify the circumstances in which its consequent is true, unlike garden-variety conditionals. The answer I give for this is that they in fact *do* specify those circumstances. Recall the dialogues that are taken to show that they don’t:

- (30) A: Grzegorz is coming over!  
B: Oh! If Grzegorz comes over, he will bring goat cheese.  
A: Sorry, I missed that. Under what circumstances is Grzegorz gonna bring goat cheese?  
B: #If he comes to visit.

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<sup>11</sup>Recall that I use these syntactic patterns merely as diagnostics. The present system does not explain them.

This example can be taken to show that FC's aren't about the circumstances in which their consequents hold if one sees the problem as something about the meaning conveyed by B's utterance. In other words, Haegeman and Iatridou tacitly assume that this dialogue is infelicitous because A's final question acts as if B had made a claim about the circumstances in which Grzegorz would bring goat cheese, when B's utterance in fact made a different claim. However, one can alternatively view the problem as arising from A's viewpoint. Since A is committed to the actual circumstances being that in which Grzegorz comes over, it makes no sense for A to generalize over the possible states of the world. Some evidence in favor of this latter interpretation comes from dialogues like the one in (31), where A revises away their earlier commitment and thereafter can speak as if B's FC had conveyed something about the circumstances in which its consequent holds.

- (31) A: Grzegorz is coming to visit.  
 B: Oh! If Grzegorz comes to visit, he will bring goat cheese.  
 A: Actually, wait, I'm mixing up the days. But it's nice to know that we'd have some goat cheese in different circumstances.

Thus, I conclude that the antecedent of a FC differs from antecedents of other kinds of conditionals only in that they create a dependent commitment.

### 4.3.2 The discourse function of a FC

Our second question asked what the discourse function of a FC is. This was unclear since some examples seemed to suggest that they function as refusals while others looked more like dependent commitments. To answer this question, we will once again follow the model of 'if so'. If we transfer our earlier account of 'if so' to cover FC's in general, what we find is that a FC triggers an objection. This result puts us in a good place to explain the equivocal data that we saw earlier, since an objection can be followed by either a refusal or a self-sourced commitment. To see how this explains our data, recall our cases of apparent refusal, repeated as (32)

- (32) a. A: This is a consular ship!  
 B: If this is a consular ship, where is the ambassador?
- b. A: I'm sober!  
 B: If you're sober, I'm a monkey's uncle.
- c. A: I'm gonna send you my paper tomorrow.

B: If you send me your paper tomorrow, I will be very pleased.

The refusals expressed by the conditional in (32a) can be explained in terms of the discourse function of its consequent. The consequent of this conditional can be seen as a sarcastic rhetorical question of the sort that might prompt an objection even in the absence of an ‘if’-clause. Similarly, (32b) could be explained by the fact that here, B seems to suggest that an absurdity would follow if A were correct. In (32c), the story is a bit different. In this case, the student A’s utterance can be understood as a promise, and hence an absolute guarantee that they will send the paper tomorrow. Thus, objecting to someone’s promise indicates a lack of trust, effectively annihilating the promise’s reason for existing. Hence, it strongly suggests a refusal.

These examples are relatively easy to account for, but our example of a FC that accepts its antecedent is a bit trickier. This example is repeated below as (33).

- (33) A: It’s Zhuoye’s birthday today!  
B: Oh! If it’s Zhuoye’s birthday, I better start baking him a cake!  
(*B hurries off to bake a cake*)

In this example, it is clear from B’s action that they do accept A’s initiative. However, given that Gunlogson (2008) treats ‘oh!’ as a diagnostic for dependent commitments, it might seem that in this example, B makes a dependent commitment before uttering the FC. This would be a problem since it would rule this example out as violating *No Vacuous Moves*. However, if we consider ‘oh’ more closely, we see that it need not represent a dependent commitment. For instance, consider the dialogue in (34).

- (34) A: The seventh layer of Troy corresponds to the city of the *Iliad*.  
B: Oh! Was the *Iliad* based on a true story?

In this example, B responds to A’s initiative with ‘oh’, but clearly does not accept it, as evidenced by them requesting confirmation of one of its presuppositions. Thus, it seems that ‘oh’ directly encodes some more general speech act and ends up requiring a dependent commitment in particular cases for other reasons. So what does ‘oh’ mean at its most general? Here, we can go with the most intuitive answer. ‘Oh’ expresses surprise, or in other words that the content of the most salient proposal is not what one would expect given one’s mental state. Hence, in (33) ‘oh’ can be taken to correspond not to a dependent commitment but rather to the objection which we already

know is there!

This is not to say that Gunlogson's diagnostic does not work. It clearly does work. But it works not because 'oh!' directly conveys a dependent commitment but rather because it conveys an objection, which precludes a self-sourced commitment. Thus, when one says 'oh' in a context where other phrases such as 'I didn't know that' signal acceptance of a commitment, that commitment will necessarily be a dependent one.

Thus, we can conclude that a FC signals that the previous initiative does not sit entirely easily with the speaker's mental state, but places no requirements on how they resolves that tension. The speaker can decide to follow their internal motivation and perform a refusal or put aside their inner qualms and accept the initiative.

### 4.3.3 Why FC antecedents are not vacuous

Our third question was why FC's are felicitous given that their antecedents do not appear to do much of anything. This question was the most pressing of the five that I raised not just because it concerns the reason for the existence of the phenomenon under discussion, but because the problem it raises threatens to unseat some of the basic things that we know about indicative conditionals in general. However, given what I have said in the past several pages, the answer to this puzzle falls out almost trivially. The antecedent of a FC *does* do something— it introduces a dependent commitment. Hence, we can square the existence of FC's with everything else we know about conditionals by appealing to general conversational principles. This is good news.

### 4.3.4 Linking via dependent commitment

Our fourth question concerned the exact mechanism which links FC's to earlier discourse. Once again, the answer to this question is made clear by what we have said so far. The defining characteristic of a FC is that its antecedent creates a hypothetical dependent commitment, thereby triggering an objection in the main context. Thus, a FC requires there to be a previous utterance which the speaker objects to in the main context and then commits to dependently in a hypothetical context. Hence the link between an antecedent and earlier discourse: the antecedent must express a dependent commitment to an earlier utterance.

### 4.3.5 Evidence leads to clashing commitments

Our final question asks why the speaker of a FC cannot have firsthand evidence for its antecedent. The crucial data concerns examples like (35).

- (35)   CONTEXT: A and B are sitting in a room, facing a window through which both can see that it is raining.  
A: It's raining!  
B: #If it's raining, I'd rather stay inside.

In this example, it is common ground that B's private evidentiary state would demand that they believe that it is raining. Thus, it would be seen as incompetently deceptive at best for B to react to A's initiative with anything other than S-ACCEPT. But if B reacts this way, then their self-sourced commitment will be inherited in the hypothetical context created by the antecedent of their conditional, where it will preclude a dependent commitment. Hence, one cannot have firsthand evidence for the antecedent of a FC.<sup>12</sup>

## 4.4 Conclusions

In this chapter, I showed that the system introduced in Chapter 3 allows us to explain factual conditionals, a phenomenon whose existence looks surprising from the perspective of earlier work on conditionals. In a nutshell, the story I told is that a FC signals an objection to an earlier initiative, but creates a dependent commitment in a hypothetical context. In this way, a FC can be seen as a vehicle for speakers to discuss the consequences of another agent's initiative while conveying that it does not sit entirely easily with their mental state.

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<sup>12</sup>Since I did not specify precise principles linking public and private attitudes, one could conceivably argue that an agent can refuse some information which everyone knows that they know, if they have social reasons for wanting to stay publicly neutral. Of course there is no sign that this is what's going on in (35), but even if it were, that would not change anything substantive, since a refusal would equally well block a hypothetical dependent commitment.

## 5. Conclusion

The central claim of this thesis is that the hypothetical aspect of conditionals does not just involve hypothetical content, but rather hypothetical discourse effects as well. The main argument for this claim comes from the fact that we can find felicity contrasts between ‘if yes’ and ‘if so’, even in contexts where they convey the same content.

Since the specific system I proposed operates via updates on fine-grained discourse contexts, it is very well suited to the task of explaining this data, but it is worth asking if it is essential or if other approaches would do the trick. This question might appear especially pressing since one of my ancillary arguments in favor of this model was that it can preserve some conventional wisdom about the pragmatics of conditionals, yet my approach departs from conventional wisdom in other ways. Thus I will conclude with some reasons to not be afraid of the stack model and some reasons why it might be difficult to account for this data with a more traditional approach.

The main concern one might have about the stack model as I have presented it is that it treats natural language conditionals as informationally equivalent to material implication (plus a mechanism for modal subordination). As a result, it suffers from the infamous paradoxes of material implication. This is indeed a serious limitation of the present system, but it does not reflect poorly on the stack model in general since it does not arise from the central features of the framework. What I take to be essential about the stack model is merely that (i) ‘if’-clauses create hypothetical contexts which can in principle linger indefinitely and (ii) that updates to this hypothetical context percolate down to other contexts. Crucially, different proposals based on these two principles can vary in terms of what they take contexts to consist of and how they define percolation. This fact is crucial since the logical problems with the system as presented here could be overcome easily by taking commitment states to be structured as systems of spheres in the manner of Lewis (1973) or as hyperdomains in the manner of Gillies (2007).

If one is not swayed by my reassurance and still wants to explore alter-

natives to the stack model, one obvious starting point might be to couple a presuppositional analysis of the contrast between ‘yes’ and ‘so’ with a more traditional analysis of conditionals such as that of Kratzer (1981, 1986, 1991). For instance, we might say that ‘yes’ presupposes that its antecedent follows from the speaker’s private epistemic-inquisitive state while ‘so’ presupposes that its anaphoric antecedent does not. The challenge with this approach is that we would expect these presuppositions to project out of the antecedent of the conditional, which is not what we see in examples like those in (1).

- (1) a. A: Is the exam today?  
B: If yes, I’m an idiot! I thought it was next week.
- b. A: Is the exam today?  
B: If so, that would explain why everybody else is nervously flipping through their notes.

This is not to say that one absolutely cannot explain this data using modal bases and restrictors. However, given data like this, the stack approach looks pretty good.

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