If and When *If*-Clauses Can Restrict Quantifiers[*]

Kai von Fintel and Sabine Iatridou

Massachusetts Institute of Technology
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Abstract

The interpretation of *if*-clauses in the scope of ordinary quantifiers has provoked semanticists into extraordinary measures, such as abandoning compositionality or claiming that *if* has no meaning. We argue that *if*-clauses have a normal conditional meaning, even in the scope of ordinary quantifiers, and that the trick is to have the right semantics for conditionals.

1 The Problem and a Folkloric Solution

When a universal quantifier like *every student* takes scope over an *if*-clause, we are not wildly surprised that the sentence appears more or less equivalent to one where the material from the *if*-clause is fashioned into a relative clause restricting the quantifier.

(1)   a.   Every student will succeed if he studies hard. $\approx$
        b.   Every student who studies hard will succeed.

The equivalence follows quite straightforwardly under the assumption that the *if*-clause is associated with the semantics of material implication. It is of course what legions of students get taught in Logic 101. On a more sophisticated level, Barker (1997) in fact used the equivalence of (1a) and (1b) as an argument for a material implication analysis of indicative conditionals.

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[*]This paper is a descendent of the second part of an older manuscript "Modals, Quantifiers, and *If*-Clauses". The first part of that ancestral paper is now called "Epistemic Containment". The material of the ancestral paper was presented at colloquia at the University of Massachusetts at Amherst, at the University of Arizona, at the University of Connecticut, and at GLOW in Braga/Portugal. We thank the audiences for their kind remarks and helpful criticism. We thank two anonymous *LI* reviewers for their very useful comments. An early version of the present paper was presented at the workshop "In the Mood" at the University of Frankfurt in June 2002, where we received very useful comments from Nick Asher, Tim Stowell, Ede Zimmermann, and others. The authors are listed in alphabetical order.

We see that this is no more than a happy accident, however, when we move to other quantifiers. Higginbotham (1986) discusses sentences like (2) with the negative quantifier *no*.[1]

(2)   No student will succeed if he goofs off.

Under a material implication analysis, (2) would come out true iff every student goofs off and succeeds nevertheless. That is of course not what the sentence means and one can see (2) as just another one of the so-called "paradoxes of material implication", i.e. natural language examples that reveal that material implication is not the correct semantics for conditionals.

What does (2) mean? Again, intuitively it appears equivalent to a sentence with a relative clause, just like (1a) did:

(3)   (2) ≈ No student who goofs off will succeed.

But how could that apparent interchangeability of *if*-clauses and relative clauses be explained? Higginbotham essentially argued that the proper analysis involves *if* meaning 'if' under *every* but 'and' under *no*:[2]

(4)   (2) ≈ No student goofs off and succeeds.

Needless to say, this makes the semantics of this construction a tad non-compositional. Higginbotham therefore uses these data as an argument against compositionality[3] (see also Pelletier 1994a,b; Janssen 1997). Dekker (2001) presents a mechanical way of turning a material conditional meaning into a conjunctive one, but we don't know of any good reason to believe that his proposal is more than a trick.

Higginbotham's analysis runs into difficulties when the *if*-clause occurs under non-standard quantifiers such as *most* or *few*:

(5)   Most letters are answered if they are shorter than 5 pages.

(6)   Few people like New York if they didn't grow up there.

These examples are due to Irene Heim and/or Angelika Kratzer. As one might expect, weird predictions arise as long as one assumes that the *if*-clause has any kind of truth-functional meaning in (5) and (6).[4] For example, under the material implication analysis (5) would be true as long as most letters are

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[1]Similar sentences were independently discussed by Bosch (1983).

[2]In fact, Higginbotham's analysis is more involved. He argues that *if* means 'if' under upward monotone quantifiers and 'and' under downward montone ones. Further, he suggests that *if*-clauses have a core meaning of weakening the claim made by a quantificational structure, hence the differential behavior depending on the monotonicity properties of the environment.

[3]Actually, Higginbotham uses the data to argue that natural language does not obey what he calls the *Indifference Principle*, which is naturally seen as a special case of compositionality.

[4]The reason one expects this is that one paid attention in introductory semantics and learned that *most* cannot be analyzed as a one-place quantifier.

longer than 5 pages no matter whether any letters at all are answered. Again, intuitively these sentences appear equivalent to sentences with relative clauses:

(7)   (5) ≈ Most letters that are shorter than 5 pages are answered.

(8)   (6) ≈ Few people that didn't grow up there like New York.

It is time to make hay while the sun shines. The continued interchangeability of *if*-clauses and relative clauses begs to be exploited in the analysis. The folkloric solution to the problem is summarized in von Fintel (1998, a response to Barker 1997): the entire set of data seem to be best analyzed as just another case where *if*-clauses do not bring with them their own peculiarly conditional meaning but where they serve as restrictors for higher operators, here quantificational noun phrases. As such, this use of *if*-clauses appears to fall under Kratzer's generalization of Lewis' analysis of *if*-clauses as restrictors of adverbs of quantification:

> The history of the conditional is the story of a syntactic mistake. There is no two-place *if ... then* connective in the logical forms of natural languages. *If*-clauses are devices for restricting the domains of various operators. (Kratzer 1986)

2 Reasonable Doubts

One might want to declare victory at this point, especially since the tenure dossier of one of the authors included von Fintel (1998). Not so fast. Upon further review, there are reasons to doubt that the folkloric analysis is entirely adequate. We will go through a number of sets of data that made us suspect that *if*-clauses come with their own conditional meaning and are not chameleons as both Higginbotham and the folklore theorists would have. In what follows, we consider mostly the contest between the folklore theory and the conditional theory, while leaving it open what Higginbotham's theory might have to say about the data we're introducing.[5]

2.1   Non-quantificational NPs

We should immediately notice is that *if*-clauses are not freely interchangeable with relative clauses. There are plenty of cases where they do not appear to be able to restrict noun phrases. The following pairs are not only not equivalent, in fact the *if*-clause variant is decidedly odd:

(9)   a.   I invited the woman who runs the store downstairs. ≉
         b.   ?I invited the woman if she runs the store downstairs.

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[5]The main reason for leaving Higginbotham's theory aside is that we have too little information about it. The 1986 discussion is quite brief and sketchy. Fortunately, it appears that we will learn more about his analysis at this workshop. Where we can, we add occasional footnotes about what his theory might have to say about particular data.

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(10) a. At the party, I met some woman who works for Clinton. $\not\approx$
   b. ?At the party, I met some woman if she works for Clinton.

The conditional theory would simply say about the weirdness of (9b) that it doesn't make much sense to say of the uniquely salient woman that I invited her if she runs the store downstairs. And if we change the example slightly so that the conditional under *the woman* makes sense, we still have a sentence that is not equivalent to the relative clause structure:

(11) a. I will invite the woman if she runs a store. $\not\approx$
   b. I will invite the woman who runs a store.

A quick response from the folklore theorist might be that *the* and *some* are not really quantifiers and thus would not be expected to fall under the Lewis-Kratzer generalization that quantifiers can be restricted by *if*-clauses. For example, one might say that *the* has a Fregean analysis as creating referential expressions of type e and that *some* as well has a quasi-referential analysis à la Fodor & Sag or à la one of the currently fashionable choice-function analyses. Point granted for the purpose of this paper.

2.2 Modified Numerals

Harder to defuse counter-examples would therefore involve quantifiers that are not so easily treated as non-quantificational, such as modified numerals, which are known to resist the typical choice-function uses. Consider then:

(12) a. They invited at least three students who oppose the policy. $\not\approx$
   b. ?They invited at least three students if they oppose the policy.

We find again that with a slight adjustment, the *if*-clause under the noun phrase becomes good but remains non-interchangeable with a relative clause:[6]

(13) a. They will invite at least three students who oppose the policy. $\not\approx$
   b. They will invite at least three students if they oppose the policy.

Again, though, the folklore theorist might derive some hope from Krifka's recent reanalysis of modified numerals (see Krifka 1999), according to which *at least three* is not in fact a quantifier, at least not in a straightforward sense. So, let's leave even these cases aside for now.

2.3 Accidental vs. Lawlike Ambiguity

We are left with determiners whose quantificational nature is above suspicion: *(almost) every*, *(almost) no*, *most*, *few*[7], and some others we will encounter

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[6]Actually, what exactly is the difference between (13a) and (13b)?

[7]*Few* is clearly quantificational under the proportional reading, less clearly so under the cardinal reading (see Partee 1988).

below. Even with these, we will soon see that relative clauses and restrictive *if*-clauses are often not interchangeable. Before we look at the next set of data, we need to establish some background.

Excursus: Background on Lawlike Generalizations

Goodman (1947) made a famous distinction between accidental generalizations like

(14)   Every coin in my pocket is silver.

and lawlike generalizations like

(15)   Every dime is silver.

(14) is most naturally read as reporting an accidental fact ("Oh look! ...") about every coin that currently happens to be in my pocket. More remotely, it can be read as reporting a policy of mine: only silver coins go into my pocket. (15) is clearly a lawlike generalization: to be a dime an object has to be silver.

More recently, Dahl (1975) discussed sentences such as the following (see also Carlson 1989: pp. 185-186 and Diesing 1992: pp. 95-97):

(16)   Every friend of John's votes for Socialists.

This has a non-generic, albeit habitual, reading which predicates of every one of John's current and actual friends that he or she habitually votes for Socialists. But it also has a generic reading where habitually voting for Socialists is predicated, indeed required, of anyone who might be a friend of John's, and it applies to all John's potential friends as well as his present ones.

Carlson sketches an analysis of (16), echoed by Diesing who leans on class notes by Kratzer, in which a generic quantifier over possible worlds takes scope over the nominal quantifier:[8]

(17) $\text{gen}_w \ C_{w,w_0}$: every_x [friend-of-John's$_{x,w}$] [hab-votes-for-Socialists$_{x,w}$]

The idea is that we are quantifying over a contextually restricted set of possible worlds and are saying that those worlds are generally such that everyone who is a friend of John's in such a world is someone who habitually votes for Socialists in that world. The worlds quantified over are perhaps those worlds compatible with John's personal preferences in the actual world w_0.

There are at least two other analyses of the logical structure of lawlike generalizations that one might consider. One could assume that *every* itself can quantify over both individuals and possible worlds as a kind of "unselective" quantifier:

(18) $\text{every}_{w,x}$ [C_{w,w_0} & friend-of-John's$_{x,w}$] [hab-votes-for-Socialists$_{x,w}$]

Lastly, one might consider an analysis where there is no quantification over possible worlds at all but instead the nominal quantifier ranges over possible individuals, that is not just over individuals in the actual world. This idea is sketched in Section 6.8.3 of Heim and Kratzer (1998, pp. 165-170).

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[8]This is not really what Carlson proposes, but it comes as close to it as possible in the kind of framework we like to work with.

Examples where *If* Triggers Lawlike Reading

Sentences with a universal quantifier are at least sometimes ambiguous between an accidental reading and a lawlike one. We saw this for example with Goodman's *Every coin in my pocket is silver*. We now would like to note that restrictive *if*-clauses seem to quite generally disambiguate in favor of a lawlike reading. It is clear that the paradigmatic examples such as (2), (5), and (6) are all lawlike generalizations about students in general, letters in general, and people in general. The effect can be seen even more clearly by looking at some carefully constructed experiments:

(19)   a.   Every book that I needed for the seminar happened to be on the table.

        b. #Every book happened to be on the table if I needed it for the seminar.

The sentence in (19b) does not appear to be very felicitous since the content matter of the claim is explicitly about a lucky accident.[9]

(20)   Yesterday afternoon we found ourselves with a lot of time on our hand and we sat down to deal with the mail. In the end,

        a.   every letter that was less than 5 pages long was answered.

        b. #every letter was answered if it was less than 5 pages long.

Again, the situation is set up to be largely about happenstance and (20b) seems inappropriate.

(21)   a.   No paper that is longer than 50 pages is on this table.

        b.   No paper is on this table that is longer than 50 pages.

        c.   No paper is on this table if it is longer than 50 pages.

Finally, (21a/b) could be interpreted about an interesting accident or as the report of a strict personal policy of mine about papers on this table. As soon as we use an *if*-clause only the policy-reading survives.

<p style="text-align:center">* * *</p>

We are led to suspect that restrictive *if*-clauses are only compatible with nominal quantifiers when the quantification is generic or lawlike in nature. The folklore theorist under attack may now see a way out: yes, s/he admits, *if*-clauses cannot just serve as restrictors of any old quantifier; *if* can only restrict quantifiers that are modal in nature, that range over possibilities.

    This might be seen as an honorable compromise. In the crucial examples, the *if*-clause does serve as a restrictor of the nominal quantifier, but that only works because in those cases the nominal quantifier doesn't just range

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[9]Readers with a fine ear will be able to hear (19b) as the report of an occurrence that only appeared to be an accident, about which the speaker with a wink suspects that it was in fact the result of elaborate machinations behind the scenes.

over this-worldly individuals but in fact over possible individuals or perhaps world-individual pairs. This in fact is the analysis we pursued in the earlier incarnation of this paper (we called this the *Modal* If *Hypothesis (MIH)*). It also illustrates the fact that the folklore theory is hard to kill; in fact, suitably restricted it is presumably true that *if*-clauses serve as restrictors for various operators. What we are beginning to see here is that they cannot be claimed to be *all purpose* restrictors.

2.4   Conditionals under "Anchored" Quantifiers

It turns out that our initial suspicion was wrong. We can in fact find *if*-clauses under non-generic nominal quantifiers:

(22)   Every one of these students will succeed if he studies hard.

(23)   None of these students will succeed if he goofs off.

(24)   Both John and Peter will succeed if they study hard.

(25)   Neither John nor Peter will succeed if he goofs off.

It should be immediately clear that none of these sentences are naturally read as ranging over more than just the actual individuals falling into the quantifier domain: these students or John and Peter. Nevertheless, the restrictive *if*-clauses are perfectly fine here. In the face of these examples, even the more restricted version of the folklore theory considered in the previous section looks troubled.

In the next two sections, the final ones of this survey of new data, we present positive arguments in favor of an analysis that locates a complete conditional structure beneath the nominal quantifier in the relevant examples.

2.5   Weak Existence Presuppositions

As pointed out to us by an anonymous *LI*-reviewer, a reason to doubt that the *if*-clauses are actually inside the restriction of the quantifier is that they do not seem to be captured by the existence presupposition such quantifiers usually induce. Consider these minimal pair:

(26)   a.   Many/A few of the students will succeed if they work hard.
        b.   Many/A few of the students who work hard will succeed.

(27)   a.   Nine of the students will succeed if they work hard.
        b.   Nine of the students who work hard will succeed.

(28)   a.   Few of the problems will be solved if we don't use a computer on them.
        b.   Few of the problems that we don't use a computer on will be solved.

In all of the (b)-sentences, it appears clear that the existence presupposition includes the material from the restrictive relative clause. In the (a)-sentences, the *if*-clause material appears not to be part of the existence presupposition. Perhaps the most striking pair is the one in (27). (27b) is naturally read as presupposing that there are more than nine students who work hard. But (27a) only presupposes that there are more than nine students simpliciter and does not presuppose anything about how many, if any, work hard.

2.6 Iffiness

We detect an element of "iffiness" in the relevant examples where an *if*-clause restricts a determiner-quantifier. This suggests that *if* is not a mere marker of quantifier restrictions (pace Kratzer's Thesis) but adds some meaning beyond that. To start getting a hint of what we mean, consider this pair found in Lewis (1975), the classic paper on restrictive *if*-clauses:

(29) $\left\{ \begin{array}{c} \text{?If} \\ \text{When} \end{array} \right\}$ Caesar woke up, he usually had tea.

While many times *if*-clauses restricting adverbial quantifiers like usually are interchangeable with when-clauses, this is not so in (29). Somehow, the *if*-variant suggests that there was a question for each day quantified over whether Caesar would wake up or not. Since people do wake up regularly, the iffiness contributed by *if* makes the sentence odd.[10]

    We think that there is iffiness contributed by *if* also in the examples where it seems to restrict determiners. Consider these variations on the letter-sentence:

(30)   Every letter will be answered if $\left\{ \begin{array}{l} \text{it is less than 5 pages long} \\ \text{it is type-written} \\ \text{it criticizes Clinton somewhere} \\ \text{it is polite} \\ \text{the arguments are smart} \\ \text{it mentions the water shortage} \end{array} \right.$

(31)   #Every letter will be answered if $\left\{ \begin{array}{l} \text{it is about the water shortage} \\ \text{it is from Europe} \end{array} \right.$

To our ears (and those of our informants), the sentences in (31) are much less successful than the ones in (30). We conjecture that the reason is that choosing *if* signals, for example, that for every letter it is iffy whether it is polite or not. The author can choose to make it polite or not. But it is not the case that for a given letter it is iffy whether it is about the water shortage or not. If it is

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[10]As soon as it is easy to see that the event in the restrictive clause is iffy, the examples start allowing *if*. A minimally changed version of (29) is perfect:

(i) $\left\{ \begin{array}{c} \text{If} \\ \text{When} \end{array} \right\}$ Caesar woke up early, he usually had tea.

not about the water shortage, then it can't be the same letter as if it is about the water shortage. We readily admit that this is a very nebulous intuition, but it does seem to correspond to quite robust judgments. Consider also this contrast:

(32)   a.   Every congressman who is from Florida is a Republican.
       b. #Every congressman is a Republican if he is from Florida.

The (a) sentence can be read as making a lawlike claim based on the voter population of Florida. But nevertheless the modal determiner-quantifier cannot be restricted by an if-clause, as (b) shows. The reason, we suspect, is that for a given congressman it is not iffy whether he is from Florida or not.

2.7   Conclusion from the Data Survey

We conclude that to cover all of the new data we unearthed here, the folklore theorist has his or her work cut out for him or her. We prefer to explore the possibility that *if*-clauses cannot after all serve as the restrictors to determiner quantifiers. We propose that all of the relevant examples we have encountered here involve a determiner quantifier with scope over a bare conditional, where the conditional actually does have a normal conditional meaning. To get the semantics of the examples right, we of course have to be quite specific what "normal conditionals" mean.

3 The Meaning of Conditionals

As we saw, the material implication analysis of the meaning of simple conditionals fails miserably over the entire range of examples that one has to consider. We will further assume that a chameleon analysis à la Higginbotham should only be employed as a last resort. But what else is there on the market for conditional meanings?

   We would like to argue that a meaning for conditionals of the kind explored and defended in von Fintel (1997, 1999, 2001) will work quite nicely here. The main properties of the analysis that we will need here are these:

  (i) The analysis is in essence a contextually variable strict conditional analysis. *If p, q* claims that all *p*-worlds in some contextually limited domain are *q*-worlds.

 (ii) There is a presupposition that there are such *p*-worlds in the contextually limited domain (essentially, an existence presupposition). Or in other words, the antecedent *p* is presupposed to be compatible with the domain of worlds quantified over.

(iii) There is an *all-or-nothing* or homogeneity presupposition: all of the relevant *p*-worlds agree on *q*. This directly derives the Conditional Excluded Middle: *if p, q* or *if p, not q*.

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(iv) The non-monotonic behavior of conditionals is traced back to the dynamic evolution of the domain of worlds quantified over during the course of a conversation.

We will see that the properties (ii) and (iii) are the ones that will do the most work for us here. One would expect then that other analyses of conditionals that validate the Conditional Excluded Middle and provide some kind of existence or compatibility presupposition should work quite well here too.

Let us see how this analysis fares when we employ it in structures of the form we're considering:

(33) Quantifier_x $[R_x]_{\text{Restriction}}$ $[\text{if}_w \ p_{w,x}, q_{w,x}]_{\text{Scope}}$

We will consider three cases: universal quantifiers like *every*, negative quantifiers like *no*, and the eternal troublemaker *most*.

3.1 Conditionals under Universal Quantifiers

This is probably the easiest case.

(34) every_x $[R_x]$ $[\text{if}_w \ p_{w,x}, q_{w,x}]$

The structure produces the claim that every individual x in the domain R is such that in any world in which p holds of x, q also holds of x. We directly predict a couple of the properties we observed earlier.

Iffiness

Since the conditional introduces an existence presupposition, the structure if_w $p_{w,x}, q_{w,x}$ will presuppose that there are worlds where x has the property in p. Under standard assumptions about presupposition projection under nominal quantifiers, this will lead to the presupposition that for every individual x in the domain of the quantifier there are worlds where x has the property in p. So, for example, we derive the presupposition that for everyone of our senators there has to be a world where he is from Florida. If this is problematic, then we derive the problematic character of (32b).

Weak Existence Presuppositions

Since the *if*-clause does not become part of the restriction of the nominal quantifier, the existence presupposition of the nominal quantifier only concerns its direct syntactic restriction. This is the correct prediction, as we saw.

3.2 Conditionals under Negative Quantifiers

As we saw, it was the negative quantifiers which led Higginbotham to say that *if* sometimes means "and" and that make the restrictor analysis of the folklore so tempting. How can our analysis help?

(35) $\left\{ \begin{array}{l} \text{No student} \\ \text{Neither John nor Peter} \end{array} \right\}$ will succeed if he goofs off.

Our diagnosis is that what we are dealing with is just another instance of the effect of the Conditional Excluded Middle. Under our analysis, a conditional under *no* leads to the following meaning: no individual x in the domain is such that in all of the worlds where p is true of x, q is true of x. But since there is the homogeneity presupposition, this is equivalent to: every individual x in the domain is such that in all of the worlds where p is true of x, q is false of x. So, we correctly predict the following equivalence:

(36) a. No student will succeed if he goofs off. $\equiv$
      b. Every student will fail if he goofs off.

Note that quite in general, under negative operators conditionals seem to have a "conjunctive" impact. This is so even when the operator is not really a quantifier over individuals.

(37) a. I doubt that John will succeed if he goofs off. $\approx$
      b. I doubt that John will goof off and (still) succeed.

This appearance of a conjunction reading of *if* is simply a consequence of the homogeneity/CEM effect.

3.3 Conditionals under *Most*

Assuming that there is a conditional structure with a material implication meaning under *most* in a sentence like (5) led to disaster.[11] Is it plausible at all to argue that there is after all a conditional under *most* in (5)?

We have to be honest for now and say that we can't tell whether the analysis is adequate for (5). But we have an example where we are sure it is better than the restrictor analysis:

(38) a. Most but not all of the students will succeed if they study hard.
      b. Most but not all of the students who study hard will succeed.

Note that (38a) basically says that studying will be effective for most but not all students. This means that for some students, studying will not be effective. Imagine that those students realize that and don't even try. The ones who do

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[11] Dekker (2001) is more sanguine about the problem, but we think it needs to be taken seriously. A strict conditional analysis of the *if*-clause works much better than the material conditional one.

study hard, all succeed therefore. In such a situation (38a) is true but (38b) is false.

3.4 Miscellanea

Counterfactuals

Under our analysis, there is no reason not to expect "restrictive" *if*-clauses of the counterfactual kind. That is indeed possible:

(39) a. Every one of these students would have succeeded if he had studied hard.
 b. None of these students would have succeeded if he had goofed off.

Epistemic Conditionals

Under our analysis, we expect the badness of this example:

(40) *Every student$_x$ is home if his$_x$ light is on.

The structure *if x's light is on, x is home* can only be read as an epistemic conditional: the light being on is evidence for (not the cause of) x's being home. But as established in our paper "Epistemic Containment", quantifiers cannot scope over epistemic operators, which means that (40) is ungrammatical. Without a quantifier, such structures are of course ok:

(41) If John's light is on, he is home.

4 Conclusion

We hope to have shown that examples with *if*-clauses in the scope of nominal quantifiers, while interesting, do not motivate widescale conclusions about non-compositionality. Neither do they in fact fall under an extension of the Lewis-Kratzer restrictor analysis. We believe that all one needs is the right theory of conditionals.

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Authors' Addresses:

Kai von Fintel
Department of Linguistics and Philosophy
Massachusetts Institute of Technology
E39-245, 77 Massachusetts Avenue
Cambridge, MA 02139, U.S.A.

mailto:fintel@mit.edu
http://web.mit.edu/fintel

Sabine Iatridou
Department of Linguistics and Philosophy
Massachusetts Institute of Technology
E39-245, 77 Massachusetts Avenue
Cambridge, MA 02139, U.S.A.

mailto:iatridou@mit.edu