

Veridicality and sets of alternative worlds¹

On embedded interrogatives and the complementizers *that* and *if*

Peter Öhl

This paper explores three related phenomena. First, not all embedded formal interrogatives (i.e. clauses introduced by *if* or *whether*) have the function of an indirect question. Second, the complementizers *if* and *that* may occur in identical syntactic contexts. Third, *if*-clauses may be licensed by certain (discourse) semantic factors, like negation, modality, and also verum focus, where otherwise *that*-clauses are preferred. The approach taken is based on epistemic logic, especially on the notion of relativized veridicality, the notion of possible worlds and the formal semantics of the complementizers *that* and *if*.

Keywords: interrogative semantics; complementizers; epistemic logic; veridicality

1. Introduction

In this paper, the modular view of *clause mood* is adopted, assuming a fundamental distinction between logical properties of clauses that are encoded by specific grammatical structures on the one hand, making sentences suitable to fulfill certain discourse functions, and the *discourse function* as such, on the other hand. Formal interrogatives, for example, may

¹ I would like to thank Kerstin Schwabe, Stefan Sudhoff, Julia Bacskai-Atkari, Anna McNay, Lisa Matthewson, Thomas Wagner and members of the audiences at the DGfS in Konstanz, the GeSuS meeting in Brno, and the ZAS in Berlin, where I presented earlier versions of this paper, for their very useful comments. I dedicate this article to Ian Roberts on the occasion of his 60th birthday in October 2017. He was the supervisor of my dissertation when I took my first steps in working on this fascinating topic.

be used as exclamations or statements (sometimes then termed rhetorical questions), as in (1a) and (1b) below.

- (1) a. Are you crazy?
b. Did you ever lift a finger to help me? (Krifka 2011: 1743)

Instead of assuming here a pragmatic re-interpretation as an indirect speech act (as might be appropriate in other cases), I take clause mood (*declarative, interrogative, . . .*) as a logical property of sentences restricting them to certain types of speech acts (*erotetic*, but also others).

I am not intending to join the discussion of this matter with respect to independent clauses (cf. Meibauer & al. 2013; Lohnstein 2007; Reis 1999; Altmann 1987; Bierwisch 1980). My contribution concerns embedded formal interrogatives that are, in my view, non-questions that are characterized by specific logical features² that they have in common with questions.

- (2) a. Bill knows who will come. (Krifka 2011: 1743)
b. Bill specified who had called.
c. I know if/whether zero is a prime number.³
d. Homer is not convinced⁴ if/whether zero is not a prime number.

² A formal view of clause mood that is independent of illocutionary force allows us to regard it as a logical feature of the compositional semantics of matrix clauses and also of embedded clauses.

³ It should be mentioned that not all speakers of English accept *if*-clauses in these contexts the same way as they do *whether*-clauses.

⁴ Similar sentences with NEG+*convinced*+*if* (and also *convinced*+*wh*) can be found on the internet:

(i) a. I was not convinced if it was for my benefit or his uncle's.
<https://books.google.de/books?isbn=145026462X> (2016/02/18); Linda Schel Moats, *Men from Cribaar*, p. 47.

- e. The library has determined if/whether books can be returned on Sundays.

My approach is based on the logical analysis of the complementizers *if*⁵ and *that*, which have been observed to be used alternately in certain epistemic contexts (cf. Lahiri 2002: 284-287; Adger & Quer 2001) or even to be in competition (Eckardt 2007) – of course, under alternating logical interpretations.

- (3) a. Bill knows **that** Mary wants to come to the party. (#I don't.)
b. Bill knows **if** Mary wants to come to the party. (I don't.)

This is true for all kinds of *if*-clauses that I regarded as non-questions above.

- (4) a. I know **if/that** 39719 is a prime number.
b. Homer is not convinced **if/that** zero is not a prime number.
c. The library has determined **if/that** books can be returned on Sundays.
-

- b. I was not convinced if it was a great investment.
https://www.tripadvisor.de/ShowUserReviews-g189180-d2470983-r280841912-Funicular_dos_Guindais-Porto_Porto_District_Northern_Portugal.html
(2016/02/18)

- (ii) a. The embassy was not convinced what you are going to do in Poland.
https://www.lonelyplanet.com/thorntree/forums/europe-eastern-europe-the-caucasus/poland/schengen-visa-appeal-how-to-solve-and-eliminate-unfair-refusal-reasons?page=1#post_19940391 (2016/02/18)

- b. Still I was not convinced what side to believe.
<http://csdb.dk/forums/index.php?roomid=7&topicid=26329&firstpost=23>
(2016/02/18)

- c. She was convinced what she had to do and it all started with the path at the end of the road.
<https://books.google.de/books?isbn=1630049301> (16/02/18); Jermaine Bethea, *The Weed and the Flower*, end of ch. 1.

⁵ This builds on work on the German complementizers *ob* and *dass* (Öhl 2017; *to appear*). It is often assumed (cf. Eckardt 2007: 457) that Gm. *ob* logically corresponds to Eng. *whether* because *if* seems to trigger a bias towards a positive answer in some contexts; for discussion see Bolinger (1978). On the other hand, *whether* is a phrasal operator possibly denoting a wider range as compared to a syntactic head. Since they are of the same category, I think it is more appropriate to compare the two complementizers *if* and *that*.

I will take and defend the view that the instances of *if* selected by rogative predicates on the one hand, and by non-rogative ones on the other hand, still have the same denotation.⁶

- (5) a. I wonder if zero is a prime number. (rogative predicate)
 b. I know if zero is a prime number. (non-rogative predicate)

The fact that in sentences like those in (4) the *if*-clauses do not have a rogative interpretation is a matter of the embedding context, not of the complementizer. Rogative predicates like *wonder* embed intensions, whereas predicates like *know* embed extensions (cf. Lahiri 2002: 287; Groenendijk & Stokhof 1982: 177, and the discussions below in Sections 2 and 3). Similar, intensional and extensional interpretations of nominal expressions vary with the predicate. Assuming that they are polysemous *per se* would be paradoxical.

- (6) a. I am looking for a unicorn. (intensional predicate)
 b. #I found a unicorn in the garden. (extensional predicate)

All expressions are intensional in the first place. Extensionalization must be regarded as a matter of the context. I proceed by comparing the use of *that* and *if* in different contexts of embedding.

⁶ A stronger hypothesis would even include conditional *if*, but that is another discussion and, in my view, improbable anyway: in contrast to complementizers of argument clauses, connectors of adverbial clauses must render quantificational operations on elements of the matrix clause possible, which is a basically different logical property. (See below, Section 3.)

2. Embedding clause types

2.1. The use of *that* and *if*

The fact that there are verbs selecting declaratives and verbs selecting interrogatives has led to the assumption that clause type embedding is a case of 's(emantic)-selection' (cf. Grimshaw 1979).

- (7) a. Homer claims **that** zero is a prime number.
b. Homer regrets **that** zero is not a prime number.
c. *Homer claims/regrets **if** zero is a prime number.
d. *Homer claims/regrets **what** prime numbers are.

- (8) a. Homer wonders if zero is a prime number.
b. Homer asks **what** prime numbers are.
c. *Homer asks/wonders **that** zero is not a prime number.

It has often been observed, however, that there is a whole range of verbs like *know* or *see* that seem to be underspecified.

- (9) a. Homer sees **if** zero is a prime number.
b. Homer sees **what** prime numbers are.
c. Homer sees **that** zero is not a prime number.

Taking a classification of 'question-embedding predicates' such as that of Karttunen (1977: 6; changed order) as a basis for comparison, it is easy to see that only a small number of predicates only take interrogative complements; the majority (bold letters) can also have *that*-clauses as a complement.

- (10) a. inquisitive verbs (*ask, wonder, investigate, . . .*)
b. verbs of retaining knowledge (***know, remember, recall, forget . . .***)

- c. verbs of acquiring knowledge (*learn, notice, discover, . . .*)
- d. verbs of communication (*tell, show, inform, . . .*)
- e. decision verbs (*decide, determine, specify, . . .*)
- f. verbs of conjecture (*guess, predict, estimate, . . .*)
- g. opinion verbs (*be certain, be convinced, . . .*)
- h. verbs of relevance (*matter, care, . . .*)
- i. verbs of dependency (*depend on, be relevant to, . . .*)

The statistic evaluation of the ZAS-Database⁷ shows that the majority of the 1,750 clause embedding predicates take different clause types as their complements in German as well. In fact, just 1% only take interrogatives, and it is questionable whether fewer than 20 predicates out of 1,750 justify the assumption of predication selection of interrogatives.

- (11) a. ***ob-* and *w*-clauses** (*fragen*/'ask', *umhören*/'ask around', . . .): ~1%
- b. *dass*-, *w*- and *ob*-clauses (*wissen*/'know', *bedenken*/'consider', *nachdenken*/'reflect', . . .): 36%
- c. *dass*- and *w*-clauses (*bedauern*/'regret', *sich freuen*/'rejoice'): 19%
- d. *dass* and *ob*-clauses (*zweifeln*/'doubt', *garantieren*/'guarantee', . . .): <1%
- e. only *dass*-clauses (*beweisen*/'prove', *glauben*/'believe', *annehmen*/'assume', . . .): 43%

The set-of-answers model of interrogative semantics points to a solution (Hamblin 1976: 'possible answers'; Karttunen 1977: 'true answers'; Huddleston 1994: 415: "Normally, sentences containing embedded questions have meanings involving 'the answer to the question.'"); it

⁷ Last evaluation 9/2016. I would like to thank Kerstin Schwabe from ZAS (Zentrum für Allgemeine Sprachwissenschaft, Berlin) for allowing me to use these statistics (cf. Schwabe 2016a; b; see also: ZAS Database of Clause-Embedding Predicates, <http://www.owid.de/plus/zasembed2017/main>, last access 2017/03/31).

captures all non-interrogative predicates termed *responsive* by Lahiri (2002: 287). Predicates may be proposition-selecting, and the restriction to either one proposition (*that*) or a proposition set (*if*) could just be lexical.

I do not think, however, that this accounts properly for cases such as the following:

- (12) a. He takes care **if** everyone is seated.
- b. **If** I find linguistics exciting is my decision.
- c. The library has determined **if** books can be returned on Sundays.

Whereas responsive predicates may embed true or possible answers, these predications do not concern the truth values but the truth conditions themselves, as specified for possible worlds. Thus, what is documented is not the evaluation of the truth of a proposition against an epistemic background but the creation of a factual background (cf. Lohnstein 2007 on *imperative* vs. *interrogative*). What they have in common is that the speaker does not state the truth value of the embedded proposition when choosing an *if*-clause. This might justify a common classification, but not as a primitive: instead these kinds of predicates and the 'responsive' ones form subclasses of a more abstract category.

It is obvious that *if*-clauses are polyfunctional. This paper argues that the interrogative complementizer *if* is not polysemous but underspecified.

Independent clauses have illocutionary force. Embedded clauses, in contrast, are interpreted within the logical context created by the embedding predicate and other factors. *If*-clauses may refer to questions, but they do not denote questions (cf. Bayer 2004: 66). Thus, a semantic account of *if* must

allow for the interpretation of the embedded clause according to the logical class of the embedding predicate.

2.2. Interrogative clauses as syntactic objects

The logical account used here is based on the interrogative semantics first proposed by Groenendijk & Stokhof (1982), where questions are treated as index dependent propositions. An *index* is defined as an ordered pair of a world w and a time t . The particular index a is the *actual index* where the truth of a proposition is evaluated (cf. Groenendijk & Stokhof 1982: 177; 186-189).

- (13) a. $i = \langle w, t \rangle$
b. $a = \langle w^a, t^a \rangle$

If we relate truth conditions for any possible index i to the same truth conditions for the actual index a , the result will be two alternative sets: p , if $p=1$ in a , and $\neg p$, if $p=0$ in a . Since one and the same question should have the same meaning in all possible actual worlds (i.e. be consistent also with worlds and times where zero is a prime number, if the definition of *prime number* were changed or whatsoever)⁸, an *intensional reading* is created by lambda-quantification over a as well. E.g.:

- (14) a. Is zero a prime number?
-

⁸ The worlds in question are epistemic worlds, not alethic ones; whereas in alethic modality, the definition of prime numbers yields an absolute truth by means of the accessibility relation between possible worlds, epistemic worlds may diverge. Otherwise, asking this question wouldn't make sense or would even be impossible.

$$b. \lambda i \lambda a [\text{prime-number}'(i, \text{zero}) = \text{prime-number}'(a, \text{zero})]$$

The meaning of this sentence consists in the set of indices i where the truth of zero being a prime number corresponds to the truth of zero being a prime number at any actual index a . Such an *index dependent proposition* is mapped to a syntactic object that can be embedded by specific predicates.

- (15) a. Homer wonders if zero is a prime number.
b. $\text{wonder}'(\text{Homer}', \lambda i \lambda a [\text{prime-number}'(i, \text{zero}) = \text{prime-number}'(a, \text{zero})])$

Non-interrogative predicates like *know*, however, embed *if*-clauses in their *extensional* reading. The meaning of the embedded clause in the following sentence consists in the set of indices i where the truth of 39.719 being a prime number corresponds to the truth of 39.719 being a prime number at the fixed actual index a .

- (16) a. Homer knows if 39.719 is a prime number.
b. $\text{know}'(\text{Homer}', \lambda i [\text{prime-number}'(i, 39.719) = \text{prime-number}'(a, 39.719)])$

Extensional epistemic or perceptual predicates like *know* or *see* are also called *veridical* (Lahiri 2002: 287; Montague 1969, cf. Giannakidou 2013: 1).

Def.: *veridicality* = property of *utterances* or *perceptions* to be assumed as true or real (abstracted from Borchert 2006: 188; 193)

- (17) a. $[[\text{I see a unicorn}]] = 1$

- b. $\Rightarrow$ There are unicorns.
- c. $\rightarrow$ *see*' is a veridical predicate.

It seems reasonable to assume that the denotation of these predicates is characterized by a logical feature such as [+ver], fixing the actual index.

(18) $\lambda a \gg \iota a$

Thus, the intensional reading of *if*-clauses is their neutral interpretation, whereas extensionalization belongs to the function⁹ of certain predicates that embed them. However, the use of an extensional *if*-clause may be context dependent: it is used only if it is not excluded because of logical inconsistency and if it is informative (cf. Eckardt 2007: 462).

In the following example (19a), the matrix implies a common ground where it is known that zero is a prime number.¹⁰ An *if*-clause, on the other hand, presupposes alternative worlds. Thus, it is logically incompatible with the presupposition of the matrix. (19b) is much better, since *Homer* is introduced as a discourse referent who evaluates the truth of the embedded proposition, whereas others may have differing judgments. Thus, there are alternative worlds established.

- (19) a. It is clear that/#if zero is a prime number¹¹.
b. To Homer, it is clear if zero is a prime number.

⁹ I take predicates as denoting functions operating on their arguments.

¹⁰ The whole sentence is false, of course, since in fact, it is common knowledge that zero is not a prime number.

¹¹ I use the symbol '#' to indicate logical and/or communicative markedness.

In the next example, the *if*-clause must be licenced by informativeness:

- (20) He has found out if 39.719 is a prime number.

The truth of [[he has found out if 39.719 is a prime number]] depends on the truth of [[39.719 is a prime number]]; thus, an *if*-clause is a logical option.

However, the *if*-clause is informative only if this truth is not known to the hearer, and it is used if for any reason it is not reported to her or him.

This means that if predicates are not specified as to whether to embed an *if*-clause or a *that*-clause, the logical and the pragmatic context must licence the use of the *if*-clause. Otherwise, an alternative *that*-clause is always preferred.

- (21) He has found out that/#if zero is not a prime number.

It is an interesting and not yet fully explained fact about these predicates that, as soon as such a predication is modified by an operator like NEG, the *if*-clause is not subject to further restrictions and thus seems to be grammatically licenced.¹²

- (22) a. It isn't clear if zero is a prime number.
b. He hasn't found out if 39.719 is a prime number.

It seems reasonable to assume that NEG is an operation potentially blocking the extensionalization of the embedded proposition, such that the *if*-clause is

¹² See Adger & Quer (2001) for a syntactic account and Eckardt (2007), Öhl (2007) for discussion and critique.

just a natural option – much like NEG licensing intensional objects also with DP-selecting extensional predicates.

(23) I have not found any unicorn in the garden.

- (24) a. $\neg \text{clear}'(\lambda i \lambda a [\text{prime-number}'(i, 39.719) = \text{prime-number}'(a, 39.719)])$
b. $\neg \text{found-out}'[\text{he}', (\lambda i \lambda a [\text{prime-number}'(i, 39.719) = \text{prime-number}'(a, 39.719)])]$

However, in all of these cases an extensional *that*-clause is also an option.

The logical difference is explained in the following paragraphs.

- (25) a. It isn't clear that zero is a prime number.
b. He hasn't found out that 39.719 is a prime number.

In short, the licensing conditions are complex and cannot be purely grammatical. In the following section I develop my proposal by taking a closer look on the notion of *veridicality*.

2.3. Polarity and relativized veridicality

Following Giannakidou (1998; 2013), I regard *veridicality* as an epistemic (and also perceptual) dimension that is subject to the world models of individuals (cf. Öhl 2017).

- (26) *Veridicality and nonveridicality* (cf. Giannakidou 2013: 220)
i. A propositional operator F is veridical iff Fp entails or presupposes that p is true **in some individual's model** $M(x)$.
ii. If (i) is not the case, F is nonveridical.

- (27) *Epistemic model of an individual i* (Giannakidou 1998: 45)
An epistemic model $M(i) \in M$ is a set of worlds associated with an individual i representing worlds compatible with what i believes or knows.

Utterances or perceptions may be interpreted as real or true in relation to the model of an epistemic agent.

(28) *Subjective veridicality and agent commitment* (Giannakidou 2013: 121)

- i. Truth assessment is relativized to epistemic agents.
- ii. In unembedded sentences the epistemic agent is the speaker.
- iii. *In embedded sentences, possible epistemic agents are the speaker and the embedding clause subject* (italics: PÖ). In embedded sentences generally the number of epistemic agents is +1 from the base case.
- iv. In texts, an additional epistemic agent is the hearer/reader.
- v. Nothing else is a relevant epistemic agent.

Whereas Lahiri (2002: 287) classifies predicates such as *certain*, *conjecture*, *agree on* (implicitly also *sure*, *convinced*, *promise* a.o.) as nonveridical, Öhl (2017) argues that they are *subjectively veridical*.

What all of these predicates have in common is the fixing of the truth value in relation to the world model of an epistemic agent. This is exactly what Giannakidou proposes for (non)veridical operations: the logic of epistemic predicates is not primarily a matter of truth in the alethic sense. In the first place, it is a matter of truth assessment relativized to epistemic agents (i.e. the speaker, the hearer and, in embedded contexts, also the subject of the matrix clause).

Moreover, there is an empirical argument: the predicates I call *subjectively veridical* allow *if*-clauses whenever they undergo a nonveridical operation (such as negation; Giannakidou 1998).

- (29) a. Being sure **that/#if** zero was a prime number, Homer failed the exam.
b. Not being sure **if** zero was a prime number, Homer failed the exam.

If those predicates as such were absolutely nonveridical, why should an additional nonveridical operation bring about the license for an *if*-clause?

I suggest that among the *epistemic* predicates, the *subjectively veridical* ones constitute a proper subclass by denoting the interpretation of the truth value relative to the *model* of the subject of the matrix clause. The reason why these predicates as such do not embed *if*-clauses is simply that they denote truth commitment by the epistemic agent, i.e. the embedding clause subject, which is marked by *that*.

(30) Homer is sure/convinced that/*if 39.719 is a prime number.

Use of an *if*-clause would be maximally uninformative, since its combination with a predicate denoting truth commitment would simply mean that nothing were being reported.

In contrast, objectively veridical predications in fact denote the truth assessment by the matrix subject in the alethic sense. It may be known to the speaker, but the relevant factor for the use of an *if*-clause is that it is not reported to the hearer.

(31) He has found out if 39.718 is a prime number.

The *if*-clause can be informative under these circumstances, since the truth of a proposition such as [[he has found out that 39.718 is a prime number]] depends on the truth of the proposition [[39.718 is a prime number]]. This is

not the case with propositions embedded by subjectively veridical predicates.

- (32) a. $[[39.718 \text{ is a prime number }]] = 0$
 b. $\Rightarrow [[\text{he has found out that } 39.718 \text{ is a prime number }]] = 0$
 c. $\nRightarrow [[\text{he is sure/convinced that } 39.718 \text{ is a prime number }]] = 0$

It can be syllogized that the complementizer *if* can be used whenever a set of alternative indices λi is related to any evaluation index λa . Propositions undergoing veridical functions are extensionalized, which means that the set of evaluation indices is reduced to the actual index a . If the set of alternative indices λi logically corresponds to the evaluation index a , which is the case when a is defined by the matrix proposition headed by a subjectively veridical predicate, an *if*-clause is uninformative or even paradoxical. What happens if a (subjectively) veridical predicate is negated? I would like to suggest that, in certain cases, negation cancels the truth commitment of the relevant epistemic agent. In formal terms this means that the extensionalization of an embedded proposition is blocked. For a subjectively veridical predicate this means that it is under exactly these conditions that an *if*-clause is licensed. E.g.:

- (33) a. He has not found out if 39.719 is a prime number.
 b. He is not sure if 39.719 is a prime number.

In both cases, the matrix subject as the epistemic agent has neither access to nor has he/she committed him/herself to the truth of $p(a)$ (39.719 being a prime number). The knowledge of other potential agents seems to be

irrelevant. This may be explained by the scope of the nonveridical operation, which will be discussed in the next paragraph.

The relevance of the epistemic agent is also very obvious with predicates such *tell*, which is classified as ambiguously veridical by Spector & Egré (2015: 1738) and thus can embed interrogative extensions in some cases.

The following example makes clear that the relevant epistemic agent is the speaker, who is at the same time referred to by the object of the matrix clause.

- (34) a. Homer told us **that** zero was not a prime number.
b. #Homer told us **if** zero was a prime number.
c. Homer **did not** tell us **if** zero was a prime number.

(34b) is not ungrammatical but (at least in the average case) excluded for the lack of informativeness. The use of *if* requires an external reason why the truth is not reported to the hearer (e.g. if the speaker has forgotten it).

The reason is that *tell* can be nonveridical only if it selects a *that*-clause:

- (35) a. He told us **that** zero was (not) a prime number (but it is (not)). (±ver)
b. He told us **if** zero was a prime number (*but it is not). (+ver)

In (35b), *tell* must be (subjectively) veridical since we can conclude that the subject of *tell* had access to the truth of the embedded proposition. In this case, there is no cancellation of the truth assessment, if the predicate is negated. Instead, the relevant epistemic agency shifts to the speaker, who does not have access to the truth of p(a) (zero not being a prime number).

- (36) He did not tell us **if** zero was a prime number (−ver)

In the following paragraphs, I will turn to the structural conditions of subjectively veridical predication by showing that subjectively veridical predicates and other predications denoting the commitment to a truth value, such as impersonal *clear*, take intensional index dependent propositions as a complement if they are directly operated on by nonveridical functors such as negation or, as another example, modal auxiliaries.

- (37) a. Now it is clear **that/#if** zero is (not) a prime number.
b. It is *not yet* clear **#that/if** zero is (not) a prime number.

- (38) Before dividing it by three, it should be clear that/if zero is not a prime number.

2.4. Scope of the nonveridical operation

There is some direct evidence from German that the relevant operations are immediate operations on the predicate, thus changing the predicate function. The first data I would like to analyze are from German negation: if NEG is adjacent to the predicate, there is preference for *ob*, whereas an intervening frame adverbial yields markedness of *ob* compared to *dass*.

- (39) a. Es ist [schon seit JEher] nicht sicher, **ob**/dass das stimmt.
it is already since ever NEG sure if/that this is-right
b. Es ist nicht [schon seit JEher] sicher, **dass**/#ob das stimmt.

If the same predicate is derivationally negated by a negative prefix, a *that*-clause is even ungrammatical.

- (40) es ist [unsicher **ob**/*dass das stimmt]
it is unsure if/that this is-right

Since predicate negation in a complex German *Vorfeld* also leads to a strong preference for *ob*, Öhl (2007: 420ff.) applies the term *coherent negation*, which means that NEG forms a complex predicate with the verb (41b), rather than negating the whole proposition (41c).

- (41) a. Unsicher ist, **ob**/*dass das stimmt.
 uncertain is if/that this right-is
 b. Nicht sicher ist, **ob**/#dass das stimmt.
 not certain is if/that this right-is
 c. Sicher ist nicht, **dass**/#ob das stimmt.

It can be assumed that an operation such as NEG can immediately compose with the predicate, which *cancels the commitment* of the relevant epistemic agent to a truth value for the embedded proposition.¹³

Even though there is no *coherent negation* in English, a similar effect can be reconstructed: with a *that*-clause, NEG is preferably interpreted as taking wide scope; with *if*, in contrast, the scope of NEG is interpreted as narrow.

¹³ One of the reviewers suggested comparing inherently antiveridical predicates such as 'negate' or 'refute'. If my assumptions are right, the same operation should yield a similar effect with these predicates if they denote the commitment to a negative truth value, which should also be able to be cancelled. This can be tentatively confirmed with data from both German and English:

- (i) Krugman himself would not be able to *refute if* he was in fact so influenced (<http://www.zerohedge.com/article/mit-billion-price-project-confirms-us-prices-surgin>; 2017/03/31)
(ii) (...) dass die Wissenschaft eben auch nicht endgültig *widerlegen* kann, *ob* an diesen Dinge[n] nicht auch etwas dran sein kann. (ZAS Database of Clause-Embedding Predicates (public beta); <http://www.owid.de/plus/zasembed2017/main>; 2017/03/31)
 ≈ "that science cannot definitely refute if there isn't anything to this."

In fact, further studies on a broader database seem promising and shall be carried out in future research.

- (42) a. He did not tell **that** he would come.
b. $\llbracket \text{told}(\text{he}, [\text{come}(\text{he})]) \rrbracket = 0$
c. $\rightarrow$ It is not true that he told that he would come.
- (43) a. He did not tell **if** he would come.
b. $\llbracket \neg \text{told}[\text{he}, \text{come}(\text{he})] \wedge \neg \text{told}[\text{he}, \neg \text{come}(\text{he})] \rrbracket = 1$
c. $\rightarrow$ It is true that he did not tell (i.e. he concealed) whether he was planning to come or not.

I assume that the option of immediate composition of NEG and specific predicates can be taken as universal. *Coherent negation* just means that this composition is overt.

German provides some more direct evidence from the scope of modals: epistemic modals, which always take wide scope, yield preference for *dass* (44a). Deontic modals, which scope directly over the predicate, produce preference for *if* (44b).

- (44) a. $[_{VP} \text{ sicher sein, } \mathbf{dass/\#ob} \text{ das stimmt}] \text{ soll } \text{es angeblich bereits}$
sure COP that/if this is-right is-said it allegedly already
"Allegedly, it is already said that it is certain that this is true."
- b. $[_{CP} \mathbf{\#dass/ob} \text{ das stimmt}] \text{ muss zun\u00e4chst sicher sein}$
that/if this is-right must at-first sure COP
"At first, it should be certain if this is true."

Other modifiers licensing *if*-clauses are future tense and non-indicative verbal mood (cf. \u00d6hl 2007: 417), which also indicates that nonveridical operations on the predicate function change the selectional properties.

- (45) a. Time will make clear **if** 39.719 is a prime number. (FUT)
b. I wished I could make clear **if** 39.719 is a prime number. (IRR)

Embedding into interrogative matrix clauses creates an intensional reading, as well, which is to be expected if the matrix is already characterized by abstraction from possible actual indices.

- (46) a. Is it clear **if** 39.719 is a prime number?
b. $\lambda i \lambda a [\text{clear}'([\text{prime-number}'(i, 39.719) = \text{prime-number}'(a, 39.719)], i) =$
 $[\text{clear}'([\text{prime-number}'(i, 39.719) = \text{prime-number}'(a, 39.719)], a)]$

It is especially telling that certain focus effects may also lead to intensionalization and the embedding of an *if*-clause. What they have in common is a contrast established between the actual index and potential alternative evaluation indices. *Verum focus* (cf. Höhle 1988; Lohnstein 2016) may induce such an alternative set by means of contrasting the truth values, just like focus on the negation.

- (47) a. It IS clear **if** zero is a prime number. (contrasting *true* to *false*)
b. It is NOT clear **if** zero is a prime number. (contrasting *false* to *true*)

So called 'only-focus', on the other hand, contrasts the model of the epistemic agent (the matrix subject in the following example) with those of other potential individuals.

- (48) Only to Homer, it is clear **if** zero is a prime number.

In both cases, two sets of alternative worlds are contrasted, which is, again, informative and not counterintuitive.

3. *That* vs. *if*: what do the complementizers denote?

A unified semantic account of both *that* and *if* must allow for the interpretation of the embedded clause according to the logical class of the embedding predicate, which may be operated on by additional truth functional elements.

- (49) a. He claims/regrets **that** . . .
b. He asks **if** . . .
c. He knows **that/if** . . .
d. He is **not** sure **if** . . .

This means the denotation of the complementizer must contain variables that can be operated on by elements of the matrix clause. I would like to propose a formalization based on Lohnstein's (2005: 124) earlier proposal of a basic semantic form (SF) for clause connectors (CONN):

- (50) Basic-SF of CONN: $\lambda p \lambda q [[OP_{w,t} : H(w_0) \wedge p(w,t)] q(w,t)]$
- $H(w_0) \wedge p(w,t)$ = restriction for quantification over proposition q
 - $OP_{w,t}$ = quantifier over world- or time variables
 - H = modal basis in the actual world w_0 (*epistemic, doxastic, bouletic, deontic, factual*).

In this model, adverbial clauses are taken as restricted quantificational operations (as first suggested for conditionals by Kratzer 1978) over the *world*, the *time* or the *world-time-index* variables of the matrix clause.

Besides the proposition(s) given by the adverbial clause, the kind of background (*epistemic, doxastic, bouletic, deontic, factual*) serves to restrict the quantification, which can be either *universal* or *existential*. Lohnstein (2005: 124) also lists *intensionalization* vs. *extensionalization* of the

propositions involved as further parameter distinguishing adverbial connectives:

(51) CONN: logical parameters

- A. the quantificational force of the operator $OP_{w,t}$ (universal vs. existential quantification)
- B. the types of the variables: *world* vs. *time*
- C. the specification of the background $H(w)$
- D. intensionalization vs. extensionalization of the propositions involved

The German conditional complementizer *falls* may serve as an example for a short explanation of the formalism (also taken from Lohnstein 2005: 124).

Conditionals are taken as universal quantifications over possible worlds.

Lohnstein suggests that the quantification is restricted by an epistemic background.

(52) a. Egon lacht, falls Paul arbeitet.

'In case Paul is working, Egon laughs.'

b. $[\forall w: H(w_0) \wedge \text{work}'(w, \text{Paul})] \text{ laugh}'(w, \text{Egon})$

c. H epistemic: $H^{\text{ep}}(w) = \{p \mid p \text{ is known in } w\}$

d. 'In all epistemically accessible worlds where Paul is working, Egon laughs.'

(53) $SF(/falls/): \lambda p \lambda q [[\forall w: H(w_0) \wedge p(w)] q(w)]$

From the basic SF proposed by Lohnstein, other connectives can be derived.

The SF of the temporal connective *nachdem* ('after') would be constituted by existential quantification over a time variable t_1 that is restricted by the anteriority condition $t_2 < t_1$, t_2 being the event time of the adverbial clause.

(54) a. Egon lacht, nachdem Paul gearbeitet hat.

'Egon laughs after Paul was working.'

- b. $[\exists t_1: H(w_0) \wedge \text{work}'(t_2, \text{Paul}) \wedge (t_2 < t_1)] \text{laugh}'(t_1, \text{Egon})$

Building on this system, Öhl (2009: 399) proposes a SF for the German complementizer *dass* ('that'), which I slightly modify in the following paragraphs, adapting to the observations made in the preceding paragraphs. One major difference between complementizers introducing argument clauses and adverbial connectives is the direction of quantification. Whereas adverbials quantify over the world/time of the matrix, complementizers such as *that* allow quantification over the *index* of the embedded clause.

Whatever predicate we choose for the matrix proposition q , it will specify the background for evaluating the embedded proposition p . Epistemic predicates such as *know* provide an epistemic background, others provide doxastic, bouletic, deontic or factual backgrounds for the evaluation of the embedded p .

- (55) a. $q = \lambda p. \text{know}'/\text{believe}'/\text{hope}'/\text{demand}'/\text{regret}' (\text{Homer}, p)$
b. $H^{\text{EP/D OX/BOUL/DEON/FACT}}(a) = \{p \mid \text{know}'/\text{believe}'/\dots'/\dots'/\dots' (a, x, p)\}$

Another basic conjecture is that p of the embedded clause is evaluated as true, assumed to be true, potentially true, or just claimed to be true in the worlds contained in the matrix q – relative to the specification of the background by the matrix predicate.

- (56) Homer *knows/believes/hopes/demands/regrets* that (it is true that) zero is (not) a prime number.

This means at those indices i contained also in the proposition q , q specifying the background for interpreting $p(i)$, $p(i)$ is evaluated as true.

This yields the desirable implication that a and λi for which $p(i)$ is evaluated as true belong to the same set of indices restricted by the truth conditions of q . The SF for *that* can then be formalized as follows:

$$(57) \quad \text{SF}(/that/): \lambda p \lambda q \lambda a [[\lambda i: i \in q(a) = H(a)] p(i) = 1]$$

All propositions are intensional before their index is fixed. This means even though the index of the embedded proposition p is defined as belonging to the same set as that of the matrix by means of the truth conditions of q , it is evaluated separately. The evaluation is carried out in relation to q , however. For the sake of illustration let us consider the indices as $\lambda \alpha \subseteq \lambda a$. Just like predications over individuals, specific predicates trigger extensionalization of the clause by one of their predicate functions.

- | | | |
|------|--|---------------------------------|
| (58) | a. I am looking for a prime number. | (function on λx) |
| | b. I have found a prime number. | (function on $\exists x$) |
| (59) | a. I hope that zero is a prime number. | (function on $\lambda \alpha$) |
| | b. I know that zero is a prime number. | (function on $\iota \alpha$) |

As above, extensionalization must be a matter of the background, which builds on the semantics of the matrix predicate. I suggest that extensional predicates *identify* the evaluation indices ($\lambda \alpha: \alpha = a$). Note also that by defining the specification of the background by the matrix proposition, this variable H in the SF of the complementizer is trivially saturated by embedding the clause as a complement. On the other hand, defining $\lambda \alpha$ by

the truth conditions of the matrix means that the matrix index¹⁴ belongs to the same set ($\lambda\alpha \subseteq a$).

Thus, the two hypotactical structures can be formalized as follows:

- (60) a. $[\text{hope}'(I, [(\lambda\alpha \subseteq a) (\text{prime-number}'(\alpha, \text{zero}') = 1)])]^a$
b. $[\text{know}'(I, [\text{prime-number}'(a, \text{zero}')^{15} = 1])]^a$

If we also allow 'truth de dicto' as a quality of the background, the same can be said to hold even for utterance verbs:

- (61) a. Homer claims that zero is a prime number.
b. $[\text{claim}'(\text{Homer}', [\text{prime-number}'(a, \text{zero}') = 1])]^a$

Not only *that* but also *if* expresses the relation between the actual indices of the connected clauses, and both *that*-clauses and *if*-clauses occur either in intensional or in extensional reading. *That*-clauses denote truth conditions for a definite set of indices constrained by a relation $\lambda i[p(i)=1]$. *If*-clauses, on the other hand, denote truth conditions for an indefinite set related to a set of possible actual indices λa via equation (see above 2.2). Thus, *if* yields propositional disjunction by relating the sets of all possible indices to possible evaluation indices. Let us again assume that the evaluation index of the embedded clause is related to that of the matrix via the implication relation $\lambda\alpha: \alpha \in q(a)$. Then the SF for *if* can be formalized as follows:

¹⁴ I presuppose that any way of realizing a matrix proposition relates it to one evaluation index, which means it is extensionalized by illocutionary force.

¹⁵ This follows simply from the identification operation $\lambda\alpha: \alpha = a$. The whole sentence is therefore false.

(62) SF(/if/): $\lambda p \lambda q \lambda a \lambda i [[\lambda \alpha: \alpha \in q(a) = H(a)] p(i) = p(\alpha)]$

This means that whereas *that*-clauses denote definite sets of worlds constrained by the relation to one truth value, *if*-clauses denote indefinite sets of worlds, or even indefinite sets of sets of worlds in the intensional reading. Extensionalization indeed reduces the set of actual indices to a , but the set of indices related to a is still indefinite. This can be illustrated as follows:

- (63) a. I wonder if zero is a prime number. (function on $\lambda \alpha$)
b. I know if zero is a prime number. (function on $\iota \alpha$)

- (64) a. $[wonder(I, [(\lambda \alpha \subseteq a) (\text{prime-nr}(i, \text{zero}) = \text{prime-nr}(\alpha, \text{zero}))])]^a$
b. $[know(I, [\text{prime-nr}(i, \text{zero}) = \text{prime-nr}(a, \text{zero})])]^a$

The use of *if* is licensed whenever the alternative set of possible indices is not empty – which would be equivalent to restricting the set λi to a , thus defining a definite set of worlds. This definite set would be encoded by the complementizer *that*, however. Looking at negated veridical predicates such as *know*, this becomes evident through the different options for the material in the scope of NEG:

- (65) a. He does not know that zero is a prime number. (cf. 57)
b. $\neg[know'(he', [\text{prime-number}(\alpha, \text{zero}) = 1])]^a$

- (66) a. He does not know if zero is a prime number. (cf. 62)
b. $[\neg know'(he', [(\lambda \alpha \subseteq a) (\text{prime-nr}(i, \text{zero}) = \text{prime-nr}(\alpha, \text{zero}))])]^a$

Note that only the sentence in (65) yields an effect of paradox. Even under negation, the veridicality of *know* triggers the truth-presupposition of zero being a prime number, which is, of course, false. In (66), however, negation as a nonveridical operation on the predicate blocks the extensionalization.

There can't be any truth-presupposition effecting in a paradox.

Note that this view implies that the SF of *if*-clauses embedded by rogative predicates and by (subjectively) veridical predicates that undergo a nonveridical operation is identical. This, however, is a strong argument for a formal and modular view of clause mood: in certain epistemic contexts, nonveridical operations promote the use of *if*-clauses, which in fact denote sets of alternative epistemic worlds (Öhl 2017). References to questions or to sets of answers, however, are just options of interpreting them.

4. Conclusion

Complementizers such as *that* and *if* express a relation between the indices of the matrix and the complement clause. The complementizer *if* yields propositional disjunction by relating complementary sets of possible indices *i* to possible evaluation indices *a*. What is often called an intensional reading is in fact the denotation of sets of complementary sets of indices.

Veridical predications fix the evaluation index *a*, which is often referred to as *extensionalization*. In fact it is reduction to two complementary sets of indices. An *if*-clause is licensed when neither of the sets is logically excluded.

Nonveridical operations on the predication, such as NEG, block the extensionalization. Subjectively veridical predications denote commitment of the matrix subject to the truth of the embedded proposition. Therefore, *if*-clauses must be licensed by a nonveridical operation or other means yielding reference to complementary sets of alternative indices, such as the verum-focus indicated by contrastive accentuation of the finite matrix verb. All *if*-clauses denote sets of alternative epistemic worlds. Reference to questions or to sets of answers, however, are just options of interpreting the logical properties of complementizers such as *if*.

References

- Adger, David & Quer, Joseph. 2001. The syntax and semantics of unselected embedded questions. *Language* 77 (1): 107-133.
- Altmann, Hans. 1987. Zur Problematik der Konstitution von Satzmodi als Formtypen. In *Satzmodus zwischen Grammatik und Pragmatik*, Jörg Meibauer (ed), 22-56. Tübingen: Niemeyer.
- Bayer, Josef. 2004. Decomposing the left periphery. Dialectal and cross-linguistic evidence. In *The syntax and semantics of the left periphery*, Horst Lohnstein & Susanne Trissler (eds), 59-95. Berlin: de Gruyter.
- Bolinger, Dwight. 1978. Yes/no questions are not alternative questions. In *Questions*, Henry Hiz (ed), 87-105. Dordrecht: Reidel.
- Borchert, Donald M. 2006. *Encyclopedia of philosophy*. Vol. 7. Detroit: Macmillan Reference.
- Eckardt, Regine. 2007. The syntax and pragmatics of embedded yes/no questions. In *On information structure, meaning and form*, Kerstin Schwabe & Susanne Winkler (eds), 447-467. Amsterdam: Benjamins.
- Frege, Gottlob. 1923. Logische Untersuchungen. Dritter Teil: Gedankengefüge. *Beiträge zur Philosophie des Deutschen Idealismus* 3 (1): 36-51.

- Giannakidou, Anastasia. 1998. *Polarity sensitivity as (non)veridical dependency*. Amsterdam: Benjamins.
- Giannakidou, Anastasia. 2013. Inquisitive assertions and nonveridicality. In *The dynamic, inquisitive, and visionary life of phi, ?phi, and possibly phi. A festschrift for Jeroen Groenendijk, Martin Stokhof and Frank Veltman*, Maria Aloni, Michael Franke & Floris Roelofsen (eds), 115-126. Amsterdam: ILLC Publications.
- Grimshaw, Janet. 1979. Complement selection and the lexicon. *Linguistic Inquiry* 10 (2): 279-326.
- Groenendijk, Jeroen & Stokhof, Martin. 1982. Semantic analysis of wh-complements. *Linguistics and Philosophy* 5 (2): 175-233.
- Hamblin, Charles L. 1976. Questions in Montague English. In *Montague Grammar*, Barbara H. Partee (ed), 247-259. New York: Academic Press.
- Höhle, Tilman N. 1988. Vorwort und Nachwort zu Verumfokus. *Sprache und Pragmatik* 5 (1): 1-7.
- Huddleston, Rodney D. 1994. The contrast between interrogatives and questions. *Journal of Linguistics* 30 (2): 411-439.
- Karttunen, Lauri. 1977. Syntax and semantics of questions. *Linguistics and Philosophy* 1 (1): 3-44.
- Kratzer, Angelika. 1978. *Semantik der Rede. Kontexttheorie – Modalwörter – Konditionalsätze*. Königstein/Taunus: Scriptor.
- Krifka, Manfred. 2011. Questions. In *Semantics. An international handbook of natural language meaning. Vol. 2*, Klaus von Heusinger, Claudia Maienborn & Paul Portner (eds), 1742-1758. Berlin: de Gruyter.
- Lahiri, Utpal. 2002. *Questions and answers in embedded contexts*. Oxford: Oxford University Press.
- Lohnstein, Horst. 2005. Sentence connection as quantificational structure. In *Event arguments. Foundations and applications*, Claudia Maienborn & Angelika Wöllstein (eds), 113-138. Tübingen: Niemeyer.
- Lohnstein, Horst. 2007. On clause types and sentential force. *Linguistische Berichte* 209: 63-86.

- Lohnstein, Horst. 2016. Verum Focus. In *Oxford handbook of information structure*, Caroline Féry & Shinichiro Ishihara (eds), 290-313. Oxford: Oxford University Press.
- Meibauer, Jörg, Altmann, Hans & Steinbach, Markus. 2013. Kontroversen in der Forschung zu Satztypen und Satzmodus. In *Satztypen des Deutschen*, Jörg Meibauer, Hans Altmann & Markus Steinbach (eds), 1-19. Berlin: de Gruyter.
- Montague, Richard. 1969/1974. On the nature of certain philosophical entities. In *Formal philosophy. Selected papers of Richard Montague*, Richmond H. Thomason (ed), 148-187. New Haven: Yale University Press.
- Öhl, Peter. 2007. Unselected embedded interrogatives in German and English: S-Selection as dependency formation. *Linguistische Berichte* 212: 403-437.
- Öhl, Peter. 2009. Sprachwandel und kognitive Ökonomie: Zur Grammatikalisierung und Substitution von Satzkonnektoren. *Linguistische Berichte* 220: 393-438.
- Öhl, Peter. 2017. Zur Akzeptanz der Einbettung von ob-Sätzen unter veridischen Prädikaten. Eine Hypothese bezogen auf epistemische Weltenmodelle – mit einem Seitenblick auf das Persische. In *Deutsch als Bindeglied zwischen Inlands- und Auslandsgermanistik. Beiträge zu den 23. GeSuS-Linguistik-Tagen in Sankt Petersburg, 22.–24. Juni 2015*, Sergej Nefedov, Ljubov Grigorieva & Bettina Bock (eds), 385-394. Hamburg: Kovač. (*Sprache und Sprachen in Forschung und Anwendung* 5)
- Öhl, Peter. To appear. Zum Denotat von Subjunktionen. In *Sprachen verbinden. Beiträge der 24. Linguistik- und Literaturlage, Brno/Tschechien, 2016*, Vera Janikova, Alice Brychová, Jana Veličková & Roland Wagner (eds). Hamburg: Kovač. (*Sprache und Sprachen in Forschung und Anwendung*)
- Reis, Marga. 1999. On sentence types in German: An enquiry into the relationship between grammar and pragmatics. *Interdisciplinary Journal for Germanic Linguistics and Semiotic Analysis* 4: 195-236.
- Schwabe, Kerstin. 2016a. Irritierende ob-Sätze. Paper presented at: Wuppertaler Linguistisches Forum, 28 Januar 2016.
- Schwabe, Kerstin. 2016b. Towards a typology of German ob-interrogatives embedding predicates. Paper presented at: SLE 2016, University of Naples. 1 September 2016.

Spector, Benjamin & Egré, Paul. 2015. A uniform semantics for embedded interrogatives: An answer, not necessarily the answer. *Synthese* 192 (6): 1729-1784.