To appear in Journal of Semantics, special volume on Language Under Uncertainty. (Scheduled: Fall 2008)

Conditional Questions

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Abstract

This paper provides an analysis of conditional questions that combines a dynamic semantics for conditionals with a partition semantics for questions. We propose that conditional questions are interpreted in two steps. First, a temporary context is created in which the propositional content of the antecedent obtains. Second, the question in the consequent is asked relative to this temporary context. Subsequent answers are then asserted relative to the temporary context. Our analysis also has a pragmatic component. Previous analyses have augmented the semantics to account for denials of the antecedents of conditional questions. We show that the effect of denying the antecedent of a conditional question is not due to the semantics of the question. Instead, denials of the antecedent deny the presuppositions of the conditional, and do not directly address the question at all.

1 INTRODUCTION

This paper provides an analysis of conditional questions (CQs) such as (1). CQs are conditional sentences with interrogative consequents.

(1) If Alfonso comes to the party, will Joanna leave?

The puzzling fact about (1) is that, as a question act, it is much more limited in scope than the plain polar question "Will Joanna leave?" While both ask for similar information about Joanna, the conditional question is only concerned with a limited set of circumstances: the ones in which Alfonso comes to the party. To capture this, the semantics of the conditional antecedents must interact with the semantics, and especially the dynamics, of questions. This paper addresses that interaction.

We argue that CQs are best analyzed by combining a dynamic semantics for conditionals (along the lines of Stalnaker 1968, Karttunen 1973, 1974, Heim 1983, Heim 1992, and much other work) with the partition semantics for questions proposed in Groenendijk (1999). We propose that a conditional adjunct restricts the domain of the question operator, and we provide a technical mechanism for describing this domain restriction in a dynamic semantics.

In our approach, the interpretation of the antecedent and the consequent of a CQ is decomposed into two steps. The first step involves making a temporary copy of the current context and updating the copy with the propositional content of the antecedent. The question in the consequent then raises an issue relative only to the temporary context. Temporary contexts for conditionals are treated on par with the temporary contexts involved in some analyses of modal subordination (Frank 1996; Kaufmann 2000). What this means is that they may persist past the sentence that introduces them. Our formalization of this persistence uses the stack-based account of modal subordination proposed in Kaufmann (2000) to model temporary contexts.

The analysis we propose also has a pragmatic component to deal with responses such as (2).

(2) Alfonso isn't coming.

Intuitively, following such a response (a denial of the antecedent), no further answer to the CQ is required. This fact has lead previous accounts to propose that denials of the antecedent are in fact answers of some sort, or at least that they play a role in the alternative structure that the question introduces. We argue that these accounts semanticize a pragmatic effect – that denials of the antecedent are denials of a presupposition of the conditional (that the antecedent is possible). We conclude that responses of this kind do not play a role in the question's alternative structure, and that their interpretation involves quite different principles – belief revision and conversational backtracking.

A major issue in the background throughout the paper is what Groenendijk and Stokhof (1997) call "Hamblin's Picture". This is a view of questions that takes the alternative structure they introduce to be a partition; i.e., it consists of mutually exclusive alternatives that exhaust the logical space. An attractive alternative analysis of the denial of the antecedent data, as well as the semantics of CQs, involves abandoning the mutual exclusivity component of Hamblin's picture (Velissaratou 2000). We argue that this is not the right way to go, and show that mutual exclusivity can be retained as a property of questions and of contexts. However, we also show that partially adopting an approach along the lines of Velissaratou (2000) leads to a simpler semantics for embedded conditional questions.

The remainder of the paper is structured as follows. In §2, we provide an overview of the background assumptions that guide our analysis. In §3, we consider previous analyses of CQs (Hulstijn 1997; Velissaratou 2000) which call some of these assumptions into question, and discuss the problems raised by and confronting alternative approaches. In this section we also review a broad range of data that an analysis must cover. In §4, we give a presuppositional account of denials of the antecedent. In §5 we provide our analysis of matrix CQs, which is then exemplified in §6. Some issues that remain unsettled up to this point, involving the status of issues and the interpretation of counterfactual CQs, are addressed in §7. We extend our analysis to embedded CQs in §8. Finally, in §9 we discuss some larger issues raised by our analysis, and in particular how it relates to the analysis of conditionals proposed by Kratzer (e.g. in Kratzer 1986).

2 Background

We assume a dynamic possible worlds semantics, with a Stalnaker (1978)-style context. For our purposes, the important member of the context is the *context set*. The context set is the set of possible worlds that describe what the actual world could be like as far as the discourse participants are concerned. For example, if the discourse participants all publicly accept that it is raining at the time of utterance, the context set will only include worlds in which it is raining at this time. While many other elements are necessary to present a full representation of an utterance context (such as the time and place of utterance, information about the speaker, hearer(s), and so on), we disregard all but the context set here.

The meaning of an utterance, in this kind of system, is given as a context change potential (CCP) – a function from contexts to contexts. Assertions are proposals to change the context by reducing the context set. Prior to the assertion of *It is raining*, the context set contains worlds in which it is raining and ones in which it is not. Once the discourse participants accept the assertion is true, the worlds in which it is not raining are removed from the context set.

In (3), we give a typical dynamic semantics definition of the CCP of an assertion (focusing exclusively on context sets).[1] The static interpretation function $[\![]\!]^{w,c}$ is given a standard treatment.

(3) **Assertive update ($\oplus$) on contexts (preliminary)**
For any context c and clause[2] ϕ:
$c \oplus \phi =_{\text{def}} \{w \in c \mid [\![\phi]\!]^{w,c} = 1\}$

Asserting ϕ (as long as the assertion is accepted) amounts to removing worlds from the input context where the proposition denoted by ϕ is not true, or alternatively, leaving behind only worlds where the proposition is true.

[1] We do not, for the most part, provide a compositional dynamic semantics below the sentence level though this would be possible; see Muskens (1996) and Bittner (2001) for dynamic semantics accounts that do.

[2] We use the word "clause" to refer pretheoretically to the syntactic object that is roughly a sentence without force, or a sentence without a speech-act operator. It does not matter for our purposes whether this is a CP, an IP, or something else.

2.1 Questions and assertions in a dynamic partition semantics

We adopt a partition semantics for questions, following most closely Groenendijk (1999) (see also Higginbotham and May 1981; Groenendijk and Stokhof 1984; Higginbotham 1993; Groenendijk and Stokhof 1997, among others). Just as in the line of work stemming from Hamblin (1958, 1973) (e.g., Karttunen 1977; Kratzer and Shimoyama 2002), to know the meaning of a question is to know the possible answers to the question. In a partition semantics, possible answers correspond to cells (or for a more general term, alternatives) in a partition that the question induces on the set of possible worlds. The word "partition" is used in the technical sense – the alternatives represented by a partition are mutually exclusive, and exhaust the range of possibilities. For the sake of simplicity, we restrict our examples to polar questions.

Following Groenendijk (1999), we incorporate the possibility of partitioning into a dynamic semantics by treating the context as an equivalence relation on worlds. An equivalence relation on some set is a symmetric, transitive and reflexive relation, and is isomorphic to a partition of that set. The equivalence relation is represented by taking the context set to be a set of pairs of worlds. In standard dynamic semantics, a world is a live candidate for the actual world when it is present in the context set. In a Groenendijk-style dynamic semantics, a world is a live candidate for the actual world if it is present as either member of a pair in the context set.

Assertive update has the affect of eliminating pairs of worlds in a context set in which one world in the pair makes the content of the assertion false.

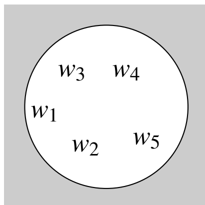
(4) **Assertive update ($\oplus$) on contexts**
For any context (set) c and clause ϕ:
$c \oplus \phi =_{\text{def}} \{\langle w_1, w_2\rangle \in c \mid [\![\phi]\!]^{w_1,c} = [\![\phi]\!]^{w_2,c} = 1\}$

The kind of update associated with questions does not ever remove worlds altogether, but rather disconnects parts of the context. It leaves worlds completely connected only if they correspond to the same complete answer – if they resolve the issue raised by the question in the same way. That is, a questioning update partitions the context set.

(5) **Inquisitive update ($\oslash$) on contexts**
For any context c and clause ϕ:
$c \oslash \phi =_{\text{def}} \{\langle w_1, w_2\rangle \in c \mid [\![\phi]\!]^{w_1,c} = [\![\phi]\!]^{w_2,c}\}$

The remainder of this section contains an example illustrating the basic dynamic semantics for questions. The example models a discussion about whether it is raining. The example will use a simple context set consisting of five worlds ($w_1 ... w_5$), shown in (6).

(6) $$c = \left\{ \begin{array}{ccccc} \langle \mathrm{w}_1, \mathrm{w}_1\rangle & \langle \mathrm{w}_2, \mathrm{w}_1\rangle & \langle \mathrm{w}_3, \mathrm{w}_1\rangle & \langle \mathrm{w}_4, \mathrm{w}_1\rangle & \langle \mathrm{w}_5, \mathrm{w}_1\rangle \\ \langle \mathrm{w}_1, \mathrm{w}_2\rangle & \langle \mathrm{w}_2, \mathrm{w}_2\rangle & \langle \mathrm{w}_3, \mathrm{w}_2\rangle & \langle \mathrm{w}_4, \mathrm{w}_2\rangle & \langle \mathrm{w}_5, \mathrm{w}_2\rangle \\ \langle \mathrm{w}_1, \mathrm{w}_3\rangle & \langle \mathrm{w}_2, \mathrm{w}_3\rangle & \langle \mathrm{w}_3, \mathrm{w}_3\rangle & \langle \mathrm{w}_4, \mathrm{w}_3\rangle & \langle \mathrm{w}_5, \mathrm{w}_3\rangle \\ \langle \mathrm{w}_1, \mathrm{w}_4\rangle & \langle \mathrm{w}_2, \mathrm{w}_4\rangle & \langle \mathrm{w}_3, \mathrm{w}_4\rangle & \langle \mathrm{w}_4, \mathrm{w}_4\rangle & \langle \mathrm{w}_5, \mathrm{w}_4\rangle \\ \langle \mathrm{w}_1, \mathrm{w}_5\rangle & \langle \mathrm{w}_2, \mathrm{w}_5\rangle & \langle \mathrm{w}_3, \mathrm{w}_5\rangle & \langle \mathrm{w}_4, \mathrm{w}_5\rangle & \langle \mathrm{w}_5, \mathrm{w}_5\rangle \end{array} \right\}$$



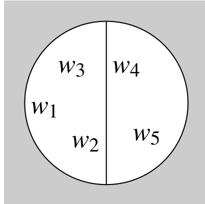
Let's assume that in w_1, w_2, and w_3 it is in fact raining, and in the other two worlds, it is not. We can then see what would happen if a speaker asked the question in (7).

(7) Is it raining?

This question is a polar question, and as such, partitions the context into two cells. The worlds in which it is raining constitute a cell, as do the ones in which it is not. Contexts consisting of more than one cell are called *inquisitive contexts* (Groenendijk 1999). The world pairs in bold are ones which resolve the question affirmatively.

(8) $c' = c \oslash \textit{it is raining} =$

$$\left\{\begin{array}{lllll} \langle \mathbf{w_1}, \mathbf{w_1} \rangle & \langle \mathbf{w_2}, \mathbf{w_1} \rangle & \langle \mathbf{w_3}, \mathbf{w_1} \rangle & & \\ \langle \mathbf{w_1}, \mathbf{w_2} \rangle & \langle \mathbf{w_2}, \mathbf{w_2} \rangle & \langle \mathbf{w_3}, \mathbf{w_2} \rangle & & \\ \langle \mathbf{w_1}, \mathbf{w_3} \rangle & \langle \mathbf{w_2}, \mathbf{w_3} \rangle & \langle \mathbf{w_3}, \mathbf{w_3} \rangle & & \\ & & & \langle \mathrm{w_4}, \mathrm{w_4} \rangle & \langle \mathrm{w_5}, \mathrm{w_4} \rangle \\ & & & \langle \mathrm{w_4}, \mathrm{w_5} \rangle & \langle \mathrm{w_5}, \mathrm{w_5} \rangle \end{array}\right\}$$



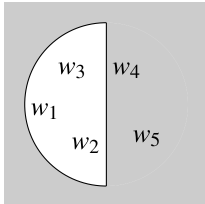
In this context, worlds w_4 and w_5 remain completely connected to each other, as do the worlds w_1, w_2, and w_3. There is no pair connecting worlds such as w_1 with w_4, which resolve the question of whether it is raining in different ways.

Answers like (9) take the form of assertions.

(9) Yes, it's raining.

Answers reduce the context set to a single, completely connected cell. When a context set contains only one cell, the context is *uninquisitive* (Groenendijk 1999). The effect of updating c' above with the assertion in (9) is given in (10).

(10) $$c' \oplus \textit{it is raining} = \left\{\begin{array}{lll} \langle \mathbf{w_1}, \mathbf{w_1} \rangle & \langle \mathbf{w_2}, \mathbf{w_1} \rangle & \langle \mathbf{w_3}, \mathbf{w_1} \rangle \\ \langle \mathbf{w_1}, \mathbf{w_2} \rangle & \langle \mathbf{w_2}, \mathbf{w_2} \rangle & \langle \mathbf{w_3}, \mathbf{w_2} \rangle \\ \langle \mathbf{w_1}, \mathbf{w_3} \rangle & \langle \mathbf{w_2}, \mathbf{w_3} \rangle & \langle \mathbf{w_3}, \mathbf{w_3} \rangle \end{array}\right\}$$



In (10), the worlds where it was not raining, w_4 and w_5, have been removed. This leaves behind the cell of the partition in c' which corresponds to an affirmative answer.

3 Denial of the antecedent

Conditional questions allow for a kind of response, which we refer to as a "denial of the antecedent," which is not available to other kinds of questions. An example discourse with a denial of the antecedent response is given in (11).

(11) A: If Alfonso comes to the party, will Joanna leave?
B: Alfonso isn't coming to the party.

Intuitively, there is some reason to think that denial of the antecedent responses are answers to CQs. Responses like (11B) are pertinent to the discourse and they seem to dispel the issue raised by the question – after the response in (11B), there is no longer any obligation to respond to the CQ in (11A). We will refer to this as the *issue-dispelling* effect. This effect has previously only been associated with complete answers to questions and requires some explanation with respect to CQs.

There is a parallel problem, when starting from a partition theory of questions: the problem of what to do with worlds where the antecedent of the conditional is false. These worlds are obviously in the domain that the whole sentence is interpreted relative to, and so we have to reconcile them with the partition that the question picks out, which does not obviously include these worlds. The fact that denial of the antecedent responses exist suggests that these worlds could form some part of the partition (or of the alternative structure, if we drop some assumptions of partition semantics). If they do not fit into the alternative structure, an independent explanation of the issue-dispelling property of denials of the antecedent must be given.

Previous analyses of CQs (Hulstijn 1997; Velissaratou 2000) take the first option, and fit worlds where the antecedent is false into the alternative structure in different ways. Hulstijn (1997) makes denials of the antecedent complete answers, giving a semantics for CQs that induces a tripartition on the context, instead of a bipartition. Velissaratou (2000) argues against this approach, and instead relaxes the mutual exclusivity constraint on partitions, proposing that CQs pick out exhaustive but not necessarily mutually exclusive alternatives. Attention is restricted in both of these analyses to indicative CQs. We discuss each of these possibilities in turn.

3.1 The tripartition analysis

A tripartition approach to indicative (polar) CQs was first suggested in Groenendijk and Stokhof (1997), fn 29. Hulstijn (1997) gives a logical and dynamic account of many properties of questions, and in the process provides a logical implementation of the tripartition approach to CQs (though this is by no means the focus of the paper), which deals with denial of the antecedent responses by having polar CQs induce a tripartition on the context set.

The tripartition comprises the usual two cells in which the antecedent is true: one in which the consequent of the CQ is also true (corresponding to "yes") and the other in which the consequent is false ("no"). There is also a third cell that contains world-pairs in which the antecedent is false. The tripartition corresponding to a CQ $\phi \rightarrow ?\psi$ is shown in Figure 1.

If other kinds of questions are taken into account beyond polar questions, this might be called an n+1 partition approach, as it adds an extra cell to whatever sized partition you would get from the non-conditionalized form of the question. This extra cell would always contain all worlds where the antecedent is false. For the sake of clarity, we focus on polar questions.

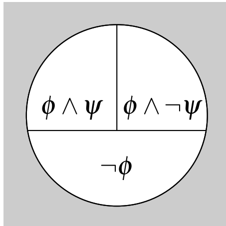


Figure 1: $\neg\phi$ worlds get their cell

This approach makes the denial of the antecedent problem a purely semantic one – denials of the antecedent are complete answers to a conditional question.

3.1.1 Arguments against a tripartition analysis – Velissaratou 2000

Velissaratou (2000) presents three compelling arguments against a tripartition analysis of CQs. The one we judge most important is an argument from intuitions. The key intuition is that denial of the antecedent responses are in some sense not "about" the issue raised by the question (though they may be relevant to some larger topics under discussion). As Velissaratou puts it, "if one allows $[\![\neg p]\!]$ to be an answer to $[\![p \rightarrow ?q]\!]$, we have the strange aspect that a proposition which cancels the reason the question was posed in the first place, is an answer." We have found this intuition to be reliably reproducible by native speakers presented with denial of the antecedent data, and use it in §4 to guide the proposal we develop as a response to Velissaratou (2000).

The second argument Velissaratou brings forward is that the tripartition analysis incorrectly predicts that full conditionals will not be complete answers to CQs. A conjunction of the antecedent and the consequent stand in this role in Hulstijn (1997), but the conjunctive response feels infelicitous or over-informative. The (felicitous) conditional response is shown in (12B), and the odd conjunctive response is shown in (12B′).

(12) A: If Alfonso comes to the party, will Joanna leave?
B: If he comes, Joanna will leave.
B′ #He will come and Joanna will/won't leave.

Finally, Velissaratou presents a series of facts that the tripartition analysis cannot derive (see Velissaratou 2000, fact 2). We do not discuss these in detail here; the most linguistically interesting point is that a theory of CQs should predict that $p \rightarrow ?p$ and $\neg p \rightarrow ?p$ are trivial questions, and a tripartition theory does not. Before discussing Velissaratou's (2000) analysis, we give two further arguments against the tripartition analysis.

3.1.2 Additional arguments

The first argument is the other side of the coin of Velissaratou's argument regarding what denial of the antecedent responses are about. Given a CQ of the form $p \rightarrow ?q$, a tripartition analysis predicts not only that $\neg p$ will be an answer, but that p will be a partial answer (assuming a suitable definition of partial answerhood, such as Groenendijk's (1999) licensing). This is because a p response affirming the antecedent of the CQ removes the $\neg p$ cell, leaving behind the other two. This conflicts with intuitions regarding what responses of this kind are about. When speakers are presented with discourses such as the following, they judge the p responses to be odd and irrelevant in some way.

(13) A: If Alfonso comes to the party, will Joanna leave?
B: #Alfonso is coming to the party.

The judgement in (13) is different from hearers' responses to denials of the antecedent, which are felicitous but not about the question in particular. Affirmations of the antecedent (for indicative conditionals) are simply infelicitous in some way. This is quite surprising, as partial answers are generally perceived as intuitively relevant. An example that should be parallel to the B response, but is not, is given in (14).

(14) A: Who is teaching Syntax A this quarter?
B: Not Jim.

The B response is a perfectly felicitous partial answer.

There is a second problem that has no obvious explanation under a tripartition analysis, though this is a problem that one could potentially respond to while maintaining a tripartition analysis. "Yes" and "no" are in some sense privileged answers that are only available to polar questions. All polar questions that have previously received significant discussion in the literature are bipartitions. In those cases it is not surprising that there are two privileged answers, and it is at least intuitively obvious why they correspond to the cells of the partition they correspond to. But these privileged answers are still usable with CQs formed out of an interrogative that has the syntactic characteristics of a polar question. The obvious concern for a tripartition account is why they are usable at all with a tripartition. Beyond that, it is unclear why they map to the cells that they map to. For instance, why does a "no" answer fail to deny the antecedent? This is not an argument against a tripartition account per se, as to the best of our knowledge, no one has tried to answer this question, but it is another issue that any tripartition account would need to deal with.

Additionally, several of the arguments that we develop later against Velissaratou's (2000) account apply equally well against a tripartition account.

3.2 Abandoning mutual exclusivity

A defining characteristic of answers to questions, due originally to Hamblin (1958), is that every question has a unique, complete answer. It follows from this notion that answers to questions are mutually exclusive – the truth of an answer implies that all other possible answers to the question are false. It also follows that answers are exhaustive. While both of these properties can be challenged (see Groenendijk and Stokhof (1997) for discussion), they are fundamental to defining partitions in a partition semantics for questions.

One way of accepting denial of the antecedent responses as (partial) answers to CQs is to maintain that answers need not be mutually exclusive.[3] This is the position taken in Velissaratou (2000), which provides a (non-dynamic) logic for conditional questions.[4]

[3] It would also be possible to challenge exhaustivity in a similar way. We do not try to develop an analysis directly along these lines, and to our knowledge it has not been done, but our proposal could in fact be seen as going in this direction. We assume (see §5) a form of local exhaustivity only – questions partition exhaustively relative to the local context set, which reflects the assumptions that have been made.

[4] Velissaratou's (2000) primary motivation for developing a logic for CQs is to provide an analysis of "which"-questions. We do not discuss "which"-questions here. However, applying the kind of domain restriction we develop here to the problems of "which"-questions, in parallel to Velissaratou's (2000) analysis, provides a tempting prospect for future work.

In this theory, questions pick out alternatives that exhaust the domain, but may not be mutually exclusive. They form maximal covers of the domain, in the sense that the union of the alternatives will include the domain. Since they do not have to be mutually exclusive, these alternatives can overlap, and in the case of conditional questions, they do. Given a polar CQ $p \rightarrow ?q$, worlds where the antecedent is false constitute the overlap, as shown in Figure 2. There are two alternatives, corresponding to $p \rightarrow q$ and $p \rightarrow \neg q$. They overlap, exactly on the $\neg p$ worlds. Because they overlap on these worlds, denying the antecedent of a CQ does not choose between the alternatives, but rather simply removes the worlds where the covers fail to overlap.

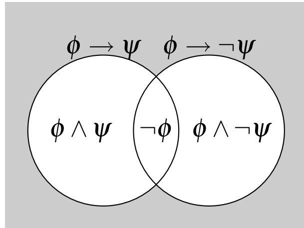


Figure 2: $\neg\phi$ worlds inside both alternatives

In dynamic terms, denying the antecedent would result in a context without distinct alternatives, i.e., a non-inquisitive context. Denial of the antecedent can be construed as issue-dispelling for this reason, but does not resolve the issue raised by the question. That is, it does not choose between alternatives introduced by the question.

Ordinary (i.e., non-conditionalized) polar questions involve no overlap, and the set of maximal covers would be a partition. Therefore, all issue-dispelling responses to a plain polar question also definitively choose one alternative or the other. In fact, all non-conditionalized questions would involve normal partitions.

This analysis works well for the core CQ data, and provides an interesting treatment of denials of the antecedent – dissociating issue-dispelling responses from responses which actually resolve the issue. It overcomes Velissaratou's arguments against the tripartition approach (though see below for further discussion of the "aboutness" issue), as well as the two additional arguments we raise. Denials of the antecedent are possible but not complete answers (when answerhood is defined in terms of entailment), and this is because their negation (affirmation of the antecedent) is not an answer to a CQ at all. This accordingly solves the problem we raise, where the affirmation of the antecedent of an indicative conditional seems uninformative and infelicitous – it does not advance the discourse. There is no problem about which meanings to assign "yes" and "no" to, because there are only two alternatives, and whatever mechanism associates the two privileged answers with the correct cells in partition theory (not a trivial matter), could presumably work here.

However, there are several problems, both conceptual and empirical, that motivate revision of this analysis. We have pointed out that there is some sense in which denials of the antecedent do not seem to be "about" the question itself, but rather about the ground upon which the question stands, and Velissaratou (2000) expressed a similar intuition. But it is unclear that the non-mutual-exclusivity analysis actually captures this intuition, as a denial of the antecedent is still a possible answer – just not a complete one. We will shortly propose an analysis which directly captures this intuition, though this might also be repaired by using a notion of answerhood that is not based on entailment.[5] A second conceptual problem is that to accept the analysis one must abandon the position that mutual exclusivity is a core property of questions. This is certainly a move that must be considered and made if the data warrant it, but we shortly provide arguments that the denial of the antecedent data can be explained in another way, without any need to give up mutual exclusivity. It is also important to note that mutual exclusivity is abandoned in a way tailored to conditional questions – the analysis reduces to a partition analysis for other non-conditionalized questions.[6] The question then arises why a property that seemed otherwise so general has a small pocket of the grammar where it fails.

[5]The obvious contender is Groenendijk's (1999) notion of licensing (see def. 8 and def. 10 of that paper). Jeroen Groenendijk (p.c.) has pointed out to us that denials of the antecedent would not be licensed, and therefore not answers, as they fail to remove any entire alternative. However, as he also points out, the notion of licensing as-is will not work with overlapping alternatives. This is because removing part of an alternative is never licensed, but if there is overlap, any response which removes all of one alternative (i.e., a complete answer, in the case of a polar CQ), would remove part of the other, and therefore not be licensed. A different notion of licensing might be developed to get around this issue, as the one in Groenendijk (1999) was tailored to a partition semantics, but that is beyond the scope of this paper.

[6]Except "which"-questions, which under Velissaratou (2000) have a logical structure based on CQs.

The following sections provide several empirical arguments against the non-mutual-exclusivity analysis. We also return to the argument in later sections of the paper where we discuss the prospects for combining aspects of our proposal with that of Velissaratou (2000).

3.2.1 Counterfactual CQs

Velissaratou (2000) treats the behavior of denial of the antecedent responses as a semantic property of conditionals.[7] As such, we would expect it to generalize to all sorts of conditionals. In this section we consider counterfactual conditionals. It is immediately clear that the expected class of responses are not, in fact, issue-dispelling. This is shown by the response in (15B).[8]

(15) A: If Jo could have fixed the car, would you have kept on using it?
B: Jo couldn't have fixed the car.

Intuitively this response does not dispel the issue, and even seems somewhat infelicitous following the counterfactual CQ, despite being the negation of the antecedent. The non-mutual-exclusivity account has something to explain here. Not only that, but ideally, the explanation will not have anything to do with the questioning nature of the consequent. This seems to be a general fact about counterfactuals – von Fintel (2001) observes that similar responses do not have any effect on counterfactuals with declarative consequents (ex. 27 there).

There is a slightly different response, which does seem to be issue-dispelling. This is illustrated in (16).

(16) A: If Jo could have(/had) fixed the car, would you have kept on using it?
B: Jo could have fixed(/did fix) the car.

It seems that for a counterfactual, the affirmation of the antecedent is issue-dispelling, but not resolving (though this discourse leads naturally to asking the plain factual form of the consequent). This is completely unexpected on the account in Velissaratou (2000). The denial of the antecedent response is infelicitous. At the least, something must be done differently for counterfactuals under this analysis.

The situation could, at first glance, be remedied by defining a different counterfactual conditional operator, that places a different set of worlds in the overlap between alternatives. The alternatives in the example above would have to overlap on worlds where Jo could have fixed (or did fix) the car. However, there is a paradox – these are the worlds that would need to be split into two by the question in the antecedent. The alternatives cannot simultaneously overlap on these worlds and break them into the "yes" and "no" alternatives. This paradox points to a deeper problem. In the case of counterfactual CQs, the normal answers are interpreted relative to counterfactual worlds. In von Fintel's (2001) terminology, a counterfactual CQ involves partitioning some worlds on the "modal horizon," and the answers should be interpreted there. But a denial of the antecedent is fundamentally a non-counterfactual statement, and is about worlds contained in the regular context set – it is not about worlds on the modal horizon. In the case of a counterfactual CQ, a denial of the antecedent seems to be a fundamentally different kind of response than a regular answer.

In §4 we propose an entirely different account of this data, which does not semanticize the denial of the antecedent behavior. We propose that these responses deny the presuppositions of conditional sentences, which in the case of counterfactuals are presuppositions that the antecedent is actually false. The denial indicates presupposition failure on the part of the denier at a point prior even to the acceptance of the question. This captures in an entirely different way Velissaratou's (2000) observation that the denial of the antecedent responses "cancel the reason the question was posed in the first place."

[7]This problem applies as well to Hulstijn (1997), which also semanticizes the problem.
[8]Thanks to Geoff Pullum for this example.

3.2.2 Modality and responses to conditional questions

Denial of the antecedent responses are incompatible with "would" modals, whereas true answers are consistently compatible with them. This is illustrated by the oddness of the B″ response below.

(17) A: If Alfonso comes to the party, would Joanna be mad?
B: Yes, she will/would.
B′: Alfonso is not coming/won't come.
B″: #Alfonso would not come.

In a tripartition theory, we would not expect any difference in the choice of modals between the three possible answers. They are also surprising for Velissaratou (2000), since we would not expect it to be possible to use a particular modal in a complete answer but not in a partial answer.

We need an explanation for why "would"-modals are disallowed in denial of the antecedent responses. This point can be taken further – the use of "would"-modals patterns with sentences uttered in modal subordination contexts (Roberts 1989; Frank 1996; Kaufmann 2000).

(18) A thief might break in.

(19) He would steal the silver.

In fact, the possibility of using a "would" modal in the answers patterns with responses to questions asked in a modal subordination context.

(20) A: A thief might break in. Do you think he would steal the silver?
B: Yes, he would.

(21) A: I hope Alfonso will come. Do you think he would be entertaining?
B: Yes, he would.

In summary, a theory of CQs should ideally explain why true answers pattern with answers to modally subordinated questions, and denial of the antecedent responses do not.

3.2.3 "Yes", "no", and fragment answers

Velissaratou (2000) makes certain assumptions about the meaning of "yes" and "no". In response to a CQ with the logical structure $p \rightarrow ?q$, "yes" means $p \rightarrow q$ and "no" means $p \rightarrow \neg q$. From a linguistic perspective, this is intuitively odd. The B response in (22) demonstrates the oddness.

(22) A: If Alfonso comes to the party, will Joanna be mad?
B: Yes, she will.
B′: Yes, if he comes, she will be mad.

If what "yes" means is the same thing as response B′, then it is not clear why the continuation in B, without the "if"-clause, should be possible. One assumption might be that there is an unpronounced (i.e., elided) "if"-clause, but this assumption seems to require justification rather than disproof. A similar point can be made about fragment answers:

(23) A: If Alfonso comes to the party, who will Joanna talk to?
B: Bill.
B′: She'll talk to Bill.

The analysis also requires fragment answers like (23B) to be treated as including an elided "if"-clause.[9] This may not appear to be surprising, at least from the perspective of an analysis of fragments like

[9] More strictly, they would have to be interpreted as having such an "if"-clause present at logical form. Ellipsis is the only obvious way we see to achieve this. However, the analysis we propose accomplishes a similar result via domain restriction, without requiring anything of the form or meaning of the answer.

that of Merchant (2004) where such a response includes much other elided material. What is surprising, however, is that responses like B′ also must be treated as including an elided "if"-clause, despite looking like non-fragment answers.

4 Accounting for denial of the antecedent

In the previous section we gave several reasons against treating denial of the antecedent responses as either complete or partial answers to CQs. This leaves us with two important questions that must be answered. The first comes in two-parts: what are denials of the antecedent, if they are not answers, and why do they sometimes have an issue-dispelling effect? The second question is: how can we reconcile the worlds where the antecedent of a CQ is false with the partition theory of questions; i.e., how do these worlds fit into the partition (if at all)? We return to the second issue in §5, where we provide our formal analysis of the context change potential of CQs. In this section, we deal with the first issue by providing a pragmatic account of responses to CQs which address the content of the antecedent.

Responses of this kind are shown to be issue-dispelling when they deny the presuppositions of the conditional structure that must be in place prior to the interpretation of the question in the consequent. These responses are identified as indications of presupposition failure. In certain conditionals, denying the antecedent is issue-dispelling. In others, affirming the antecedent has an issue-dispelling effect. We treat responses that fail to be issue-dispelling as failures to advance the conversation toward resolving the issue raised by the question; i.e., they are infelicitous and uninformative.

4.1 Presupposition denial

We call conditionals *non-counterfactuals* when they carry the presupposition that their antecedents are possible (see Stalnaker (1968), and much other work); i.e., the context set contains both worlds in which the antecedent is true and ones in which the antecedent is false.[10] The non-counterfactual conditional in (24) can only be uttered in a context in which Alfonso's coming to the party is a live option.

(24) If Alfonso comes to the party, Joanna will leave.

Following von Fintel (1999) (among others), we call conditionals *counterfactuals* when they carry the presupposition that the proposition expressed by the antecedent is not possible; i.e., not a member of the context set. The counterfactual conditional in (25) can only be uttered in a context in which it has already been established that Jo did not fix her car.

(25) If Jo could have fixed her car, she would have lent it to us.

Denial of the antecedent responses come in two varieties. Sometimes they have the effect of nullifying the utterance they address. The response in (26B) indicates that the conditional is no longer worth considering.

(26) A: If Alfonso comes to the party, Joanna will leave.
B: Alfonso isn't coming to the party.

Other times, denying the antecedent, simply fails to advance the conversation in the anticipated way. The response in (27B) does not accept or reject (27A), but rather seems to miss the point of the assertion. The example in (28) from von Fintel (1999) makes a similar point.

(27) A: If Jo could have fixed the car, she would have lent it to us.
B: Jo couldn't have fixed the car.

(28) A: If John had been at the party, it would have been much more fun.
B: But John wasn't at the party.

[10] In other parts of the paper, we refer to *indicative conditionals*. In this section, since the kind of presupposition the conditional carries cannot be reliably predicted on the basis of morphological mood, we temporarily adopt different terminology.

A: Yes. I said if he had been there, it would have been more fun.

This pattern can be given a simple and natural explanation by appealing to the presuppositions carried by different kinds of conditionals. Denial of the antecedent responses are felicitous exactly when they reject the presuppositions of a conditional. Otherwise, they simply fail to advance the conversation in the anticipated way.

The non-counterfactual conditional in (29) carries the presupposition that it is possible that Alfonso will come to the party. The response in (29B) directly refutes this presupposition, indicating presupposition failure, in saying that it is not possible that Alfonso will come to the party.

(29) A: If Alfonso comes to the party, Joanna will leave.
B: Alfonso isn't coming to the party.

The same thing happens when the presuppositions of counterfactual conditionals are denied. The antecedent of the counterfactual conditional in (30) carries the presupposition that Jo could not have fixed that car. The response in (30B) indicates presupposition failure by making the opposite claim.

(30) A: If Jo could have fixed the car, she would have lent it to us.
B: Jo could have fixed the car.

In general, presupposition failure is indicated by denial of the antecedent responses with respect to non-counterfactuals and affirmation of the antecedent responses with respect to counterfactuals.

We see a similar effect when the consequent of the conditional is a question, and the same explanation holds. A denial of the antecedent is felicitous (and issue-dispelling) exactly when it denies the presuppositions of the conditional. In non-counterfactual CQs, presupposition failure occurs when the questioner's interlocutor claims that the antecedent is not possible, as in (31). This is the standard denial of the antecedent case considered in the previous literature on CQs.

(31) A: If Alfonso comes to the party, will Joanna leave?
B: Alfonso isn't coming to the party.

Presupposition failure is indicated in relation to counterfactual CQs when the questioner's interlocutor suggests that the antecedent is true, as in (32).

(32) A: If Jo could have fixed the car, would you have kept on using it?
B: Jo could have fixed the car.

The responses in both (31B) and (32B) are issue-dispelling.

The non-issue-dispelling cases are affirmations of the antecedent of a non-counterfactual conditional, and denials of the antecedent of a counterfactual. These neither deny a presupposition, nor address the issue raised in the consequent of the preceding conditional. All they do is fail to advance the conversation in any useful way, regardless of whether the consequent is an assertion or a question, as shown by (33B) and (34B).

(33) A: If Alfonso comes to the party, Joanna will leave.
B: Alfonso is coming to the party.

(34) A: If Alfonso comes to the party, will Joanna leave?
B: Alfonso is coming to the party.

The same holds true of responses to counterfactual conditionals (35) and counterfactual CQs (36).

(35) A: If Jo could have fixed the car, she would have lent it to us.
B: Jo couldn't have fixed the car.

(36) A: If Jo could have fixed the car, would she have lent it to us?
B: Jo couldn't have fixed the car.

The conclusion is that denials of the antecedent are not answers of any kind. They are either indications of presupposition failure (the licit cases) or simply as responses which fail to advance the conversation in the anticipated way (the cases that miss the point). This treatment of the licit cases of denials of the antecedent directly captures Velissaratou's (2000) intuition that denials of the antecedents of non-counterfactual CQs are not about the issue raised by the question. They are about the presuppositions of the structure in which the question is embedded. If they are about any issue, this issue is the issue of whether the presuppositions of the conditional are true (which may be an issue that has been salient in the discourse). They are still pertinent to the discourse (and therefore felicitous) in the sense that they indicate a significant misunderstanding of the common ground/context set.

When the hearer indicates presupposition failure, this marks that the hearer did not get to the point of considering the consequent of the conditional. What is indicated is that the context set is not what the asker thought it was, and the asker must undertake some kind of (non-monotonic) belief revision in order to determine the correct context set. Part of this revision will involve "undoing" the asking of the question – the context is rolled back to a state prior to the utterance of the CQ. We do not attempt to detail this process here, except to point out that it is the very same process that should happen in any case of presupposition denial, regardless of the linguistic element that bears the presupposition.

4.2 Prospects for previous analyses

The semantic analysis in Velissaratou (2000) is designed to deal exclusively with non-counterfactual CQs. Questions in Velissaratou (2000) denote alternatives which are taken to overlap when the question is a CQ in order to treat denial of the antecedent responses as answers in a technical sense. The fact that denial of the antecedent responses are issue-dispelling provides motivation for this move. However, denial of the antecedent responses to counterfactual CQs are not issue-dispelling. As shown in (35), the issue remains raised following the response in (35B). As a result, the system in Velissaratou (2000) fails to generalize; i.e., it would have to provide a different set of alternatives for non-counterfactual and counterfactual CQs. The same is true of the tripartition account.

Our pragmatic treatment of denial of the antecedent could be appended onto either of the previous analyses. However, doing so would make the semanticization of denial of the antecedent responses in both of these theories redundant – each analysis places the worlds where the antecedent is false in the alternative structure, and those parts of the alternative structure would never be used. In other words, having a pragmatic analysis removes the motivation for the third cell (for Hulstijn 1997), and for the overlap between alternatives (for Velissaratou 2000). We must still account for worlds where the antecedent is false when interpreting indicative CQs, but without additional motivation, it seems best to try to keep mutual exclusivity as a property of questions if possible. The pragmatic analysis of denial of the antecedent allows us to consider analyses where these worlds never participate in the alternative structure involved in the question at all. We propose such an alternative, based on the semantics of modal subordination, where the mutual exclusivity property is not abandoned, and questions can be given a very standard interpretation. We turn to our analysis in the next section.

5 The formal interpretation of conditional questions

We provide a theory of conditional questions in which their interpretation is decomposed into two steps. The first step involves making a temporary copy of the current context and updating the copy with the propositional content of the antecedent. In the second step, the question in the consequent raises an issue relative to the temporary context. The goal of this analysis is to account for the fact that worlds where the antecedent of the conditional is false do not seem to play any role in the alternative structure introduced by the question.

In §5.1, we discuss previous decompositional approaches to conditionals and the relevance of temporary contexts to theories of conditionals and modal subordination. In §5.2, we provide an overview of the stack-based semantics proposed in Kaufmann (2000) to analyze modal subordination. In order to maintain temporary domain-restricted contexts, we adopt a version of Kaufmann's semantics in our treatment of conditionals. The technical definitions are provided in §5.3. In §5.4, we apply these definitions to interpret CQs. §5.5 we return to the problems raised for previous analyses, and discuss how our analysis accounts for them.

5.1 Decomposing conditionals

The dynamic view of conditionals (Stalnaker 1968; Karttunen 1974; Heim 1982, among others) is (reinterpreting slightly) that they involve a two step update procedure. First, a derived context is created by updating the speech context with the antecedent of the conditional. Second, the derived context is updated with the consequent. In the standard view, at this point the derived context is thrown away, with any relevant information in it percolating up to the main context. For instance, Heim (1983) gives the following context-change potential (CCP) for a conditional (where $M \setminus N$ stands for the intersection of M with the complement of N, i.e $M \cap (\mathscr{W} - N)$):

(37) For any context set c, clause A, and clause B:
$c + \mathit{If}\, A,\, B = c \setminus (c + A \setminus c + A + B)$

The two update steps correspond to the parts $c+A$ and $c+A+B$ in the formula above. The rest of the machinery is simply to get the effect of the update on the temporary context to have the right effect on the resulting main context – any worlds that were lost on the second step and are present in the main context, will be lost from the main context as well. The entire contents of $c+A+B$ are never needed again – no future interpretation makes reference to them, and there is no formal mechanism for retaining them.

Various complications of conditionals can be added to this kind of treatment straightforwardly, although they are for the most part irrelevant here. Heim (1992), for instance, takes the temporary context to be the set of closest worlds in the context set where the antecedent holds, not just the set of worlds in the context set where it holds:

(38) For any context set c, clause ϕ, and clause ψ:
$c + [[\text{if } \phi]\ \ \psi] = \{w \in c : \mathit{Sim}_w(c+\phi) + \psi = \mathit{Sim}_w(c+\phi)\}$
(where $\mathit{Sim}_w(c)$ picks out the closest worlds to w in c)

Additional discussion of conditionals and the interaction of conditionals and modals discussed by Kratzer (e.g., in Kratzer 1986) is given in §9.

We propose that the dynamic account of conditionals gives us the right tools to model the interpretation of CQs, if it is acknowledged that temporary contexts may be needed outside the sentence that introduces them. In our analysis, the question in the consequent of a CQ partitions the temporary context, instead of asserting in it, rendering it inquisitive. Because the context is inquisitive, it cannot be discarded, and following answers will be interpreted relative to the temporary context.

The acknowledgement that temporary contexts can persist has been made in some parts of the literature on modal subordination (Frank 1996; Kaufmann 2000) and mood (Farkas 2003). In this line of research, modal subordination introduces a temporary context in which something that is not necessarily true has been, for the moment, supposed to be true. A classic example of modal subordination from Roberts (1989) is given in (39).

(39) a. A thief might break into the house.
b. He would take the silver.

The clearest indicator of the subordination is that the pronoun "he" in (39b) cannot possibly be bound by "a thief" in (39a), but that it still covaries with the choice of thief. However, this point is independent of the presence of a pronoun, as the following possible response to (39a) from Farkas and Ippolito (2005) shows:[11]

[11] Farkas and Ippolito (2005) argue that the effect of modal subordination is independent of *any* presupposition trigger.

(40) I would be unhappy.

What (40) says, following (39a), is that, restricting ourselves to talking only about the case where a thief breaks in, the speaker would be unhappy. It says nothing about the speaker's happiness in the case where a thief does not break in. A temporary-context approach to modal subordination can capture this interpretation very directly by taking (39a) to introduce a temporary context, where hearers assume that "A thief will break in" is true. Subsequent sentences that contain modal subordination cues (e.g., "would" in (40)) are interpreted relative to the temporary context, not the main context. Effects of updating the temporary context percolate up to the main context, just like in the dynamic analysis of conditionals. Worlds that are lost in the temporary context due to interpreting sentences like (40) are also lost in the main context. However, worlds that were supposed out of the way at the time of creation of the temporary context are never affected.

We can see from (39a) that "might" sentences can introduce temporary contexts, and so can conditionals, as the following examples show.

(41) a. If Edna forgets to fill the birdfeeder, she will feel very bad.
b. The birds will get hungry. (Roberts 1989, ex. 2)

(42) a. If a thief breaks into the house, he will take the silver.
b. If in addition he finds the safe, he will open it. (Frank 1996, ch. 3, ex. 79)

In each (b) sentence, the claim is made only relative to cases where the antecedent of the conditional in (a) is true. In (41b), the birds will only get hungry if Edna forgets to fill the feeder. The whole conditional in (42b) is only true if the thief breaks in in the first place. The dynamic approach to conditionals can handle these effects, if the temporary contexts it needs anyway are allowed to stick around.

5.2 The stack model

We use the stack-based model of Kaufmann (2000) as the formal tool for maintaining temporary contexts. In this model, utterances are not interpreted relative to single contexts, but to stacks of contexts. Utterances that involve the creation of temporary contexts cause them to be added to the stack, where they may remain if needed. When an utterance triggers the creation of a temporary context, the utterance involves making assumptions, or the act of *supposing*. Kaufmann (2000) uses this model to give an account of modal subordination – sentences that introduce modal subordination ("A thief might break in") involve temporarily making the assumption that the subordinating possibility is true. Sentences that continue or trigger modal subordination ("He would steal the silver") involve interpretation relative to the temporary context. Kaufmann (2000) also makes the parallel between antecedents of conditionals and utterances that introduce modal subordination contexts.

A case where there is no modal subordination will typically involve only one context on the stack, corresponding to the standard Stalnakerian context of utterance. The effect of a plain assertion on this kind of stack will be the same effect a plain assertion would have on that one context set in the standard analysis. An utterance that introduces modal subordination *push*es (inserts at the top) a temporary context onto the stack, and future utterances that continue the modal subordination see that temporary context as the main one. Utterances that do not contain modal subordination cues (e.g., simple past sentences, though we do not concern ourselves here with what these cues might be) cause the stack to be *pop*ped before interpretation – an operation where the top element is removed and discarded.[12]

A conditional, in this kind of system, behaves much like a conditional in the standard dynamic analysis. First, a derived context is created by making a copy of the current top of the stack, and updating it with the antecedent of the conditional. This context is pushed onto the top of the stack.

[12]The use of a stack of temporary contexts has precedent in the analysis of presupposition projection in Zeevat (1992). Similar stack-based mechanisms have been used for logically modeling temporary assumptions; see the "Fantasy Rule" of Hofstadter (1979) (pp.183-5) and further development in Zeinstra (1990), as well as discussion of both in Muskens et al. (1997). See Kaufmann (2000) also for discussion of other ways that stacks have been used in modeling discourse.

The consequent of the conditional is then interpreted relative to the stack, but the stack is guaranteed to have a temporary context as its top element, so the consequent will see that context as the main one. The stack-based analysis makes explicit what has always been implicit in the dynamic analyses of conditionals – interpretation of the antecedent involves making a temporary assumption. The difference is that the stack provides a way for the context to be retained after its immediate use.

If the conditional is declarative, the update to the top context in the stack will be reductive – it will remove worlds just as any assertion does (this will also have an effect on other elements of the stack, discussed later). We propose that if the conditional is a CQ, the second step involves partitioning the temporary context, instead of reducing it.

5.3 Formal implementation: assertions, questions, and modally subordinated questions

We now give the technical definitions that make up the stack model, and in the next section, apply them to the interpretation of CQs. Utterances are interpreted relative to *macro-context*s; a macro-context for our purposes is a stack of Stalnakerian contexts (which we treat as simply context sets, abstracting away from other necessary elements). A macro-context is an ordered pair, either empty or consisting of a context and a macro-context:

(43) **Definition: macro-context**

a. $\langle\rangle$ is a macro-context.

b. If c is a (Stalnakerian) context and s is a macro-context, then $\langle c,s\rangle$ is a macro-context.

c. Nothing else is a macro-context.

d. If s is a macro-context, then s_n is the nth context (counting from 0 at the top) and $|s|$ is its size (excluding its final empty element).

We refer to a macro-context either by using variables s, s', and so on, or as $\langle c,s'\rangle$ where c is the top element of the macro-context and s' is the rest of the macro-context. The case where no suppositions have been made is going to involve a stack like $s=\langle c,\langle\rangle\rangle$. In this stack, c is s_0, and the size of the stack is 1. A more complex stack might look like $s'=\langle c,\langle c',\langle c'',\langle\rangle\rangle\rangle\rangle$. The size of s' is 3, and c would be s_0, c' would be s_1, and c'' s_2. This size stack might involve a case where stacked "if"-clauses have introduced two assumptions. Push and pop operators, which add to and remove from a macro-context, respectively, are defined as follows:

(44) **Definition: push operator**
For any macro-context s and context c:
$\text{push}(s,c) =_{\text{def}} \langle c,s\rangle$

(45) **Definition: pop operator**
For any macro-context $\langle c,s'\rangle$:
$\text{pop}(\langle c,s'\rangle) =_{\text{def}} \langle c,s'\rangle$ if $s'=\langle\rangle$, s' otherwise

Given a macro-context $\langle c',\langle c'',\langle\rangle\rangle\rangle$ and a context c, the operation $\text{push}(\langle c',\langle c'',\langle\rangle\rangle\rangle,c)$ results in $\langle c,\langle c',\langle c'',\langle\rangle\rangle\rangle\rangle$. The operation $\text{pop}(\langle c,\langle c',\langle c'',\langle\rangle\rangle\rangle\rangle)$ would then result in $\langle c',\langle c'',\langle\rangle\rangle\rangle$.

In §2.1 we discussed the definitions of update functions on single contexts. Assertions involved reductive updates – they removed some worlds entirely from the context set, and increased the information content of that set. Now we consider how to extend this to stacks of contexts, i.e., discourse situations where temporary assumptions have been made. The most obvious possibility is that assertions will affect the top member of macro-context. That is, we'd have a definition like: $\langle c,s'\rangle+[\text{Assert } \phi] =_{\text{def}} \langle c\oplus\phi,s'\rangle$. This is simple and appealing, and will work exactly right for the case where the macro-context has only one context set on it. However, it should be clear that this would not by itself be what we want. The reason is that any information gained during a conditionalized or subordinated sentence could be lost by popping the stack. This information must live on somehow – it must "percolate" down to other members of the macro-context. One way of accomplishing this, which we do not develop here, is to preserve it at the time of the pop operation. The other way, which we develop (following Kaufmann) is to percolate it down immediately.

In Kaufmann (2000), reductive updates center around the operation of learning in lower contexts that the top context supports the content of the update. This is formally captured by the $\vdash$ operator. The version of the $\vdash$ operator we use here takes three contexts as arguments, and an instance of it will look like "$\vdash (c, c', c' \oplus \phi)$". This should be read as, roughly, "Discourse participants learn in a context c that another context c' supports ϕ." (In general, they learn that c' supports information gained between c' and $c' \oplus \phi$.) (46) gives the formal version of it:

(46) **Definition of $\vdash$**
For any contexts c and c', and c'':
$$\vdash (c, c', c'') =_{\text{def}} \left\{ \langle w_1, w_2 \rangle \in c \;\middle|\; \begin{array}{ll} & \neg\exists w \in W \text{ s.t. } \langle w_1, w \rangle \in c' \text{ or } \langle w, w_2 \rangle \in c' \\ \text{or} & \langle w_1, w_2 \rangle \in c'' \end{array} \right\}$$

What this amounts to is really just $(c - c') \cup (c \cap c'')$, but care must be taken to use the right version of "$-$" as we are dealing with world-pairs here. A pair of worlds is in $\vdash (c, c', c' \oplus \phi)$ iff either (i) neither world in the pair appears in c' (but the worlds are in c), or (ii) the worlds would remain if c' were updated with ϕ. Condition (i) corresponds to the case where the worlds have been supposed out of the way in c'; these worlds can have nothing said about them by further updates to c'. Clause (ii) corresponds to whatever the update represented by the c'' argument (for us, typically $c' \oplus \phi$) does to c'. Building on this, the macro-context change potential (MCCP) of assertions is given in (47).

(47) **Assertive update on macro-contexts**
For any macro-context s and clause ϕ:
$$s + [\text{Assert } \phi] =_{\text{def}} s' \quad \text{where } |s'| = |s| = n \text{ and } s'_i = \vdash (s_i, s_0, s_0 \oplus \phi) \text{ for all } i, 0 \leq i < n$$

This definition is very similar to Kaufmann (2000)'s "conclude" operation, but here we go further in associating the operation with the act of asserting. How it is so associated can be seen in two ways: either it is just a fact about how declaratives are interpreted, or the assertive force is associated with a speech-act operator that has syntactic presence (perhaps as a force feature). For convenience, we will take the second view to be right.

One key to understanding what (47) is supposed to do is the fact that the effect of an assertive update on the top member of a macro-context is always the same as the $\oplus$ operator. This is clearest for macro-contexts of size 1: for any context c and (speech-act-less) clause ϕ, $\langle c, \langle\rangle\rangle + [\text{Assert } \phi]$ is equivalent to $\langle c \oplus \phi, \langle\rangle\rangle$. Thus, this notion of assertion is simply a generalization of the standard dynamic notion of assertion (due to Stalnaker (1978)) – it is generalized to handle suppositions. An example of this operation appears in §6 below.

Next, we must generalize the notion of questioning. This case is somewhat different than the case of asserting – the simplest idea can work. This is the idea that what a question update does to a stack is just what a $\oslash$ operator would do on the top element. The reason this can work is that questions, under Groenendijk (1999), do not contribute to information gain. They raise issues by disconnecting worlds, but they do not remove any worlds themselves. In terms of licensing answers, the effect of a question is much more immediate than the effect of an assertion – intuitively, an issue is raised in an immediate and local way. What this means is that a simple definition like (48) can work.

(48) **Inquisitive update on macro-contexts**
For any macro-context $\langle c, s' \rangle$ where c is the top member, and s' is a stack, and clause ϕ:
$$\langle c, s' \rangle + [\text{Question } \phi] =_{\text{def}} \langle c \oslash \phi, s' \rangle$$

On this view, a question acts only on the top element of the stack, partitioning it in a straightforward manner. This allows us to keep the standard properties of the theory of questions (mutual exclusivity and exhaustivity). The idea behind (48) is that questions are asked only relative to whatever assumptions are present in the context at a given time, and the issues raised by questions are also necessarily relative to those assumptions. The answers to questions may be informative, and this information should percolate. This notion of questioning can be understood best in concert with the following constraint:

(49) **Inquisitiveness constraint**
A macro-context may not be popped if the top element is inquisitive.

The idea is that issues persist only so long as they are not resolved, but they must persist long enough to be resolved or otherwise dispensed with. One other way of dispensing with them, for instance, would be to deny the presuppositions of a CQ. This constraint ensures that any answers to a CQ will be interpreted with the temporary context on top.

At this point an apparent difference between questions and assertions appears. Assertions provide information, and this information persists. Questions raise issues, and on our analysis so far, these issues do not percolate down the stack, and therefore do not persist. This might be perceived as a stipulative difference between questions and assertions. The difference, however, is really between information and issues. Our present analysis percolates information immediately on assertion, but this is not a necessary property of a stack based analysis – percolation could happen at the point where the stack was popped. (This would be more like the stack-based logic of Zeinstra 1990; Muskens et al. 1997, where we do not learn the non-local impact of hypothetical assumptions until we apply the definition for the pop operation.) So the claim implicit in (48) is that information percolates, and issues do not. This allows us to keep the mutual exclusivity and exhaustivity properties in a very strong form – if issues percolated they would percolate to a point on the stack where there are worlds not in any cell of the original partition. At that point one would be forced to treat them as being in every cell (following Velissaratou 2000) or as being in no cell (abandoning exhaustivity). This would involve applying the $\vdash$ operator to the definition of questioning as well:

(50) **Inquisitive update on macro-contexts (immediate percolation version; cf. (48))**
For any macro-context s and clause ϕ:
$s + [\text{Question } \phi] =_{\text{def}} s'$ where $|s'| = |s| = n$
and $s'_i = \vdash(s_i, s_0, s_0 \oslash \phi)$ for all $i, 0 \leq i < n$

This new notion of questioning is more complicated, but it is also much more homogeneous with the definition of Assert above. We do not know of any empirical ways of deciding between (48) and (50).[13] Percolating issues does require abandoning the strong form of mutual exclusivity (that all context sets always contain only alternatives that are mutually exclusive). However, the notion in (50) does retain a limited version of mutual exclusivity, at least in concert with the Inquisitiveness Constraint – the currently "active" context will always be partitioned. Either way, mutual exclusivity is retained as a property of the $\oslash$ operation, and so plausibly, of the meaning of questions themselves.

Because there is no deciding empirical choice, we continue the present section and example with the simpler version in (48). However, we return to the issue in §7, and we make use of the more complicated notion in (50) in our discussion of embedded conditional questions in §8. There it turns out to simplify the analysis of embedded conditional questions.

Before we turn to the analysis of CQs, note that this semantics for questions also gives us a straightforward account of questions in modal subordination contexts:

(51) A: A thief might break in.
B: Would he steal the silver?

(52) A: A thief might break in.
B: Would you be upset?

[13] It is certainly true that the (meta) information that a particular issue was raised at all may need to be available. But this is also true of assertions, and the present system models none of this meta-information (i.e., it does not model the history of the discourse at all).

In each of these cases, the question is asked relative to the subordinate context. In (51), the questioner is not asking about what anyone would do in the case where a thief did not break in. In (52), the questioner is only asking whether the A speaker would be upset in the case where a thief did break in – discarding entirely the issue of upsettedness in the case where a thief did not. On the surface, this data would seem to cause problems for the theory of questions, since (51) and (52) obviously cannot be interpreted exhaustively relative to the entire context set or domain of possible worlds.

This difficulty parallels the problems centering around denials of the antecedent (see §3-4), and our account has a simple solution. Modal subordination involves pushing a temporary context onto the stack (assuming Kaufmann 2000 or a similar analysis); in the case of (51) this is the previously top context, updated with the assumption that a thief will break in. The modally subordinated question partitions only the top context of the stack, and the alternatives it creates are exhaustive and mutually exclusive relative to that context. Therefore, the question in (51) or (52) would partition a context where it has been temporarily assumed that a thief does break in. The issue raised by the question automatically has nothing to do with cases where a thief does not break in, a natural consequence of our use of the stack model.

5.4 *Conditional questions*

We are now in a position to discuss the interpretation of conditionals.[14] The dynamic theory of conditionals decomposes their interpretation into two updates, one corresponding to the antecedent, and one corresponding to the consequent. Our version of this, focusing on indicative conditionals, is given in (53):

(53) **MCCP of an indicative conditional**:
For any macro-context s, "if"-clause [*if* ϕ], and clause ψ:
$s + [\text{if } \phi,\ \psi] =_{\text{def}} s + \text{if } \phi + \psi$

This is a two step update based on the standard dynamic semantics for conditionals. It has been generalized to work in the stack model (following Kaufmann 2000), and to handle question complements. The MCCP of "if"-clauses is given in (54):

(54) **MCCP of an "if"-clause**
For any macro-context s and "if"-clause [*if* ϕ]:
$s + \text{if } \phi =_{\text{def}} \text{push}(s, s_0 \oplus \phi)$
Admittance conditions: "If ϕ" is admissible in a macro-context s iff $s_0 \oplus \phi \neq \emptyset$

The admittance conditions provide the standard presupposition for indicative conditionals (going back to Stalnaker 1968) that the content of the antecedent is possible.[15]

Our analysis is a truth-conditional, suppositional theory of conditionals: the antecedent of a conditional directly introduces an assumption into the context. Suppositional theories of conditionals (see Adams 1965; Mackie 1973; Gärdenfors 1986, among others) are often traced back to the following remark in Ramsey (1931):

(55) "If two people are arguing 'If p, will q?' and are both in doubt as to *p*, they are adding *p* hypothetically to their stock of knowledge and arguing on that basis about *q*."
(Ramsey 1931; p. 247)

[14] Our analysis is set up to account for CQs regardless of their type. However, creating temporary contexts for counterfactual CQs involves further complications. For the sake of simplicity, we concentrate on non-counterfactual CQs in the formal component. See §7.2 for more discussion.

[15] We treat this as a presupposition, not as a general felicity condition in the style of Stalnaker. It is not clear that the difference matters, as long as it is subject to presupposition projection. This admittance condition is often accompanied by another felicity condition, which we do take to be general: a ban on updates that do not reduce the context set.

For us, adding p hypothetically involves (for indicative conditionals) creating a temporary context by adding p to a copy of the main context, and pushing the temporary context onto the stack. How we treat the consequent depends on what kind of speech-act it involves – i.e., what its force is. If it is an assertion, we see the effect on the context just as in (47) – the operation is reductive and affects both the top context (the supposed context) and the original top, s_1. If the consequent is a question, the top of the context will be partitioned. In this case, the context cannot be popped without resolving (or discarding) the issue that the interpretation of the consequent raises. Subsequent answers are automatically interpreted with respect to the unpopped stack, where the antecedent of the conditional is still supposed.

Note that this treatment of conditionals drastically complicates the task of giving a definition of entailment, as conditional sentences will lead to stacks of different sizes than non-conditional sentences, and many entailments between the two will trivially not go through under a standard dynamic notion of entailment. We postpone this task until our treatment of embedded conditional questions (see §8.2).

This account of conditionals, and therefore conditional questions, inherits the standard dynamic treatment of presupposition projection. This is our technical analysis of the points raised in §3 and §4. Responses to CQs that deny the presuppositions of the antecedent do so prior to the interpretation of the question. This indicates presupposition failure on the part of hearers of the CQ which happens during the act of supposing, before the context could even be partitioned.

5.5 *Explaining the data*

We are now in a position to return briefly to the problems raised in §3. Some of these have already been dealt with in §4, namely those involving denials of the antecedent, but there are a few remaining. The availability of "would" in answers to CQs now has a straightforward explanation, or at least, we have reduced it to the problem of why "would" signals modal subordination in general. The grammatical mechanisms for interpreting answers to CQs are the same as those involved in modal subordination.

The issues of what polarity particles such as "yes" and "no" mean, and whether answers to CQs in general involve a covert "if"-clause, also have a linguistically straightforward solution. Because of the modal subordination, there is no need to assume any covert "if"-clauses – the use of the stack model for domain restriction sees to this. It also allows polarity particles to have the same meaning one would assign to them on the basis of non-conditionalized questions. In general, answers are interpreted relative to the top element of the stack, including fragment answers.

The analysis of counterfactual CQs also has a solution in sight. Affirmations of the antecedent have already been explained (as presupposition denials). The interpretation of counterfactual CQs then reduces to the general problem of understanding counterfactuals, and all that is needed is to integrate an existing dynamic analysis of counterfactuals into the stack model. Potential candidates include von Fintel (2001) and Veltman (2005). We return to the topic of this integration in §7.2.

There is one issue that is not immediately clear under our analysis, and this is a version of one of Velissaratou's (2000) objections to the tripartition account. It is unclear why full conditionals should be available as answers to CQs. In fact, examples of this sort often seem mildly infelicitous, but this may be because of a general dispreference for redundant answers. If interpreted relative to the temporary context a conditional answer will do no harm, but it will involve a vacuous update when interpreting the antecedent, which should perhaps be independently ruled out. One possibility is that answers of this kind are actually "factual conditionals", similar to the one found in the following discourse: A: "I'm tired." B: "Well, if you're tired, take a nap." (Zaefferer 1990, 1991; Iatridou 1991). We leave this issue for future consideration.

The next section walks through a sample computation of a conditional question.

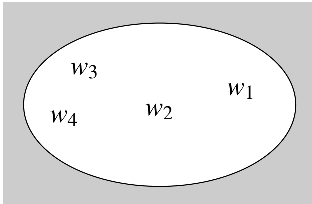
6 Example computation of a CQ

This section goes through an example of the interpretation of a conditional question. Note that here we use the simpler definition of questioning from (48).

We assume an input macro-context $s = \langle c, \langle\rangle\rangle$ for some context c in (56). The facts of the worlds in the context are as follows: Alfonso comes to the party in w_1, w_2 and does not come in w_3, w_4 and Joanna leaves the party in w_1, w_3 and does not leave in w_2, w_4. This is shown in (56) with a direct representation of the stack on the left, and a picture of the stack on the right. The picture shows the worlds in a top-down way – the white area represents the active top context of the stack.

(56) $s = \boxed{s_0 : \mid c} =$

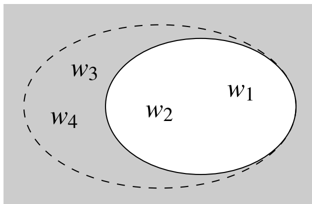
$$
\begin{array}{r|c}
s_0 : & \left\{ \begin{array}{cccc}
\langle \mathrm{w}_1, \mathrm{w}_1 \rangle & \langle \mathrm{w}_2, \mathrm{w}_1 \rangle & \langle \mathrm{w}_3, \mathrm{w}_1 \rangle & \langle \mathrm{w}_4, \mathrm{w}_1 \rangle \\
\langle \mathrm{w}_1, \mathrm{w}_2 \rangle & \langle \mathrm{w}_2, \mathrm{w}_2 \rangle & \langle \mathrm{w}_3, \mathrm{w}_2 \rangle & \langle \mathrm{w}_4, \mathrm{w}_2 \rangle \\
\langle \mathrm{w}_1, \mathrm{w}_3 \rangle & \langle \mathrm{w}_2, \mathrm{w}_3 \rangle & \langle \mathrm{w}_3, \mathrm{w}_3 \rangle & \langle \mathrm{w}_4, \mathrm{w}_3 \rangle \\
\langle \mathrm{w}_1, \mathrm{w}_4 \rangle & \langle \mathrm{w}_2, \mathrm{w}_4 \rangle & \langle \mathrm{w}_3, \mathrm{w}_4 \rangle & \langle \mathrm{w}_4, \mathrm{w}_4 \rangle
\end{array} \right\}
\end{array}
$$



Asking a CQ relative to the initial context (s + *[If [Alfonso comes to the party]], [will Joanna leave?]*) leads to a two step process of interpretation. The first step involves creating a temporary context by making a copy of the main context and altering it to ensure that the antecedent is true: c $\oplus$ *Alfonso is coming to the party*. The temporary context is then pushed onto the stack resulting in the stack shown in (57) in which the temporary context is the active (top) context. Since, by stipulation, the antecedent is true in worlds w_1 and w_2 but not in w_3 and w_4, only world-pairs containing w_1 and w_2 are present in the temporary context. This is shown in the picture to the right as well, where the dashed oval represents the lower context on the stack, and the solid oval the top context.

(57) $s' = s +$ [If [Alfonso comes to the party]] =

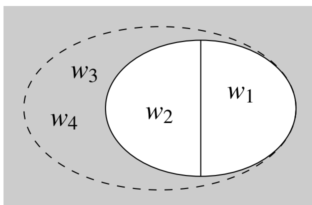
$$
\begin{array}{r|c}
s'_0 : & \left\{ \begin{array}{cc}
\langle \mathrm{w}_1, \mathrm{w}_1 \rangle & \langle \mathrm{w}_2, \mathrm{w}_1 \rangle \\
\langle \mathrm{w}_1, \mathrm{w}_2 \rangle & \langle \mathrm{w}_2, \mathrm{w}_2 \rangle
\end{array} \right\} \\
\hline
s'_1 : & c
\end{array}
$$



The consequent question is then asked relative to the temporary context. In w_1, Joanna leaves the party but in w_2 she does not. Since these worlds resolve the issue raised by the question differently, they populate different cells of the partition. The polar question induces the following bipartition on the temporary context:

(58) $s'' = s' +$ [Will Joanna leave?] =

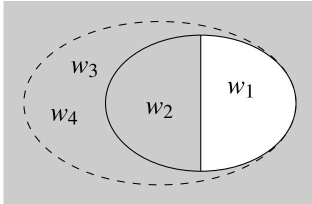
$$
\begin{array}{r|c}
s''_0 : & \left\{ \begin{array}{cc}
\langle \mathbf{w_1}, \mathbf{w_1} \rangle & \\
 & \langle \mathrm{w}_2, \mathrm{w}_2 \rangle
\end{array} \right\} \\
\hline
s''_1 : & c
\end{array}
$$



An answer is interpreted with respect to the temporary context. A positive answer eliminates the cell containing the pair $\langle \mathrm{w}_2, \mathrm{w}_2 \rangle$. The temporary context is rendered uninquisitive after the "yes" answer. The answer (which is an assertion) also has an effect on other members in the stack – the information gained must percolate down to the other contexts on the stack before the temporary context is popped (see the definition in (47)). In s'''_1 below, the world-pairs that have been removed are removed as the result of learning in s''_1 that the top of the stack supports the "yes" answer – of updating with $s''_1 \vdash_{s''_0}$ *yes*. This amounts to removing worlds where both the assumption created by the antecedent is true, and the answer is false.

(59) $s''' = s'' + \text{Yes} =$

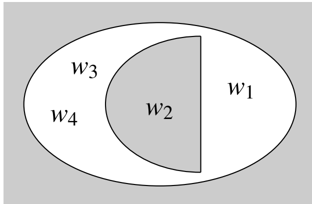
$$\begin{array}{r|c}
s_0''' : & \{\ \langle \mathbf{w_1}, \mathbf{w_1} \rangle\ \} \\
\hline
s_1''' : & \left\{ \begin{array}{lll} \langle w_1, w_1 \rangle & \langle w_3, w_1 \rangle & \langle w_4, w_1 \rangle \\ \\ \langle w_1, w_3 \rangle & \langle w_3, w_3 \rangle & \langle w_4, w_3 \rangle \\ \langle w_1, w_4 \rangle & \langle w_3, w_4 \rangle & \langle w_4, w_4 \rangle \end{array} \right\}
\end{array}$$



At the point at which the temporary context is no longer inquisitive, it can be popped off the stack, assuming that no further subordination cues appear.

(60) $s'''' = \text{pop}(s''') =$

$$\begin{array}{r|c}
s_0'''' : & \left\{ \begin{array}{lll} \langle w_1, w_1 \rangle & \langle w_3, w_1 \rangle & \langle w_4, w_1 \rangle \\ \\ \langle w_1, w_3 \rangle & \langle w_3, w_3 \rangle & \langle w_4, w_3 \rangle \\ \langle w_1, w_4 \rangle & \langle w_3, w_4 \rangle & \langle w_4, w_4 \rangle \end{array} \right\}
\end{array}$$



This is the same state that would be reached by a declarative conditional "If Alfonso comes to the party, Joanna will leave."

7 The dynamics of information and issues

The main analysis assumed so far treats information and issues in a heterogeneous way. On assertive update, information percolates from temporary contexts to main contexts immediately, and issues do not percolate at all. This distinction serves three purposes: i) it allows us to maintain a partition semantics; ii) it captures the (debatable) intuition that questions are "local" to temporary contexts in a way that assertions are not; and iii) it allows for a very simple statement of the kind of belief revision that occurs when the presupposition of a conditional question is denied (the stack is popped). However, it is worth considering what the cost would be of homogenizing the treatment of issues and information. We have already given a definition which makes this happen – the definition in (50). In this section we return to the question of what this involves. We also discuss in more detail what happens to information and issues in counterfactual CQs.

7.1 Percolating issues

Allowing issues to percolate forces us to give up several of the principles we have argued for, but it may be that the cost is worth it. The result is effectively a dynamicized version of Velissaratou's (2000) static analysis of conditional questions. The only required change from the simpler analysis (where issues do not percolate) lies in the definition of a question update. What we need to ensure is that, if a question removes world-pairs from the top context, it does so from every context on the stack. In the definition for Question (repeated from (50) above), we did this by using the $\vdash$ operator in a way exactly parallel to the definition for Assert.

(61) **Inquisitive update on macro-contexts (immediate percolation version)**
For any macro-context s and clause ϕ:
$s + [\text{Question } \phi] =_{\text{def}} s'$ where $|s'| = |s| = n$
and $s'_i = \vdash(s_i, s_0, s_0 \oslash \phi)$ for all $i, 0 \leq i < n$

This alternative MCCP for questioning should still be taken in concert with the Inquisitiveness constraint from (49):

(62) **Inquisitiveness Constraint**
A macro-context may not be popped if the top element is inquisitive.

In the alternative system, where issues percolate immediately, this constraint now enforces partitionhood only on the top context. Lower contexts are now guaranteed to be non-partitions following the raising of an issue (similar to question meanings in Velissaratou's account). However, as long as an issue is resolved before popping the macro-context, the new top will be a safe, non-inquisitive, partition.

This version of the semantics shares with Velissaratou's semantics that mutual exclusivity is not absolutely enforced. However, our dynamic (stack-based) version, unlike the static version, does partially retain Hamblin's exhaustivity/mutual exclusivity constraint: the top element of the stack is always a partition, though lower elements never are. The meaning of a question also retains exhaustivity and mutual exclusivity. The dynamic effect of a question (and thus its meaning) always has a partitioning effect on the top context on the stack, and its effect on other contexts is always mediated through that top context. This is not so on Velissaratou's static version, where the meaning of a question is directly not a partition.

Note that in a plain context with one conditional question asked, the lower member of the stack will correspond to the meaning of a conditional question in Velissaratou's analysis. In this sense, the immediate-percolation version of our analysis is a dynamic reconstruction of Velissaratou's analysis (modulo the addition of a mechanism for presupposition denial).

The general conclusion of this section is that a version of the partition theory can be retained regardless of whether issues percolate. If they do, the analysis of questioning is complicated. We will see shortly that this simplifies the treatment of embedded conditional questions. First, there are some loose ends about counterfactuals to wrap up.

7.2 Percolation in counterfactual conditionals

On our analysis, information gained during the interpretation of a counterfactual conditional never percolates to the main context set, including information gained from answers to counterfactual CQs. This is achieved by maintaining that information can only percolate to a lower context if it is compatible with that context (see the definition of $\vdash$ in (46)). However, it is worth considering where, if anywhere, information gained during the interpretation of a counterfactual is retained. At present, our system predicts that it goes nowhere. This amounts to the claim that counterfactuals lack truth-conditions, which is certainly a respectable view, but it is not one we happen to agree with.

We have also been non-specific about which context gets pushed onto the macro-context when updating with the antecedent of a counterfactual conditional. It clearly cannot be a subset of the main context, as we have been assuming for non-counterfactuals. Our hope is that a ready-made dynamic theory of counterfactuals can be applied directly. One prime candidate is the analysis proposed by von Fintel (2001) (also, Veltman 2005). In von Fintel (2001), counterfactuals update a context that has been expanded to what is called the **modal horizon**. Von Fintel (2001) provides the following dynamic procedure for choosing the context for a counterfactual: "If a conditional is accepted as an assertion, the context will first be changed to expand the modal horizon if the antecedent was not already considered a relevant possibility. Then, the conditional will be interpreted in the new context." This expansion of the context involves adding worlds that make the antecedent true (in line with the sphere condition of Lewis (1973), i.e., closest in some relevant sense).[16] This approach provides a straightforward way of choosing the appropriate context to push onto the macro-context when interpreting a counterfactual CQ.

The remaining issue is where the information gained ends up at the end of a counterfactual. We have been implicitly treating contexts on the macro-context as "views" of some part of the lowest (main) context on the stack. They are what this main context looks like given some temporary assumptions. However, given expansion to parts of the modal horizon as a possibility, this cannot possibly be right, because the modal horizon is typically not a part of the lowest context on a stack. Perhaps, then, every context on the stack simply provides a view of some larger information store. By default, we work with views that are known to be factual – ones that involve mutual public beliefs – but this is not the whole of

[16]Note that this is in some sense separate from the effect of the antecedent on the truth-conditions of the counterfactual: the antecedent also causes us to ignore worlds where it is false.

the information store. Information does not really percolate down the stack, but percolates to the larger information store, and so all views of that store might change. The Inquisitiveness Constraint on popping the stack (see (49)) might then be generalized to a constraint on any view of the information store. This generalized inquisitiveness constraint states that any view of the store must involve a partition. This is yet another way of realizing Hamblin's Picture, the idea that questions involve a mutually exclusive set of exhaustive alternatives. We leave formalization and exploration of this idea for the future, and turn now to the analysis of embedded conditional questions.

8 Embedded CQs

Just as plain interrogatives can appear as the complement of certain verbs ("know", "wonder", "ask", etc.), conditionals are also possible. And like in matrix cases, embedded conditionals seem to have an effect on the scope of possible (or actual) answers to embedded questions. For example, when Alfonso knows the answer to a conditional question, as in (63), what he knows is much more restricted than if he knows the answer to the plain question. Similarly, if he wonders about the answer to a CQ, as in (64), he wonders something quite different, and more restricted, than wondering about the answer to the plain question.

(63) a. Alfonso knows whether the party will happen.
b. Alfonso knows whether the party will happen if it rains.

(64) a. Alfonso wonders whether the party will happen.
b. Alfonso wonders whether the party will happen if it rains.

The goal of this section is to show that one version of our analysis of CQs can be extended to work in such cases. We focus on the verb "know", and we ignore the question of whether the complement of extensional interrogative selecting verbs really denotes a question act, as opposed to something like a question radical (see Krifka 1999; McCloskey 2006 and work cited therein). As far as we can see, our analysis extends to intensional verbs regardless.

The analysis works by defining a cross-categorial notion of *support* (which can be thought of as entailment) in the stack model, and taking "know" to mean that the knower's epistemic state (cross-categorially) supports the meaning of the complement of "know". Our approach is derived from Aloni and van Rooy (2002) and has been generalized to allow for conditionals on the stack semantics. We define the relevant notion of support using the version of our semantics for CQs discussed in §7.1 where issues percolate immediately on update, and lower contexts are not partitions (but rather are broken into Velissaratou-style alternatives). The appropriate notion of support turns out to be simpler to define on this version of the analysis, for reasons discussed below.[17]

First, some preliminary facts. Embedded CQs are better if the "if"-clause is not fronted, as in (65) and (66).

(65) Isabella knows whether Joanna would leave the party angry if Alfonso showed up.

(66) Isabella wondered whether the picnic would happen if it rained.

The "if"-clause is possible in the fronted position, but needs to be uttered with a very particular intonation.

(67) Isabella knows, if Alfonso showed up, whether Joanna would leave.

(68) Isabella wondered, if it rained, whether the picnic would happen.

There appears to be no interpretive difference caused by the position of the "if"-clause (at least, no more than is caused in matrix conditionals), and we assume that if examples like (67) and (68) are degraded,

[17]Thanks to Jeroen Groenendijk for comments on this section, which pushed us towards the current (much simpler) analysis.

the issue is a syntactic one. We further assume that semantically, the "if"-clauses in sentences like (65) are interpreted outside the scope of the question operator. (This assumption is an obvious potential point of contention.)

8.1 A dynamic, cross-categorial semantics for "know"

We follow Aloni and van Rooy (2002) in giving a Hintikka 1962-style semantics for "know", that is dynamicized and based on cross-categorial support. We will start from Groenendijk's (1999) simpler notion of support. Here is the essence of Aloni and van Rooy's (2002) semantics, not yet adapted for the stack theory:

(69) Let $K_w(x)$ be the set of epistemically accessible worlds to individual x from world w.[18]

(70) **Preliminary CCP for "know" sentences**
For any individual-denoting DP α, clause ϕ, and context c:
$c + [\alpha \text{ knows } \phi] =_{\text{def}} \{w \in c \,|\, K_w([\![\alpha]\!]^{w,c}) \text{ supports } \phi\}$

In prose, someone knows a thing just in case their epistemically accessible worlds, $K_w(\alpha)$, support that thing. This idea could be spelled out with any definition of support, but it is particularly useful with a cross-categorial notion of support (following Groenendijk 1999 and much other work) which makes the notion well-defined between declarative and interrogative sentences (or between assertions and questions). In particular, assertions support questions to which the assertion provides an answer. By using this notion of support, we can allow both questions and assertions to provide the value of ϕ and ψ.[19] Groenendijk's (1999) definition of support is given in (71).

(71) **Support (Groenendijk 1999 version)**
For any sentences ϕ and ψ:
ϕ supports ψ iff $\forall c \in \mathscr{P}(W \times W) : c + \phi = c + \phi + \psi$

This is a fairly standard dynamic notion of support/entailment, which has updated to work for contexts as equivalence relations, allowing it to handle questions. Intuitively, an assertion will support a question when it is redundant to ask the question after the assertion has been made. This is exactly the case where the assertion would have answered the question, if it had occurred in the opposite order.

Following Aloni and van Rooy (2002), we generalize the epistemic accessibility function to handle contexts of world-pairs and give a revised CCP for "know" sentences.[20] The epistemic accessibility function K^* in (72) makes accessible any world pairs if both of the worlds are epistemically accessible from the index provided to K^*.

(72) For any world w and individual x:

$$K^*_w(x) =_{\text{def}} \left\{ \langle w_1, w_2 \rangle \;\middle|\; \left(\begin{array}{rl} & w_1 \in K_w(x) \\ \wedge & w_2 \in K_w(x) \end{array} \right) \right\}$$

A CCP for "know" sentences making use of this is given in (73).

(73) **CCP for "know" sentences (2nd version)**
For any individual-denoting DP α, declarative or interrogative clause ϕ, and context c:

$$c \oplus [\alpha \text{ knows } \phi] =_{\text{def}} \left\{ \langle w_1, w_2 \rangle \in c \;\middle|\; \begin{array}{rl} & K^*_{w_1}([\![\alpha]\!]^{w_1,c}) \text{ supports } \phi \\ \wedge & K^*_{w_2}([\![\alpha]\!]^{w_2,c}) \text{ supports } \phi \end{array} \right\}$$

[18] One simple candidate for $K_w(x)$ would be (informally) $\bigcap\{p : x \text{ believes } p \text{ at } w \wedge w \in p\}$ – as far as we can tell this gets the right results for our purposes. Of course there is also much discussion in the literature of the fact that the objects of beliefs are not propositions, but we will ignore this here.

[19] For the sake of clarity, in this section we abuse the $+$ notation, in not discriminating between cases where ϕ is a set of world-pairs (a proposition) and where it is a sentence (a linguistic object). In the case where ϕ is a set, it is straightforward to define update on contexts as set intersection, and it also would be straightforward to extend this to the stack semantics.

[20] Aloni and van Rooy use a more complicated notion of support than that in (71), but the differences are not important to us here.

The CCP given in (73) can handle plain questions and assertions straightforwardly. In prose, someone "knows whether ϕ" just in case internally "asking" ϕ would be redundant to their private epistemic state. Similarly, if we knew what they know, asking "whether ϕ" would be redundant. At this point, we have an account of interrogative complements of extensional question-embedding verbs, assuming we can find some suitable accessibility function/modal base to check the support relation with.[21] Embedded CQs take more work.

8.2 Support in the stack model

Something more needs to be said about what the partition on α's epistemically accessible worlds looks like when ϕ is a CQ. In particular, we need to update the notion of support to work with the stack model. Given the assumptions in §7.1 this turns out to be relatively straightforward. With the main analysis presented, it is significant more complicated.

The way of defining support used above effectively involves comparing contexts. Given the assumption that issues percolate immediately, the most straightforward way to implement support is to do updates in parallel, and to check if the bottom contexts on the stack are the same.

(74) For any stack s, let $s_\perp$ be $s_{|s-1|}$ (the bottom/tail of the stack).

(75) **Support (stack version)**
For any sentences ϕ and ψ:
ϕ s-supports ψ iff $\forall s \in \mathscr{S} : (s+\phi)_\perp = (s+\phi+\psi)_\perp$

This new notion does exactly the same thing as the old one; i.e., we check to see if new information is added by ψ on top of ϕ. It also checks if new issues are raised by ψ. If ϕ resolves the issue that ψ would raise, the comparison comes out true. What is important is that the comparison abstracts away from all the temporary assumptions made in the discourse by either ϕ or ψ. It does so by looking at the bottom element of the stack.

If issues did not percolate immediately, such a straightforward treatment of supporting would not be available. We would still need a mechanism to abstract away from temporary assumptions in order to check the results of ψ on the output of ϕ. Such a notion is technically possible, but it is complicated. It would basically import any temporary assumptions made by ϕ into the context that is the output of ψ. The idea is that someone "knows whether ϕ if ψ" when, if we first knew what they knew and then supposed ψ, ϕ would follow.[22] In the simpler treatment sketched above, we avoid this complexity by allowing issues to percolate. As a result, the bottom element of the macro-context represents the results of importing the suppositions already.

[21] This account can perhaps be extended to intensional question embedding verbs such as "wonder", if our private knowledge/belief/etc. states are allowed to contain issues (be partitioned). On this view, wondering is like asking a question "internally", where asking is the act of rendering a context into a particular inquisitive state, and an "ask" sentence reports this of some other context. One thing is crucial: if epistemic states can be partitioned, then the account above of "know" will not work, as it will predict that "know" and "wonder" will have essentially the same semantics. Extensional verbs seem to involve a notion of not just support but *uninquisitive support*, whereas intensional verbs involve *inquisitive support*. This is where the more classical distinction between selecting for the extension and intension of a question would be cashed out in this system.

[22] The following technical definitions spell this out. The variables s and s' are arbitrary stacks, and ϕ and ψ are sentences.

(i) $\text{supp-worlds}(s) =_{\text{def}} \left\{ w \in W \;\middle|\; \exists i \in \mathscr{N} : \begin{pmatrix} & \exists w' \in W : & (\langle w,w'\rangle \in s_i \vee \langle w',w\rangle \in s_i) \\ \wedge & \neg\exists w'' \in W : & (\langle w,w''\rangle \in s_0 \vee \langle w'',w\rangle \in s_0) \end{pmatrix} \right\}$

(ii) $\text{supp-match}(s,s') =_{\text{def}} \{\langle w_1,w_2\rangle \in s_0 \mid w_1 \notin \text{supp-worlds}(s') \wedge w_2 \notin \text{supp-worlds}(s')\}$

(iii) $s =_{\text{stack}} s'$ iff $\text{supp-match}(s,s') = s'_0$

(iv) Support (supposition-matching version)
ϕ s-supports ψ iff $[\forall s : s \in \mathscr{S}]\, s+\phi =_{\text{stack}} s+\phi+\psi$

This version is probably not general enough to account for cases where ϕ introduces suppositions (cases that are not relevant to the use s-support is put to here).

8.3 Updating "know" for the stack model

We are now in a position to make some trivial changes to the Aloni and van Rooy-style CCP of "know" from (73), in order to handle CQs. The interpretation of "know"-sentences is defined in terms of update on contexts. To get the macro-CCP, a (force-less) "know" sentence is combined with a speech-act operator just as any force-less sentence would be (see §5.3). The final CCP for "know" sentences is given in (76).

(76) **CCP for "know" sentences (final version)**
For any individual-denoting DP α, declarative or interrogative clause ϕ, and context c:
$$c \oplus [\alpha[\text{ knows } \phi]] =_{\text{def}} \left\{ \langle w_1, w_2 \rangle \in c \;\middle|\; \begin{array}{rl} & K^*_{w_1}([\![\alpha]\!]^{w_1,c}) \text{ s-supports } \phi \\ \wedge & K^*_{w_2}([\![\alpha]\!]^{w_2,c}) \text{ s-supports } \phi \end{array} \right\}$$

Someone "knows whether ϕ if ψ" when their knowledge supports the question "whether ϕ". More generally, someone "knows ϕ" when their knowledge supports ϕ. The semantics is not defined on any properties (i.e., the presence of a conditional) of the complement of "know" – so any arbitrary assumptions introduced in any way could be handled. Thus, this analysis extends readily to embedded double conditionals, to the extent that they are syntactically well-formed.[23] The analysis retains the property from previous treatments of embedded questions of straightforwardly handling conjoined questions and assertions, in addition to conjoined CQs and assertions, conjoined questions and conditional assertions, and so on.

The idea behind this analysis might be clearer with an example. Ferdinand, who is close to being omniscient, knows at least that we are in one of eight worlds, $w_1 ... w_8$. Suppose that a party has be planned and that Joanna is invited. Suppose that Alfonso has also been invited, and may or may not attend. In this scenario, Joanna and Alfonso are sometimes on bad terms, and sometimes on good terms. The full range of possibilities for these eight worlds is shown in (77).

(77)

	Alfonso goes	Joanna goes	A & J fight
w_1	+	+	+
w_2	+	+	-
w_3	+	-	+
w_4	+	-	-
w_5	-	+	+
w_6	-	+	-
w_7	-	-	+
w_8	-	-	-

Let's further assume that Ferdinand also knows that if Alfonso and Joanna are on bad terms, there is no way that both of them would be at the party. That is, he knows that w_1 and w_4 are out from the start. He also knows that if they are on good terms, Joanna will attend the party of Alfonso does.

Consider first the case where Ferdinand happens to learn that they are fighting. He now knows that we must be in one of w_3, w_5, w_7. ($K_w(\text{ferd}) = \{w_3, w_5, w_7\}$ for w in the context set.) In this scenario, it seems entirely true to say:

(78) Ferdinand knows whether Joanna will go to the party if Alfonso goes.

Intuitively, this should be true because Ferdinand's knowledge will make unnecessary the question of whether Joanna will come to the party if Alfonso does, and this is what the present analysis captures. The interpretation of (78) involves an update which reduces the context set to pairs of worlds where Ferdinand's knowledge state in both worlds s-supports the embedded CQ. To find out if his knowledge state s-supports the embedded CQ, we have to test the following (pseudo-)formula:

[23] It appears that only one "if"-clause can be easily left-adjoined, and only one can be easily right-adjoined.

(79)
$$[\forall s : s \in S]\left(\begin{array}{rl} & s + \text{Ferdinand's knowledge state} \\ = & s + \text{Ferdinand's knowledge state} + \text{Whether Joanna will go if Alfonso goes}\end{array}\right)$$

The updates can be calculated straightforwardly – on the left side of the equals sign we get the intersection of the (top element of) the stack s with Ferdinand's knowledge state, and on the right side we get the result of updating the stack containing Ferdinand's knowledge with the CQ, just as if it were a matrix CQ. This is done for arbitrary stacks, but let's focus on a case where the arbitrary stack does not tell us much and has only one level. The result of adding Alfonso's knowledge state in this scenario is shown here:

(80)
$$s = \begin{array}{|r|c|}\hline s_0: & \left\{\begin{array}{ccc} \langle w_3, w_3\rangle & \langle w_5, w_3\rangle & \langle w_7, w_3\rangle \\ \langle w_3, w_5\rangle & \langle w_5, w_5\rangle & \langle w_7, w_5\rangle \\ \langle w_3, w_7\rangle & \langle w_5, w_7\rangle & \langle w_7, w_7\rangle \end{array}\right\} \\ \hline \end{array}$$

The antecedent of the conditional causes Alfonso to set aside worlds where Alfonso does not go. This results in a stack s', with a simplified s'_0. Stack s'_1 is identical to the s_0 above.

(81)
$$s' = \begin{array}{|r|c|}\hline s'_0: & \{\ \langle w_3, w_3\rangle\ \} \\ \hline s'_1: & \left\{\begin{array}{ccc} \langle w_3, w_3\rangle & \langle w_5, w_3\rangle & \langle w_7, w_3\rangle \\ \langle w_3, w_5\rangle & \langle w_5, w_5\rangle & \langle w_7, w_5\rangle \\ \langle w_3, w_7\rangle & \langle w_5, w_7\rangle & \langle w_7, w_7\rangle \end{array}\right\} \\ \hline \end{array}$$

Next, we update this stack with the consequent, partitioning depending on whether Joanna attends to the party. This has no effect on the context set containing just w_3 (i.e., s'_0). Correspondingly, the update will have no effect on the tail of the stack, s'_1, since there is no issue to percolate. Thus, the tails of s and s' are identical, and the sentence comes out true.

Consider now the case where Ferdinand does not learn whether Alfonso and Joanna are fighting. In this version of Ferdinand's knowledge state, worlds w_2, w_4, and w_6 have not been excluded. The result of adding Alfonso's knowledge state to some arbitrary stack will look like t in (82):

(82)
$$t = \begin{array}{|r|c|}\hline t_0: & \left\{\begin{array}{cccccc} \langle w_2, w_2\rangle & \langle w_3, w_2\rangle & \langle w_5, w_2\rangle & \langle w_6, w_2\rangle & \langle w_7, w_2\rangle & \langle w_8, w_2\rangle \\ \langle w_2, w_3\rangle & \langle w_3, w_3\rangle & \langle w_5, w_3\rangle & \langle w_6, w_3\rangle & \langle w_7, w_3\rangle & \langle w_8, w_3\rangle \\ \langle w_2, w_5\rangle & \langle w_3, w_5\rangle & \langle w_5, w_5\rangle & \langle w_6, w_5\rangle & \langle w_7, w_5\rangle & \langle w_8, w_5\rangle \\ \langle w_2, w_6\rangle & \langle w_3, w_6\rangle & \langle w_5, w_6\rangle & \langle w_6, w_6\rangle & \langle w_7, w_6\rangle & \langle w_8, w_6\rangle \\ \langle w_2, w_7\rangle & \langle w_3, w_7\rangle & \langle w_5, w_7\rangle & \langle w_6, w_7\rangle & \langle w_7, w_7\rangle & \langle w_8, w_7\rangle \\ \langle w_2, w_8\rangle & \langle w_3, w_8\rangle & \langle w_5, w_8\rangle & \langle w_6, w_8\rangle & \langle w_7, w_8\rangle & \langle w_8, w_8\rangle \end{array}\right\} \\ \hline \end{array}$$

Just as before, we then accept the content of the antecedent of the conditional, that Alfonso is going. This results in a stack t' with t'_1 identical to t_0.

(83)
$$t' = \begin{array}{|r|c|}\hline t'_0: & \left\{\begin{array}{cc} \langle w_2, w_2\rangle & \langle w_3, w_2\rangle \\ \langle w_3, w_2\rangle & \langle w_3, w_3\rangle \end{array}\right\} \\ \hline t'_1: & t_0 \\ \hline \end{array}$$

In this case, updating with the consequent question does have an effect. It causes us to disconnect the worlds w_2 and w_3. This disconnection must then percolate immediately, and will have an effect as well on the tail of the resulting stack t''.

(84)
$$t'' = \begin{array}{|r|c|}\hline t''_0: & \left\{\begin{array}{cc} \langle w_2, w_2\rangle & \\ & \langle w_3, w_3\rangle \end{array}\right\} \\ \hline t''_1: & \left\{\begin{array}{cccccc} \langle w_2, w_2\rangle & & \langle w_5, w_2\rangle & \langle w_6, w_2\rangle & \langle w_7, w_2\rangle & \langle w_8, w_2\rangle \\ & \langle w_3, w_3\rangle & \langle w_5, w_3\rangle & \langle w_6, w_3\rangle & \langle w_7, w_3\rangle & \langle w_8, w_3\rangle \\ \langle w_2, w_5\rangle & \langle w_3, w_5\rangle & \langle w_5, w_5\rangle & \langle w_6, w_5\rangle & \langle w_7, w_5\rangle & \langle w_8, w_5\rangle \\ \langle w_2, w_6\rangle & \langle w_3, w_6\rangle & \langle w_5, w_6\rangle & \langle w_6, w_6\rangle & \langle w_7, w_6\rangle & \langle w_8, w_6\rangle \\ \langle w_2, w_7\rangle & \langle w_3, w_7\rangle & \langle w_5, w_7\rangle & \langle w_6, w_7\rangle & \langle w_7, w_7\rangle & \langle w_8, w_7\rangle \\ \langle w_2, w_8\rangle & \langle w_3, w_8\rangle & \langle w_5, w_8\rangle & \langle w_6, w_8\rangle & \langle w_7, w_8\rangle & \langle w_8, w_8\rangle \end{array}\right\} \\ \hline \end{array}$$

The tail of t'' is clearly not identical to the tail of t, and so the sentence comes out false. Note that the structure in t''_1 is not a partition on worlds $w_1 ... w_8$, though it does contain a Velissaratou-style alternative structure. While it is possible to implement a version of this analysis that involves partition structures all the way down (as per §7), using the simple notion of inquisitive updates (see (48), and fn. 22), it is somewhat complicated to do in a general way. In this example, it would involve taking any suppositions introduced between t and t'', and backing them out in t so that the top element of t'' (containing the new issue) is comparable with the top element in t.

In the following section, we turn to a brief discussion of how our analysis meshes with the standard analysis of modals.

9 Dynamic semantics and domain restriction

Viewed from an abstract perspective, our analysis of conditional questions is really an analysis of domain restriction in questions and answers, and the stack semantics of Kaufmann (2000) is really a tool for modeling temporary but persistent domain restrictions. Much of our analysis boils down to the claim that in CQs, the “if”-clause restricts the domain of the question operator. More generally, we propose that an “if”-clause restricts the domain of any speech-act operator that is present in a clause that it adjoins to.

This claim could be cast in a variety of ways and is not at all contingent on using a dynamic semantics. However, there is some reason to choose a dynamic account over a static account. The domain restrictions in question are temporary, but are clearly seen to persist past the end of a single sentence.

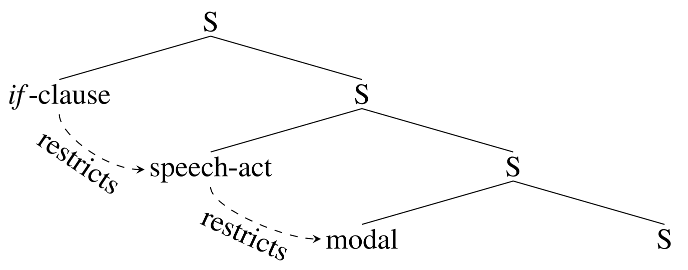
(85) a. If Alfonso comes to the party, will Joanna go home angry?
b. Yes, she will.

The antecedent of the conditional in (85a) clearly provides a domain restriction not just for the consequent of the conditional, but for a following answer uttered by an entirely different speaker. Despite the temporariness of the restriction, it can potentially persist indefinitely – in our analysis it is exactly because the issue raised by the CQ in (85a) is still on the table that the temporary context cannot be discarded. A dynamic approach, using stacks to model temporary domain restrictions, directly provides the tools to analyze these effects. A static account of domain restriction struggles, because the effects are clearly discourse-level effects, not just sentence-level effects, and are clearly tied to discourse-level dynamics. We contend that at least for this sort of domain restriction, a dynamic account provides the best model.

The claim that “if”-clauses restrict the domain of a speech-act operator can be reconciled with the standard (linguist’s) analysis of conditionals, due to Lewis and Kratzer (see Lewis 1975; Kratzer 1977, 1981, 1986, 1991, etc.). According to the standard analysis, an “if”-clause restricts the domain of an operator in the clause it adjoins to. In the case of the examples under discussion here, that operator would appear to be a modal. The resolution is straightforward.

On our analysis, every full clause contains a speech-act operator (or, alternatively, has the interpretive force of some speech act), regardless of whether there is a modal in the sentence. If a clause has an adjoined “if”-clause, the “if”-clause restricts whatever speech-act operator is present. If a modal is also present, it will receive its domain restriction from the speech-act operator. If the speech-act operator has been restricted by an “if”-clause, then the modal’s domain will be indirectly but straightforwardly restricted by that same “if”-clause. This is illustrated schematically in (86).

(86)



This analysis provides a welcome result for conditionals with no overt modal. Kratzer (1986) (and earlier work by Kratzer) argues that a covert modal must be present in any indicative conditional that lacks an overt modal. On our analysis, something very similar, but not quite the same, happens. Restricting the (covert) speech-act operator does all the work that restricting a covert modal would do, and a speech-act operator would need to be present in any case. One could think of speech-act operators as a kind of covert modal with an epistemic flavor, in fact – to assert ϕ is to reduce the context set to a state where ϕ is necessarily true given that context set. To question ϕ (considering a polar question) is to partition the context into cells where either ϕ is necessarily true, or it necessarily does not follow. More generally, a question induces a partition into cells where in each cell, some complete answer is necessarily true.

We now sketch what the semantics of an overt modal looks like under these assumptions. Modal words, in Kratzer's system, are sensitive to two contextual parameters: a modal base and an ordering source. We abstract away from the reasons for using an ordering source in our discussion, but our analysis is entirely compatible with it. The modal base corresponds to the accessibility function of standard modal logic, and the "if"-clause provides a restrictor to it. We derive the restriction indirectly. The modal base provided by the context is further restricted by the context set. Here is a denotation for "must", assuming that f_c is the modal base provided by the context, and that cs_c is the (one-dimensional) context set provided by the context (for use in static interpretation below the clause level).

(87) $[\![\textbf{must}]\!]^{w,c} = \lambda p \in D_{\langle st \rangle} \, . \, \forall w' \in D_s [w' \in \bigcap f_c(w) \wedge w' \in cs_c] \, p(w')$

This denotation leaves out reference to an ordering source, but it could be added in straightforwardly. The denotation in (87) is really only trivially different from a Kratzer-style modal. In place of "$w' \in cs_c$", the Kratzer-style modal would have $w' \in p'$, where p' is the proposition denoted by the content of the "if"-clause.

It is clear that there may be much more to examine, in the interaction of a modal with a conditional question. Our suggestion for the means of interaction between "if"-clauses, modals, and question operators is only a tentative one. For instance, Cohen (2006) argues (based on data we have not considered here, involving conjoined consequents) that the logical structure actually places the modal outside the question operator. We will leave for the future determining the best way to go.

10 Concluding Remarks

On our analysis, CQs involve the straightforward combination of a dynamic semantics for conditionals and a partition semantics of questions. The interpretation of the antecedent and the consequent is decomposed into two steps. In the first step, a temporary copy of the current context is made, and is updated to entail the propositional content of the antecedent. The question in the consequent is then taken to raise an issue relative to the temporary context. This happens in a way exactly parallel to modal subordination. The resulting analysis is technically complex, but it is complex in an expected way – it arises from the combination of independently motivated analyses.

The semantic analysis we provide works in tandem with a pragmatic analysis of responses which address the content of the antecedent. In previous analyses, responses that deny the truth of the antecedent of indicative CQs have been incorporated into the semantics, because they seem to dispel the issues raised by the question. We argue that this issue-dispelling effect arises because such responses deny the presuppositions of the conditional structure. This pragmatic analysis allows us to maintain a standard partition semantics of questions, and also provide an account which can generalize to counterfactual CQs.

We have presented two ways of retaining mutual exclusivity: one that retains it for all contexts, and one only for the context most immediately affected by a question. We showed that adopting the second assumption simplifies the analysis of embedded conditional questions. However, the first assumption does not make it technically impossible to analyze embedded CQs. The choice between these alternatives does not yet appear to make any empirical predictions, and one question for the future is whether it does.

A recently revived debate in the semantics of declarative conditionals revolves around the scope a speech-act operator takes relative to an “if”-clause (see Lycan 2006; Stalnaker 2005 for recent discussion). On one view, the *Asserted Conditional Theory*, the utterance of a conditional with a declarative consequent amounts to the assertion of the entire conditional. On the other, the *Conditionalized Assertion Theory*, the utterance of the consequent alone counts as the assertion. The antecedent simply provides information about when the assertion obtains.

Historically, this debate has focused almost exclusively on conditionals with declarative consequents. Stalnaker (2005) argues that, for the case of assertions, the two approaches achieve the same results. When considering our analysis of conditional questions, the picture changes. Our analysis crucially involves conditionalized questions – this allows the “if”-clause to prepare a restricted context for the question, and the denial of the antecedent to deny a presupposition prior to the question. Cohen (2006) also argues against the questioned conditional approach.

The general implication is that “if”-clauses might always be scopally higher than speech-act operators (following similar proposals about embedded speech act operators in Krifka (2001, 2004)). This suggests not only that conditional exclamations and commands should be possible, but that there is nothing special about the fact that they are conditionalized. Both are indeed possible:

(88) If you go to the store, buy some milk.

(89) If the sun comes out, what a nice day it will be!

We predict that the “if”-clause in each case should simply restrict an imperative and exclamative operator respectively. This hypothesis provides a broad scope for future investigation.

Acknowledgements

We would like to thank Cleo Condoravdi, Donka Farkas, Hans-Martin Gärtner, Jim Higginbotham, Michela Ippolito, Ruth Kramer, Bill Ladusaw, Frank Veltman, and the editors, as well as audiences at UCSC, the Language Under Uncertainty workshop at Kyoto University, ZAS, the University of Frankfurt, and S-Trend 2006 for discussion and comments on various stages of this work. We are especially grateful to Jeroen Groenendijk for extensive written comments on earlier versions.

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