Questions and Connectives

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Abstract. We propose a conservative analysis for conditional questions, i.e. those of the form *if* ϕ, Q where ϕ expresses a proposition and Q a question. Our analysis retains the standard interpretation of *if* as a propositional operator and predicts the right intuitions regarding the answers to these questions. Furthermore, we explain why *and* and *or* cannot embed questions the same way *if* does. We show how our account overcomes difficulties faced by previous theories, and discuss some open problems for future research.

Keywords: Questions · Connectives · Co-ordinate Structure Constraint · ATB-movement

1 Introduction

Our starting point is an observation which, to the best of our knowledge, is novel. The observation concerns a difference between *and* and *or* on the one hand, and *if* on the other. The basic intuition we have about these words is that they connect propositions. More technically, these "connectives" denote functions which map two propositions into one: suppose ϕ and ψ express propositions, then ϕ *and* ψ, ϕ *or* ψ, and *if* ϕ, ψ express propositions as well. For present purposes, we will assume the familiar meanings of *and* and *or* as the conjunction and the disjuction, respectively. For *if* we assume the Stalnaker-Lewis-Kratzer 'closest world' analysis (Stalnaker, 1968; Lewis, 1973; Kratzer, 1986).[1]

(1) a. $[\![\text{and}]\!](p)(q) = p \cap q = \lambda w.\ p(w) + q(w) > 1$
b. $[\![\text{or}]\!](p)(q) = p \cup q = \lambda w.\ p(w) + q(w) > 0$
c. $[\![\text{if}]\!](p)(q) = p \boxdot\!\!\rightarrow q = \lambda w.$ the p-world closest to w is a q-world

[1] Assuming, of course, that $p(w)$ is either 1 or 0, and the addition sign + has its ordinary meaning. The "p-world closest to w" is the world which differs from w only so much as to make p true. Thus, (*if* ϕ, ψ) says that ψ is true if the actual world were to change minimally as to make ϕ true. Note the singular definite: we make the so-called "limit assumption" that there is exactly one p-world closest to w, for any p and w. For more details see the cited works.

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The central puzzle which this paper sets out to resolve is this: *if* can connect a proposition with a question, while *and* and *or* cannot.

(2) a. If it's raining, will John come?
b. #It's raining and will John come?
c. #It's raining or will John come?

There is a clear contrast between (2-a) on the one hand and (2-b) and (2-c) on the other.[2] It should be noted, right away, that there is a reading of (2-b) and (2-c) under which these sentences become acceptable. This is the "speech act" reading. Apparently *and* can be used for addition and *or* for revision of speech acts. In written texts, these uses can be brought out more transparently by a non-standard, "creative" punctuation.

(3) a. It's raining. And: Will John come?
'I'm telling you that it's raining. In addition, I'm asking you whether John will come.'
b. It's raining. Or: Will John come?
'I'm telling you that it's raining. On second thought, let me ask you whether John will come.'

Note that the speech act reading is not possible with *if*. An *if*-clause cannot be independent, and thus cannot constitute a speech act. This is reflected in the fact that such creative punctuation as exemplified by (3) cannot be transferred to conditionals.

(4) #If it's raining. Will John come?

The contrast between (4) on the one hand and (3-a) and (3-b) on the other can be derived from the following preference principle regarding the use of the period in English.

(5) The period should end an expression which constitutes a speech act.

Since *it's raining* can constitute a speech act, it can be ended by a period, hence (3-a) and (3-b) are acceptable. In contrast, *if it's raining* cannot constitute a speech act, hence cannot be ended by a period, which is why (4) is odd. Now, is there a way to exclude the speech act reading for *and* and *or*? We think there is. Consider the texts in (6).

(6) a. (i) It's both raining and John will come.
(ii) #It's both raining. And: John will come.
b. (i) It's either raining or John will come.
(ii) #It's either raining. Or: John will come.

[2] As we said in the beginning paragraph, we think this observation is new. It has been noted that a question can be the consequent of a conditional (cf. Isaacs and Rawlins, 2008; Krifka, 2019; Bledin and Rawlins, 2019), but the contrast between *if* and the other two connectives has not been pointed out, as far as we know.

As we can see, the "creative" punctuation does not work when *both* and *either* accompany *and* and *or*, respectively. Given (5), this is evidence that neither *it's both raining* nor *it's either raining* can constitute a speech act. This means that the speech act reading is not available for co-ordinations of the form *both* ϕ *and* ψ and *either* ϕ *or* ψ. Now consider the sentences in (7).

(7) a. #It's both raining and will John come?
b. #It's either raining or will John come?

Speakers we consulted find (7-a) and (7-b) to be substantially worse than (2-b) and (2-c). We believe the reason is that the latter can be rescued by the speech act reading while the former cannot, due to the presence of *both* and *either*.

Let us state the generalization we want to derive.

(8) *If* can connect a proposition and a question, while *and* and *or* cannot

We will propose an analysis which derives (8) and, at the same time, maintains that *if* is propositional in both arguments. Our discussion will focus on polar questions, but the proposal generalizes to constituent questions, as will be seen.

2 Two Previous Accounts

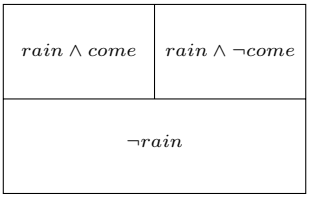
Henceforth we will use the term "conditional questions", short CQs, to refer to sentences such as (2-a). We will now discuss two (kinds of) analyses of CQs that have been proposed in the literature.

2.1 The Tripartition Analysis

According to the "tripartition analysis", proposed by Groenendijk and Stokhof (1997), CQs partition the context set into three cells.[3] For example, the CQ in (2-a), reproduced in (9), would result in the context set in (10).

(9) If it's raining, will John come?

(10) Context set induced by (9)



[3] The "context set" is the set of possible worlds which represents the conjunction of all mutual assumptions of all discourse participants (cf. Stalnaker, 1978).

The question thus presents the addressee with three choices: (i) affirm the antecedent and saying "yes" to the consequent (11-a); (ii) affirm the antecedent and saying "no" to the consequent (11-b); and (iii) denying the antecedent (11-c).

(11) a. It's going to rain and John will come
b. It's going to rain but John will not come
c. It's not going to rain

We agree that the sentences in (11) can be used as responses to (9). To the extent that this is true, the tripartition analysis does have merits. However, we believe that there is a clear sense in which the responses in (11) do not directly address the question. They seem to target not the question but, rather, its presupposition, triggered by *if*, that rain is possible but not certain (von Fintel, 1999). The question asks whether John will come in the closest rain-world, i.e. whether John will come if the actual world were to change minimally so that it is raining. It does not ask whether it's going to rain, or whether John will come. However, these are the questions which are answered by the sentences in (11). Our claim, therefore, is that the tripartition analysis overgenerates: it includes sentences that should not be included.

The tripartition analysis, we believe, also undergenerates. Our intuition, which is shared by native speakers we have consulted, is that both *yes* and *no* are perfect answers to (9), and are interpreted as indicated in (12-a) and (12-b).

(12) If it's raining, will John come?
a. Yes (= 'if it's raining, John will come')
b. No (= 'if it's raining, John will not come')

But according to the tripartition analysis, (12-a) and (12-b) are not answers to (9), reproduced in (12), at all. In fact, this analysis implies that CQs are not yes/no questions. A yes/no question has two answers, which means it partitions the context set into two cells, not three. Thus, the tripartition analysis undergenerates: it excludes sentences that should not be excluded.

Last but not least, the tripartition analysis has nothing to say about the contrast between *if* on the one hand and *and* and *or* on the other (Velissaratou, 2000). Why should (7-a) not be a well-formed question which partitions the context set into a $rain \wedge come$ cell and a $rain \wedge \neg come$ cell, for example?

We take the above considerations to be sufficient grounds to look for another analysis.

2.2 The Context Update Analysis

The "context update" analysis, proposed in various forms by Isaacs and Rawlins (2008); Krifka (2019); Bledin and Rawlins (2019), take the interpretation of CQs to be a two-step process. First, the initial context c is updated to a "temporary" context c' by the *if*-clause. Then the question in the consequent is asked with respect to this local context c'.

(13) $c +$ If $[_p$ it's raining$]$, $[_Q$ will John come?$]$
(i) update c with p
$\rightarrow$ resulting in c'
$= \lambda w.\ w \in c \wedge$ it's raining in w
(ii) update the output of (i) with Q
$\rightarrow$ resulting in a partition of c'
$= \lambda w.\ \lambda w'.\ w, w' \in c' \wedge$ (it's raining in $w \leftrightarrow$ it's raining in w')

This analysis seems more promising than the tripartition analysis. A CQ does seem to work in just the way described. In uttering the CQ in (2-a), we are not asking whether John will come in the actual context. Instead, we are asking whether he will come in the hypothetical scenario in which it is raining. Also, we can see how *yes* and *no* can be interpreted under this analysis: *yes* means John will come in the hypothetical scenario, and *no* means he won't come in the hypothetical scenario. Thus, the context update analysis is also superior to the tripartition analysis in that it predicts *yes* and *no* to be answers to CQs and, furthermore, to have the intuitively correct interpretation.

The context update analysis also assimilates CQs and regular conditionals with respect to the phenomenon of "denying the antecedent".

(14) A: If it's raining, John will not come.
B: It's not going to rain.

(15) A: If it's raining, will John come?
B: It's not going to rain.

Intuitively, B is doing the same thing in both (14) and (15), which is claiming that the update to be performed as instructed by the *if*-clause is not realistic. What B says is that all worlds in the context set are non-rain worlds. Thus, updating this context with *it's raining* will result in the contradiction, and will not be a pragmatically felicitous move (Stalnaker, 1978).

Another virtue of the context update analysis is that it squares with facts about presupposition projection. Consider the assertion in (16-a) and the question in (16-b).

(16) a. The king of France is bald. $\rightsquigarrow$ France has a king
b. Is the king of France bald? $\rightsquigarrow$ France has a king

Both of these sentences presuppose that France has a king. Now, we know that the presupposition of *if* ϕ, ψ_p, where p is the presupposition of ψ, is $[\![\phi]\!] \subseteq p$ (Karttunen, 1973; Heim, 1990). In other words, the *if*-clause "filters out" the presupposition of the consequent. This means that if $[\![\phi]\!] = p$, then *if* ϕ, ψ_p will have the trivial presupposition that $p \subseteq p$, which is to say that it will not presuppose anything. That this is the case is evidenced by (17).

(17) If France has a king, the king of France is bald $\rightsquigarrow \top$

The update semantics proposed for conditionals predicts exactly this projection behavior. Now consider (18).

(18) If France has a king, is the king of France bald? $\rightsquigarrow \top$

Intuitively, (18) presupposes nothing, in exactly the same way that (17) presupposes nothing. This means the same update semantics holds for *if*-clauses, both in regular conditionals and in conditional questions. A good result.

So why should we not adopt the context update analysis for CQs? Well, it does not answer the question we want to answer, namely why *if* is different from *and* and *or*. According to the standard update semantics for *and* and *or*, the presupposition projection behavior of ϕ *and* ψ is similar to that of *if* ϕ, ψ and the presupposition projection behavior of ϕ *or* ψ is similar to that of *if* $\neg\phi$, ψ. Thus, the local context for the second conjunct is the first conjunct, and the local context for the second disjunct is the negation of the first disjunct. This is evidenced by the fact that neither (19-a) and (19-b) presupposes anything.

(19) a. France is both a monarchy and the king of France is bald
b. France is either not a monarchy or the king of France is bald

But then it's not clear why *and* and *or* cannot embed questions. Why should (20-a) and (20-b) not be well-formed and presuppose nothing in the same way as (19-a) and (19-b), respectively?

(20) a. #France is both a monarchy and is the king of France bald?
b. #France is (either) not a monarchy or is the king of France bald?

Let us consider another analysis.

3 Proposal

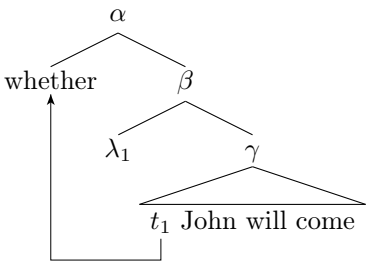
This section presents our explanation of the generalization in (8). We show that it reduces to a well-known fact, namely the Coordinate Structure Constraint, assuming that all connectives are propositional.

3.1 Analysis of Polar Questions

We implement the semantics of (matrix) polar questions along the line of several well-known analyses (cf. Bennett, 1977; Higginbotham, 1993; Krifka, 2001a; Guerzoni, 2004). Specifically, we assume that polar questions contain a covert *whether* which moves to [Spec, C] from the edge of a propositional constituent, leaving a trace and creating a λ-abstract. We take the head-movement of *will* which results in subject-auxiliary-inversion to be semantically inconsequential, and will not represent it in logical form.

(21) a. will John come?

b.

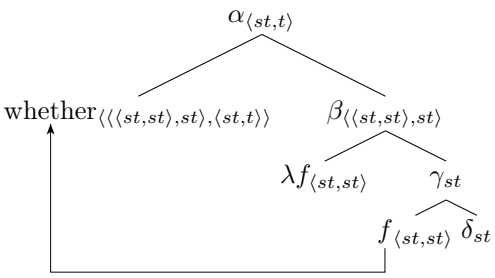


We define two functions from propositions to propositions: YES $=_{\text{def}} \lambda p.\ p$, and NO $=_{\text{def}} \lambda p.\ \neg p$. Let us call YES the "positive polarity" and NO the "negative polarity", and write "$pol(f)$" to mean f is a polarity, i.e. f is either YES or NO. We want the interpretation of (21-a) to be the set in (22).

(22) {YES(John will come), NO(John will come)}
= {John will come, John will not come}

This means α in (21-b) should be of type $\langle st, t\rangle$. The semantic types of the constituents are presented in (23). Note that the trace of *whether* is of the "polarity" type, i.e. $\langle st, st\rangle$.

(23)



Here are the meanings of the constituents. We invite the readers to verify that applying this analysis to (21-a) will yield the set in (22), as desired.

(24) a. $[\![\text{whether}]\!] = \lambda Q_{\langle\langle st,st\rangle,st\rangle}.\ \lambda p_{st}.\ \exists f_{\langle st,st\rangle}.\ pol(f) \wedge p = Q(f)$
b. $[\![\beta]\!] = \lambda f.\ f([\![\delta]\!])$
c. $[\![\alpha]\!] = \lambda p.\ \exists f.\ pol(f) \wedge p = [\![\beta]\!](f)$
$= \{[\![\delta]\!], \neg[\![\delta]\!]\}$

3.2 Deriving the Observations

Types and Locality – Let us now turn to the main topic of this paper: conditional questions (CQs) and the difference between *if* and the other two connectives. We start with the claim in (25).

(25) All connectives are propositional

In other words, both arguments of *if*, as well as those of *and* and *or*, are of type $\langle s, t\rangle$, and the interpretation of the three connectives are as presented in (1). We propose that CQs are just polar questions whose prejacent is a conditional. In particular, there is a covert *whether* which moves from the edge of the main clause, i.e. the consequent, leaving a trace (Bennett, 1977; Higginbotham, 1993; Krifka, 2001a; Guerzoni, 2004). The logical form of (33) would be (26-b), whose interpretation would the set in (26-c).

(26) a. if it's raining, will John come

b. $[_{\alpha}$ whether λ_1 [[if it's raining] $[t_1$ John will come]]]]

c. $[\![\alpha]\!] = \{\text{rain} \boxrightarrow \text{John comes}, \text{rain} \boxrightarrow \neg\text{John comes}\}$
$= \{$if it's raining John will come, if it's raining John won't come$\}$

Note that movement of *whether* violates no locality constraints because the *if*-clause is a subordinate clause, which is an adjunct. As evidenced by (27) below, a wh-phrase can move across an *if*-clause, just like it can move across a non-sentential adjunct.

(27) a. that's the movie which [[if it's raining] I would watch t]

b. that's the movie which [[surely] I would watch t]

But note that wh-movement out of a conjunct or a disjunct is not possible, due to the Coordinate Structure Constraint (CSS) (Ross, 1967).

(28) a. *that's the movie which [[it was raining] and [I watched t]]

b. *that's the movie which [[I read the book] or [I watched t]]

We are now in the position to resolve the central puzzle of the paper. First, let us address the fact that *and* and *or* cannot connect a proposition and a question. Consider, again, the (unacceptable) sentence in (2-b), reproduced here in (29).

(29) #It's raining and will John come?

What are the possible analyses of (29)? Suppose *whether* moves within the second conjunct, as depicted in (30).

(30) $[_{st}$ it's raining] and $[_{st,t}$ whether t John will come]

Given (25), (30) is a case of type mismatch: the left argument of *and* is a proposition (type st), but the right argument is a question, i.e. a set of propositions (type $\langle st, t\rangle$). Now, suppose *whether* moves to scope above both conjuncts, as depicted in (31).

(31) [whether [$_{st}$ it's raining] and [$_{st}$ t John will come]]

In this case, both arguments of *and* are of the right type. However, the movement of *whether* violates the CSC. We do not see any other landing site for *whether*. Since both possible parses of (29) are problematic, the sentence is unacceptable.

A completely parallel story can be told for *or*. The possible parses for the unacceptable (2-c), reproduced in (32), are given in (32-a), which is a type mismatch, and (32-b), which violates the CSC.

(32) It's raining or will John come?

a. [$_{st}$ it's raining] or [$_{st,t}$ whether t John will come] → *type

b. [whether [$_{st}$ it's raining] or [$_{st}$ will t John t_{will} come]] → *CSC

Answers – Our account of CQs makes the correct predictions regarding the answers to these questions. As seen from (26), we predict (33-a) and (33-b) to be the two answers to (33).

(33) If it's raining, will John come?

a. If it's raining, John will come = 'yes'

b. If it's raining, John will not come = 'no'

If we make the completely natural assumption that *yes* and *no* associate with assigning the values YES and NO to the polarity function, respectively, we get the result that the *yes* answer to (33) has the meaning of (33-a), and the *no* answer the meaning of (33-b). This result, we believe, accords with intuition: (33-a) and (33-b) are felt to be the two answers to (33). Furthermore, we predict the sentences in (11), reproduced below in (34-a) to (34-c), not to be congruent answers to (34).

(34) If it's raining, will John come?

a. It's going to rain and John will come

b. It's going to rain but John will not come

c. It's not going to rain

This, we believe, is also intuitively correct. All of these responses have a feel of "presupposition denial". They seem to say that there is something infelicitous about the question. And this is exactly what we predict. Look again at the two answers (33-a) and (33-b). Both of them are conditionals of the form *if* ϕ, ψ. This means both of them presuppose that rain is possible but not certain: some worlds in the context set are rain worlds, and some of them are non-rain worlds (von Fintel, 1999). This is thus the presupposition of the question. The assertions in (34-a) to (34-c) all deny this presupposition: (34-a) and (34-b) entails that all worlds in the context set are rain worlds, and (34-c) entails that all worlds in the context set are non-rain worlds.

4 Loose Ends

4.1 Factivity Effects

Consider the contrast between (35-a) and (35-b).[4]

(35) a. If it's raining, will John come?
b. #Because it's raining, will John come?

Suppose *because*, just like the other connectives, is propositional in the sense that both of its arguments are of type *st*. Then the only parse for (35-b) which does not incur type mismatch is (36).

(36) $[_{\alpha}$ whether λ_1 [[because it's raining] $[t_1$ John will come]]]]

Note that *because* comes with a factive presupposition for both of its arguments. This means that movement of *whether* in (36) is one out of a "factive island", which in turns means that it is not available. The contrast below provides independent evidence of this fact.

(37) a. what do you think $[_{\alpha}$ John saw $t]$

b. #what do you know $[_{\alpha}$ John saw $t]$

4.2 Constituent Questions

We have discussed polar questions, but the account we propose should generalize to constituent questions. First, note that the contrast between *if* and the other two connectives obtains for constituent questions as well.

(38) a. If it's raining, who will come?
b. #It's (both) raining and who will come?
c. #It's (either) raining or who will come?

We have interpreted *whether* as 'which polarity f is such that ...'. Let us interpret *who* in the same manner, namely as 'which person x is such that...'. The semantics for *who* is given in (39-b), and that for *whether* is reproduced in (39-a) for easy comparison.

(39) a. $[\![\text{whether}]\!] = \lambda Q_{\langle\langle st,st\rangle,st\rangle}.\ \lambda p_{st}.\ \exists f_{\langle st,st\rangle}.\ pol(f) \wedge p = Q(f)$
b. $[\![\text{who}]\!] = \lambda P_{\langle e,st\rangle}.\ \lambda p_{st}.\ \exists x_e.\ person(x) \wedge p = P(x)$

[4] A qualification is in order. We believe that there is a "speech act embedding" reading in which (35-b) is felicitous, namely 'because it is raining, I am going to ask you whether John will come'. Similarly for sentences such as *since it's raining, will John come?*, or *now that we know it's raining, will John come?* (we thank an anonymous reviewer for drawing out attention to these data points.) We have nothing to say about this reading within the confines of this paper. For analyses of embedded speech acts see Krifka (2001b, 2014).

The logical form of (38-a) is (40-a), and its denotation is the set in (40-b). The congruent answers are predicted to be such sentences as those in (40-c).

(40) a. who λx [if it's raining [t_x will come]]

b. {rain $\Box\!\!\rightarrow$ John comes, rain $\Box\!\!\rightarrow$ Mary comes, rain $\Box\!\!\rightarrow$ Sue comes,...}

c. (i) If it's raining, John will come
(ii) If it's raining, Mary will come
(iii) If it's raining, Sue will come

We believe this is the intuitively correct result. As for the unacceptable (38-b), the logical form would be (41-a), the denotation would be the set in (41-b), and the congruent answers sentences such as those in (41-c).

(41) a. who λx [[it's raining] and [t_x will come]]

b. {rain $\wedge$ John comes, rain $\wedge$ Mary comes, rain $\wedge$ Sue comes...}

c. (i) It's raining and John will come
(ii) It's raining and Mary will come
(iii) It's raining and Sue will come

As far as we can see, there is nothing wrong with (41-b) and (41-c). The unacceptability of (38-b) is thus due to a syntactic constraint, i.e. the CSC. And what we just said about (38-b) can obviously be extended to (38-c), as the above arguments can be reproduced with *or* replacing *and*.

4.3 Ordering

The above discussion does not depend on the ordering of the arguments of the connectives: an *if*-clause is an adjunct whether it precedes or follow the main clause, and movement out of a co-ordinated clause is excluded whether it is the right or the left argument of the relevant connective. We thus predict that ordering of the clauses should not matter. This prediction is borne out, as evidenced by the contrasts in (42) and (43).

(42) a. Will John come if it's raining?
b. #Will John come and it's raining?
c. #Will John come or it's raining?

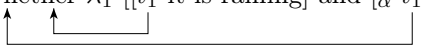
(43) a. Who will come if it's raining?
b. #Who will come and it's raining?
c. #Who will come or it's raining?

4.4 ATB-Movement and Open Problems

It is a well-known fact that questions can be conjoined, as illustrated in (44). For this case, we make the correct prediction, as nothing prevents *whether* to ATB-move out of both co-ordinate clauses, as shown in (44-a). The set of answers is predicted to be that in (44-b).

(44) is it raining and will John come?

a. whether λ_1 [[t_1 it is raining] and [$_\alpha$ t_1 John will come]]



b. {rain ∧ John comes, ¬rain ∧ ¬John comes}

The readings of *yes* and *no* seem to support the analysis. Specifically, the *yes* answer seems to confirm both conjuncts, while the most natural reading of *no* seems to be that which denies both conjuncts.

(45) Is it raining and will John come?

a. Yes. ⇝ it's raining and John will come

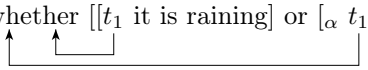
b. No. ⇝ it's not raining and John won't come

However, we admit that the *no* answer also has the 'not both' reading, i.e. ¬(rain ∧ John comes). We do not yet see how this reading of *no* can be explained given the logical form in (44-a). This is thus an open problem for us.

Another open problem concerns disjunction. As it stands, the analysis does not rule out ATB-movement from both disjuncts, which means we predict (46) to be possible with (46-a) as its logical form and (46-b) its denotation.

(46) #Is it raining or will John come?

a. whether [[t_1 it is raining] or [$_\alpha$ t_1 John will come]]



b. {rain ∨ John comes, ¬rain ∨ ¬John comes}

As indicated by the # sign, we believe (46) is not acceptable under the intended reading. There is, of course, the "alternative" reading of (46) under which this question denotes the set of proposition in (47), but this reading is not one that is expressed by the logical form in (46-a).[5]

(47) {it's raining, John will come}

We leave these issues to future research.

5 Conclusion

It has been observed that *if* can embed a proposition as antecedent and a question as consequent. We pointed out the fact that this is not possible with *and* and *or*, which has not been highlighted in the literature. We then provide an explanation for this fact. Our account is based on independently motivated claims about syntax and semantics: (i) connectives are propositional; (ii) *if* is a subordinator while *and* and *or* are co-ordinator; (iii) matrix polar questions contain a covert *whether* which quantifies over polarities and undergoes wh-movement; (iv) wh-movement is subject to the Co-ordinate Structure Constraint. We show that our

[5] We will remain agnostic about the analysis of alternative questions in this note.

analysis does justice to intuitions about the answers to conditional questions in contrast to previous theories. Finally, we discuss some open problems regarding ATB-movement of wh-phrases which we leave to future research.

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