The *doubt-whether* puzzle

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Abstract

The English predicate *doubt* is known to exhibit a distinctive selectional restriction: it is compatible with declarative as well as *whether*-complements but is incompatible with constituent *wh*-complements. The interpretation of a *whether*-complement under *doubt* is also puzzling, as ‘*doubt whether p*’ is almost—but not completely—synonymous with ‘*doubt that p*’. I will argue that these behaviors of *doubt* can be given a semantic account, by making use of the mechanisms of HIGHLIGHTING and EXHAUSTIFICATION. *Doubt* expresses an existential doxastic attitude toward the negation of the highlighted content of the complement while having presuppositions that are sensitive to the ordinary content of the complement. Given that ‘*that p*’ and ‘*whether p*’ are equivalent in the highlighted content but non-equivalent in the ordinary content, the semantics explains fine-grained differences in interpretations between ‘*doubt whether p*’ and ‘*doubt that p*’. Furthermore, given the lack of a stronger scalemate, the interpretation of ‘*doubt that/whether p*’ undergoes strengthening due to exhaustification, akin to the behavior of ‘scaleless’ modals reported in the literature.

1 Introduction

The dubitative predicate *doubt* in English exhibits puzzling behaviors concerning its selectional restriction and its interpretation. As Karttunen (1977a,b) notes, *doubt* has a distinctive selectional restriction, where it is compatible with both declarative and polar-question (PolQ) complements,¹ but not with alternative-question (AltQ) complements and constituent-*wh* complements. As for the interpretation, Karttunen (1977b) suggests that the interpretation of a PolQ complement under *doubt* is equivalent to that of a corresponding *that* complement. However, close examination reveals that there are fine-grained dis-

* [acknowledgements to be added later]

¹In this paper, I will include *if* complements under the class of what I refer to as ‘PolQ complements’ and will collapse *whether* and *if* complements in my discussion. See, however, Iyeyri (2009) for differences in the historical development of *doubt-whether* and *doubt-if*.

tinctions between the interpretations of *doubt-that* and *doubt-whether*, which interact with negation in systematic ways, as we will see in detail shortly (Dixon, 2005). There are several formal semantic treatments of *doubt* in the literature, including Fischer (2005), Pruitt and Roelofsen (2011), Biezma and Rawlins (2012), and Anand and Hacquard (2013). However, to my knowledge, no existing treatment can successfully account for both the selectional restriction and the fine-grained semantic properties of *doubt*.

In this paper, I will argue that these puzzling behaviors of *doubt* can be accounted for by combining two independently motivated semantic mechanisms: HIGHLIGHTING (Pruitt and Roelofsen, 2011, Roelofsen and Farkas, 2015, Theiler, 2020) and EXHAUSTIFICATION (Fox, 2007, Bar-Lev and Fox, 2020, Jeretič, 2020, Mirrazi and Zeijlstra, 2021). The analysis will furthermore show that the selectional restriction of *doubt*, even though puzzling at first sight, can be given a semantic explanation, advancing the ongoing research programme that aims to give meaning-driven explanations of selectional restrictions for clause-embedding predicates (Uegaki 2015, Mayr 2018, Theiler et al. 2019, Uegaki and Sudo 2019; cf. also White and Rawlins 2016, 2020, White 2021 for different perspective).

The rest of the paper is structured as follows. In §2, I will introduce empirical properties of English *doubt*, specifically its selectional restriction and semantic properties. Within the section, I will also discuss the behaviors of non-English counterparts of *doubt* based on a short survey of cross-linguistic data, which motivates a semantic analysis of certain aspects of the selectional restriction of *doubt*. §3 surveys three prominent analyses of *doubt*, i.e. Fischer (2005), Biezma and Rawlins (2012), and Pruitt and Roelofsen (2011), and shows that they do not provide a proper account of the semantic properties of *doubt* observed in §2. In §4, I will propose a concrete semantic analysis of *doubt*, making crucial use of the mechanisms of highlighting and exhaustification.

2 Desiderata for an analysis of *doubt*

In this section, I will discuss empirical properties of *doubt* following Karttunen (1977b), Dixon (2005), and Djärv (2019). I will furthermore present additional data from a number of non-English languages and explore to what extent the selectional restriction of *doubt* can be taken to be cross-linguistically stable.

2.1 The selectional restriction and interpretation

Karttunen (1977a,b) and Huddleston and Pullum (2002: 983) observe that the English predicate *doubt* exhibits a peculiar selectional restriction, exemplified in (1) below:

- (1) a. Ann **doubts** that they serve breakfast. (DECLARATIVE)
- b. Ann **doubts** whether they serve breakfast. (POLQ)

- c. *Ann **doubts** whether they serve breakfast or not. (POLQVN)
- d. Ann **doubts** whether they serve coffee or tea. (ALTQ)
- e. *Ann **doubts** who has passed the test. (CONSTITUENT *wh*)

I refer to the types of complements exemplified in (1) using the labels in parentheses to the right: DECLARATIVE, POLQ, POLQVN, ALTQ and CONSTITUENT *wh*, partially following Biezma and Rawlins (2012). As exemplified in (1), *doubt* is compatible with both a declarative complement and a PolQ complement. On the other hand, it is not compatible with either a PolQvN or a constituent-*wh* complement (Huddleston and Pullum 2002: 983; see also Huddleston 1994). Even though a disjunctive complement as in (1d) is by itself acceptable under *doubt*, its interpretation suggests that the complement is acceptable only if it is interpreted as a PolQ complement on a par with (1b), rather than as an AltQ complement (Karttunen, 1977b).²

The particular selectional pattern in (1) is not observed with other classes of clause-embedding predicates in English. As is well-known, the selectional restrictions of many English clause-embedding predicates can be stated in terms of declarative and interrogative complements, where the latter includes PolQ, PolQvN, AltQ, and constituent-*wh* complements in my terminology. Specifically, ANTI-ROGATIVE PREDICATES, such as *believe* and *hope*, only embed declarative complements; RESPONSIVE PREDICATES, such as *know* and *tell*, embed either declarative or interrogative complements; ROGATIVE PREDICATES, such as *wonder*, only embed interrogative predicates (Grimshaw, 1979, Ginzburg, 1995, Lahiri, 2002, Theiler et al., 2019). These patterns are exemplified below:

- (2) a. Ann **believes** that they serve breakfast. (declarative)
- b. *Ann **believes** whether they serve breakfast. (PolQ)
- c. *Ann **believes** whether they serve breakfast or not. (PolQvN)
- d. *Ann **believes** whether they serve coffee or tea. (AltQ)
- e. *Ann **believes** who has passed the test. (constituent *wh*)
- (3) a. Ann **knows** that they serve breakfast. (declarative)

²Interestingly, the rating results for *doubt* in the MegaAttitudes database (White and Rawlins, 2016, 2020) do not show significant difference between the acceptability of declarative and PolQ complement on the one hand (declarative: 7-point likert scale response averaged 6.67 ± 0.80 , $n = 30$; PolQ: response averaged 6.37 ± 1.16 , $n = 30$) and the constituent-*wh* complement on the other (6.13 ± 1.40 , $n = 15$). I used Ver. 2 of the MegaAcceptability database (<http://megaattitude.io/projects/mega-acceptability/>). The ratings for the declarative complement are for the frames ‘NP V that S’ and ‘NP V that S[+future]’ (15 observations each), those for the PolQ complement are for the frames ‘NP V whether S’ and ‘NP V whether S[+future]’ (15 observations each), and those for the *wh* complement are for the frame ‘NP V whichNP S’ (15 observations). Any of the pairwise comparison of responses across the complement types did not reach statistical significance, according to likelihood ratio tests of linear mixed-effects models fitted to the data. The database does not contain syntactic frames corresponding to PolQvN and AltQ complements. See White and Rawlins (2016) and White and Rawlins (2020) for methodologies of their data collection. In this paper, I will assume the judgements in (1) reported in the literature, and leave open the question of why the relevant contrasts were not observed in White and Rawlins’s (2016, 2020) experiments.

- b. Ann **knows** whether they serve breakfast. (PolQ)
 - c. Ann **knows** whether they serve breakfast or not. (PolQvN)
 - d. Ann **knows** whether they serve coffee or tea. (AltQ)
 - e. Ann **knows** who has passed the test. (constituent *wh*)
- (4)
- a. *Ann **wonders** that they serve breakfast. (declarative)
 - b. Ann **wonders** whether they serve breakfast. (PolQ)
 - c. Ann **wonders** whether they serve breakfast or not. (PolQvN)
 - d. Ann **wonders** whether they serve coffee or tea. (AltQ)
 - e. Ann **wonders** who has passed the test. (constituent *wh*)

Among responsive predicates, the restricted class of EMOTIVE FACTIVES, such as *surprise*, *annoy* and *bother*, are special in that they are incompatible with PolQ, PolQvN and AltQ complements (Karttunen, 1977a):

- (5)
- a. Ann **is surprised** that they serve breakfast. (declarative)
 - b.??Ann **is surprised** (at/by) whether they serve breakfast. (PolQ)
 - c.??Ann **is surprised** (at/by) whether they serve breakfast or not. (PolQvN)
 - d.??Ann **is surprised** (at/by) whether they serve coffee or tea. (AltQ)
 - e. Ann **is surprised** by who has passed the test. (constituent *wh*)

The selectional patterns of these classes of predicates are clearly distinct from that of *doubt*, which are compatible only with declarative and PolQ complements, as shown in (1).³

³Recently, White (2021) has pointed out that there are examples involving PolQ complements embedded by *believe*, *think*, *hope* and *fear*, which have traditionally been assumed to be interrogative predicates. Some of his data, taken from attested examples in corpora, are shown below:

- (i) (White, 2021: 13, (19))
 - a. [...] I didn't believe the Bible growing up, I wasn't a Christian growing up, I struggled to **believe whether** I could trust the Scriptures [...]
 - b. We can choose to **believe whether** the word of God is true [...] or not.
- (ii) (White, 2021: 11, (13-15))
 - a. When Jan Brown completed her safety briefing for the passengers, she tried to **think whether** she had covered everything.
 - b. I'm trying to **think whether** I'd have been a star today or not.
- (iii) (White, 2021: 14, (23))
 - a. I was **hoping whether** you are able to guide me.
 - b. I was **hoping whether** someone with more experience could confirm my understanding of a few points.
- (iv) (White, 2021: 14-15, (25))
 - a. Interstellar space is so vast that there is no need to **fear whether** stars in the Andromeda galaxy will accidentally slam into the Sun.
 - b. I **fear whether** this test would run safely on the oxygen sensor as it has a lot of drawback when compared with the others.

In addition to the peculiar selectional restriction, the interpretation of *doubt* is also intriguing. Karttunen (1977b) suggests that the two complement types *doubt* allows give rise to equivalent interpretations. That is, according to Karttunen, the following two examples, repeated from above, are equivalent:

- (1) a. Ann **doubts** that they serve breakfast. (declarative)
- b. Ann **doubts** whether they serve breakfast. (PolQ)

Specifically, Karttunen points out that both of these examples can be paraphrased as ‘Ann doesn’t believe the proposition that they serve breakfast.’ Based on this observation, he argues that the semantic value of a *whether*-clause under *doubt* shouldn’t be treated as an embedded polar question, and that it should be treated as a proposition on a par with a corresponding *that*-clause. This proposal is the basis of two prominent semantic analyses of *doubt*, to be discussed in the next section: Biezma and Rawlins (2012) and Pruitt and Roelofsen (2011).

However, there is evidence suggesting that *doubt-that* and *doubt-whether* are not equivalent. This is discussed by Dixon (2005: 239), who makes the following observations about the contrast in meaning between *doubt-that* and *doubt-whether*. First, in positive environments, ‘*I doubt that p*’ can be used ‘to imply disagreement with an assertion which has been made’ that *p*. On the other hand, ‘*I doubt whether p*’ ‘could be used when no one has seriously suggested that *p*, but the idea has just been floated’. This point is illustrated in the following contrast, suggested by a reviewer for this volume:

- (6) A: Do they serve scrambled eggs?
B: I doubt that/whether they serve scrambled eggs.
- (7) A: (I bet/assume/am sure) they serve scrambled eggs.
B: I doubt that/#whether they serve scrambled eggs.

The context in (6) is one where there is an immediate question under discussion (QUD) concerning whether they serve scrambled eggs while there is no prior assertion that they do. In contrast, the context in (7) is one where A is publicly committed to the proposition that they serve scrambled eggs. In (6-7), it is shown that *doubt-that* is compatible with both types of contexts while *doubt-whether* is compatible only with a context that does not involve a discourse participant’s commitment to the complement proposition.

Based on these data and an additional assumption that these predicates disallow other types of interrogative complements, one might think that these predicates share their selectional restrictions with *doubt*. However, corpus data suggest that *believe/hope/fear-whether* cases are significantly less frequent than *doubt-whether*. The transitional probabilities of *believe-whether*, *hope-whether* and *fear-whether* (the frequencies of the sequences given various inflectional realizations of the verb *believe/hope/fear*) in the iWeb corpus (<https://www.english-corpora.org/iweb/>) are 87/4197731, 16/2784840, and 34/403764, respectively. On the other hand, the transitional probability of *doubt-whether* is 4426/290569. Although frequency per se does not inform us about the qualitative nature of these constructions, I take this to be a viable reason to treat *doubt* separately from *believe*, *hope* and *fear* for the purpose of this paper. As for *think-whether*, Özyıldız (2021) shows that *think* is in fact responsive under its eventive interpretation, as in *Alice is thinking who she should invite for dinner*, and that the examples in (ii) involve this eventive *think*.

Secondly, the two constructions exhibit starkly different behaviors in negative environments. *Doubt-that* is acceptable under negation, and licenses the inference that the attitude holder believes the complement.⁴ This is exemplified in the following:⁵

- (8) a. I don't doubt that he is sick.
 ↪ 'I believe that he is sick.' (Dixon, 2005: 239)
 b. (She didn't eat anything before the event because....)
 she didn't doubt that the event organisers would serve breakfast.
 ↪ 'She believed that they would serve breakfast.'

The existence of this inference is experimentally confirmed by rating studies reported in Djärv (2019: 147-157). Specifically, Djärv has investigated levels of the attitude holder's commitment to the declarative complement in positive and negated sentences with a range of attitude verbs including *believe* and *doubt*, and observed that the scores for the commitment to *p* are as high with 'not doubt that *p*' as with 'believe that *p*'. Similar observations are also reported in Kane et al. (2021).

On the other hand, when we turn to *doubt-whether*, the general observation is that it is unacceptable under negation:

- (9) a.??I don't doubt whether he is sick. (Dixon, 2005: 239)
 b.??She doesn't doubt whether they serve breakfast.

These observations suggest that *doubt-that* and *doubt-whether* are in fact distinct in their interpretations, contra Karttunen's (1977b) claims.

All in all, there are two empirical properties of *doubt* that have to be accounted for. One is its selectional restriction—its compatibility with both declarative and PolQ complements and incompatibility with other types of interrogative complements—and the other is the fine-grained differences in interpretations between *doubt-that* and *doubt-whether*. In principle, there are two approaches we can take to analyse these properties of *doubt*. One is to pursue a semantic analysis of *doubt* which *uniformly* explains both its selectional restriction and its interpretation. The other is to provide an analysis in which the selectional restriction and the interpretation are accounted for independently from each other. One concrete analytical possibility within the latter approach is to account for the selectional restriction in terms of syntactic features while positing an independent lexical entry that accounts for the semantic properties. In this paper, I will not be able to offer a definitive argument in favor of one approach over the other. However, I will explore possible links between the selectional restriction and the interpretation of dubitative predicates based on a

⁴Dixon doesn't describe the phenomenon in terms of inference. He writes: 'I don't doubt that he is sick, and is very close in meaning to the positive assertion I believe that he is sick' (Dixon, 2005: 239).

⁵Roelofsen (2019, fn. 12) quotes similar observations about *doubt* under negation in *The American Heritage dictionary* (<https://www.ahdictionary.com/>).

small-scale survey of cross-linguistic data and pursue a unified semantic analysis of *doubt* which is compatible with the relevant cross-linguistic observations, to which I now turn.

2.2 Cross-linguistic picture

Karttunen (1977b) ends his squib by mentioning that the Finnish counterpart of *doubt*, i.e., *epäillä*, behaves in a way similar to that of English *doubt*. Biezma and Rawlins (2012: fn.33) also suggest that the selectional restrictions of dubitative predicates (i.e., *doubt* and its counterparts) are cross-linguistically stable. If this speculation is correct, it would motivate an approach that links the selectional restriction of *doubt* with its lexical semantics (following the approach advocated by Pesetsky 1991 and proposed more recently for clause-embedding predicates by Theiler et al. 2019 and Mayr 2019 a.o.), as opposed to an approach that treats the selectional restriction independently from lexical semantics. To evaluate this speculation, this section offers a short survey of the selectional properties of dubitative predicates in 12 languages (Swedish, Czech, Russian, Estonian, French, Italian, Spanish, Portuguese, Romanian, Sardinian, Mandarin, and Japanese). As my data are quite limited and heavily overrepresented by European languages, the goal of this section is not to make concrete claims about cross-linguistic universals or sources of variation. Rather, my goal here is to explore to what extent cross-linguistic data from the (limited) language sample motivate a semantic analysis of the selectional restriction of *doubt* and its cross-linguistic counterparts. If the selectional restriction of dubitative predicates is stable across languages, it will provide an argument for positing a link between the dubitative lexical semantics and selectional restrictions (though such a pattern will by no means *necessitate* this approach). To preview, the cross-linguistic picture suggests that clausal complements of dubitative predicates across languages are limited to declarative complements as well as interrogative complements in which a specific answer is *mentioned*, although there are language-specific restrictions as to what types of such interrogative complements are allowed. For example, English *doubt* is normally incompatible with PolQvN complements while many Romance languages normally disallow PolQ complements under the dubitative predicate. These findings motivate a semantic analysis of *doubt* and its counterparts which (a) predicts that the predicate only allows declarative and answer-mentioning interrogative complements by virtue of its lexical semantics; and (b) is compatible further language-specific restriction on complementation.

2.2.1 Cross-linguistic similarities

In many languages in the sample, dubitative predicates are compatible with both declarative and PolQ complements, while they are incompatible with constituent-*wh* complements. This is shown in the following examples from Swedish, Czech, Russian, Estonian, Mandarin, and Japanese.

(10) **Swedish**⁶

- a. Lisa **tvivlar** på [att hon kan komma på festen].
Lisa doubts on that she can come to party.DEF
'Lisa doubts that she can come to the party.'
- b. Lisa **tvivlar** på [om hon kan komma på festen].
Lisa doubts on whether she can come to party.DEF
'Lisa doubts whether she can come to the party.'
- c.??Lisa **tvivlar** på [vad hon ska göra].
Lisa doubts on what she will do

(11) **Czech**⁷

- a. ... A **pochybuju**, [že se k tomu ještě někdy
and doubt.IPFV.1SG that REFL to that.DEM still some.time
odhodlám].
take.courage.PFV.1SG
'And I doubt that I will take courage some time to do it.'
- b. ... já jsem chvílemi **pochybovala**, [jestli
I AUX.1SG now.and.then doubt.IPFV.PST.SG.F whether
dokážu být matkou].
manage.PFV.1SG be.INF mother
'... now and then I doubted whether I'll manage to be a mother.'
- c. ***Pochybuju** [kdy bude pršet].
doubt.1SG when will.3SG rain.INF

(12) **Russian**⁸

- a. ja **somneva-ju-s'** [čto svin'ji ume-jut leta-t'].
I doubt-PRS.1SG-REFL COMP pigs can-PRS.3PL fly-INF
'I doubt that pigs can fly.'
- b. ?ja **somneva-ju-s'** [ume-jut=li svin'ji leta-t'].
I doubt-PRS.1SG-REFL can-PRS.3PL=Q pigs fly-INF
'I doubt whether pigs can fly.'
- c. *ja **somnevajus'** [kto prišel na večerinku]
I doubt-PRS.1SG who arrive.PST.M on party.ACC

(13) **Estonian**⁹

- a. **Kahtlen**, [et kass kargas]
doubt.1SG that cat jumped
'I doubt that a cat jumped.'
- b. **Kahtlen**, [kas kass kargas]
doubt.1SG whether cat jumped

⁶Examples and judgments due to Kajsa Djärv (p.c.).

⁷Examples a and b from The Czech National Corpus (korpus.cz) and example c and its judgment due to Radek Šimík (p.c.).

⁸Examples and judgments due to David Erschler (p.c.).

⁹Examples and judgments due to Martin Aher (p.c.).

‘I doubt whether a cat jumped.’

(14) **Mandarin Chinese**¹⁰

- a. wo **huaiyi** [mingtian hui qing].
I doubt sunny FUT tomorrow
‘I doubt it will sunny tomorrow.’ (Huang, 2020: 6)
- b. xiaohuang **huaiyi** [xiaotang shi-bushi xihuan xiaoqiang].
Huang doubt Tang be-NEG.be like Qiang
‘Huang doubts whether Tang likes Qiang’ (Huang, 2020: 6)
- c. renmen shenzhi kaishi **huaiyi** [aoyunhui neng-fou anshi
people even start doubt Olympics can-NEG on.time
zhaokai].
happen
‘People even began to doubt if the Olympics can happen on time.’
(Yuan, 2014: 4)
- d. wo **huaiyi** [shei hui chuxian zai zheli].
I doubt who will appear at here
*‘I doubt who will appear here’
‘I suspect that somebody will appear here’

(15) **Japanese**¹¹

- a. Hana-wa [chikyuu-ga marui koto]-o **utagatteiru**.
Hana-TOP earth-NOM round fact -ACC doubt.ASP.
‘Hana doubts that the earth is round.’
- b. Hana-wa [chikyuu-ga marui-ka] **utagatteiru**.
Hana-TOP earth-NOM round-COMP_{int} doubt.ASP.
‘Hana doubts whether the earth is round’
- c. *Hana-wa [dare-ga kita-ka] **utagatteiru**.
Hana-TOP who-NOM came-COMP_{int} doubt.ASP

2.2.2 Points of variation

Interestingly, the counterparts of *doubt* in many Romance languages (with a possible exception of Spanish) do not readily allow a PolQ complement. This is pointed out by Fagard et al. (2016), who mention the following examples:

(16) Fagard et al. (2016: 28, (66))¹²

- a. *je **doute** s’il est arrivé (French)
- b. ***dubito** se è arrivato (Italian)

¹⁰Examples (14b) and (14c) involve the so-called A-not-A question in the complement. Following Hagstrom (2006) and Huang (2020), I assume that Mandarin A-not-A questions semantically correspond to English PolQs. See §4.3 for more discussion on the treatment of A-not-A questions. Also, in (14d), the *wh*-item *shei* allows a reading as a *wh*-indefinite but not as a question word.

¹¹The author’s own judgment. The verb *utagau* ‘doubt’ selects a factive complementizer *koto* in Japanese (Kuno, 1973, Nakau, 1973).

¹²Fagard et al. (2016) do not provide glosses for these examples.

- c. **dudo** si llegó (Spanish)
 - d. ***dúvido** se chegou / chegasse (Portuguese)
 - e. ***mă îndoiesc** dacă a sosit (Romanian)
 - f. ***dubbido** si est arribau (Sardinian)
- ‘I doubt if he has arrived’

This said, further examination suggests that PolQ complements under the counterparts of *doubt* are not entirely impossible at least in French and Italian. This is exemplified by the following attested examples:

(17) **French:** *douter* + PolQ complement¹³

- a. Je **doute** s’il arrivera un jour à ses fins
I doubt.1SG if=he arrive.3SG.FUT one day to his goals
‘I doubt if he will ever achieve his goals.’
- b. Il se mit à **douter** si elle était venue
he himself put to doubt if she be.3SG.IMPERF come
‘He started to doubt if she would come.’

(18) **Italian:** *dubitare* + PolQ complement¹⁴

- a. **Dubito** se potevamo accendere un fiammifero in che
doubt.1SG if can.IMP.1PL light a match in the
atmosphere.
atmosphere
‘I doubt if we can light a match in the atmosphere.’
- b. **Dubito** se apprezzerete nel loro giusto valore le
doubt.1SG if appreciate.FUT.2PL in their proper value the
cause delle mie sofferenze.
cause of=the my sufferings
‘I doubt if you will appreciate the causes of my sufferings in their proper value.’

Thus, although it may generally be the case that the Romance languages listed in (16) except for Spanish disallow PolQ complements under the counterpart of *doubt*, this restriction is not categorical.

Another possible point of variation concerns PolQvN complements. In many of the languages sampled, PolQvN complements are at least marginally acceptable under the dubitative predicate, in contrast to the judgment for English due to I discussed in the previous section. This is exemplified below for Swedish, Czech, and Japanese:

¹³Examples from Sketch Engine (www.sketchengine.eu), due to Fabienne Martin (p.c.). The dictionary *Trésor de la langue française* also mentions the following example:

- (i) Je **doute** si je partirai demain
I doubt.1SG if I leave.1SG.FUT tomorrow
‘I doubt if I leave tomorrow.’

However, this particular example is quite marked according to native speakers.

¹⁴Examples from Sketch Engine.

(19) **Swedish**

?Lisa **tvivlar på om** hon kan komma på festen **eller inte**.
Lisa doubts on whether she can come to party.DEF or not
'Lisa doubts whether she can come to the party or not.'

(20) **Czech**

Začal **pochybovat, jestli** jeho přítelkyně přijde **nebo**
started.SG.M doubt.INF whether his girlfriend come.PFV or
ne.
not
'He started doubting whether his girlfriend will come at all.'

(21) **Japanese**

Hana-wa [chikyuu-ga marui-**ka-dooka**] **utagatteiru**.
Hana-TOP earth-NOM round-COMP_{int}-or.not doubt.ASP.
'Hana doubts whether the earth is round'

It is also worth noting that the syntactic forms of the PolQ complement in Mandarin—exemplified in (14b-c)—involves a negative affix attaching to a (reduplicated) predicative head, superficially resembling PolQvN clauses. However, it is unclear if the semantics of these clauses completely align with that of English PolQvN (see Huang 1991, McCawley 1994, Hagstrom 2006 for relevant discussion on the so-called Mandarin A-not-A questions and similar constructions, exemplified in (14b-c)). I will come back to this point later in §4.

Furthermore, at least in some Romance languages, speakers report that the dubitative predicate sound acceptable with PolQvN or AltQ complements:

(22) **French**¹⁵

- a. On **doute** si l'acte auquel on pense est moral ou non.
we doubt if the=act which we think be moral or not
'We doubt if the act we are thinking about is moral or not.'
- b. Enfin il est normal de **douter** si notre écrit est correct ou non.
Finally it is normal to doubt if our writing is correct or not.
'Finally, it is normal to doubt if our writing is correct or not'

(23) **Italian**¹⁶

- a. **Dubito** se accettare o no.
doubt.1SG if accept or not
'I doubt whether to accept or not.'
- b. **Dubito** se intervenire o stare zitto.
doubt.1SG if intervene or stay silent
'I doubt whether to intervene or shut up.'

¹⁵Examples from Sketch Engine (sketchengine.eu)

¹⁶Examples from <https://dizionari.repubblica.it/Italiano/D/dubitare.html> and <https://dizionario.internazionale.it/parola/dubitare> identified by Giosuè Baggio (p.c.).

2.2.3 A tentative generalization

All in all, the data suggest that dubitative predicates in the languages sampled are compatible with declarative complements as well as PolQ, PolQvN, and/or AltQ complements, although there are language-specific restrictions as to what types of interrogative complements are permitted. For example, many Romance languages disallow PolQ complements while English disallows PolQvN and AltQ complements (at least according to the traditional judgments; Karttunen 1977b, Huddleston and Pullum 2002). One way to generalize the cross-linguistic picture is to group together PolQ, PolQvN, and AltQ as those interrogative complements that *mention a specific answer* (ANSWER-MENTIONING INTERROGATIVE COMPLEMENTS for short). The emerging generalization is the following:

(24) **Hypothesized cross-linguistic generalization**

Cross-linguistically, dubitative predicates are in principle compatible with answer-mentioning interrogative complements (modulo further language-specific restrictions on permissible types of such complements) in addition to declarative complements. In contrast, they are incompatible with constituent *wh* complements.

To make any conclusion about possible links between the lexical semantics and the selectional restrictions based on a generalization like (24), we also have to identify any cross-linguistic variation in the *lexical semantics* of dubitative predicates. My preliminary investigation suggests that the relevant examples from the languages considered above can be translated to English using the predicate *doubt*. Furthermore, Dixon's (2005) observations regarding the interaction between the predicate and the negation hold at least for Swedish, Czech, Russian, Estonian, Japanese, and French. That is, in these languages, dubitative + declarative under negation gives rise to the inference that the attitude holder believes the complement¹⁷ while dubitative + PolQ under negation is low in acceptability. This suggests that the lexical semantics of the relevant predicates is fairly stable across languages.¹⁸

This in turn means that the data are compatible with an analysis where the generalization in (24) is analyzed in terms of a mechanism rooted in the semantics of dubitative predicates, which is taken to be cross-linguistically general. If such a meaning-driven account of the coarse-grained selectional restriction of dubitative predicates (i.e. compatibility with answer-mentioning complements and incompatibility with constituent *wh* complements) is possible at all, it should be preferred over an alternative account where the restriction is accounted for independently of the dubitative lexical semantics. For, such an alternative would not be able to capture the cross-linguistic generalization in

¹⁷Djävrv (2019) replicates the aforementioned rating-study results for German and Swedish.

¹⁸The Mandarin predicate *huaiyi*, however, seems to be ambiguous between 'doubt' and 'suspect' (Yuan, 2014, Huang, 2020). The selectional pattern exemplified in (14) holds under the 'doubt' interpretation, according to native speaker judgments (Yunchong Huang, Ciyang Qing, p.c.).

(24). In the rest of the paper, I will explore such a semantic account of the selectional restriction of *doubt*.

As I suggested above, my goal in this paper is not to make claims about the possible sources of variation among languages. In particular, my analysis will leave open what determines the language-specific restrictions on the types of answer-mentioning complements a dubitative predicate is compatible with. My analysis of English *doubt* to be presented in §4 will account for the cross-linguistically general selectional restriction of dubitative predicates, i.e., its compatibility with answer-mentioning complements and incompatibility with constituent *wh* complements. At the same time, it will account for the English-specific facts, i.e., the incompatibility between *doubt* and PolQvN and AltQ complements. The analysis of the English-specific facts, however, will be dependent on extra assumptions about the semantics of the English PolQvN and AltQ constructions. In §4, I will speculate on the possibility that these extra assumptions are language-dependent and thus provide a source of variation which we observed in this section. Nevertheless, it will be beyond the scope of the present paper to evaluate this speculation about sources of cross-linguistic variation.

2.3 Interim summary

In this section, I have surveyed the core empirical properties of *doubt* in English (§2.1) as well as those of its counterparts in several non-English languages (§2.2). Specifically, these properties are the predicates' selectional restrictions and their interpretations relative to particular complement types. In English, it is observed that *doubt* is compatible with declarative and PolQ complements but is incompatible with PolQvN, AltQ, and constituent *wh* complements. As for the interpretation, *doubt* exhibits slightly different interpretations depending on whether it takes a declarative or a PolQ complement: (a) $\lceil \text{doubt that } p \rceil$ can be used when p has just been asserted in the context while $\lceil \text{doubt whether } p \rceil$ is infelicitous in a similar context. Furthermore, $\lceil \text{not doubt that } p \rceil$ leads to the inference that the attitude holder believes p while $\lceil \text{not doubt whether } p \rceil$ is degraded at best. Dubitative predicates in the non-English languages surveyed show similar selectional and semantic properties at an abstract level. That is, they only select for answer-mentioning complements and their interpretation is comparable to English *doubt* although there are several fine-grained variations.

3 Existing accounts

There are three prominent compositional semantic treatments of the selectional pattern of dubitative predicates: Fischer (2005), Pruitt and Roelofsen (2011) and Biezma and Rawlins (2012).¹⁹ In this section, I will consider and critically evaluate these accounts.

¹⁹Another prominent formal analysis of *doubt* is in Anand and Hacquard (2013), but the analysis does not consider PolQ complements.

3.1 Fischer (2005)

Fischer (2005) provides an analysis of German *zweifeln* ‘doubt’, which is extendable to English *doubt*. He also provides corpus and questionnaire study results that show that *zweifeln* exhibits a selectional restriction similar to *doubt* with the exception of its compatibility with PolQvN and AltQ complements. His semantic analysis can be summarised as follows, where $P(\mathbf{m})(p)$ is Maria’s subjective probability assigned to the proposition p :

- (25) a. $\llbracket \text{Maria zweifelt dass } p \text{ ‘Maria doubts that } p \text{’} \rrbracket \Leftrightarrow P(\mathbf{m})(p) < 1$
 b. $\llbracket \text{Maria zweifelt ob } p \text{ ‘Maria doubts whether } p \text{’} \rrbracket$
 $\Leftrightarrow P(\mathbf{m})(p) < 1 \ \& \ P(\mathbf{m})(\neg p) < 1$
 c. $\llbracket \text{Maria zweifelt ob } p \text{ oder } q \text{ ‘Maria doubts whether } p \text{ or } q \text{’} \rrbracket$
 $\Leftrightarrow P(\mathbf{m})(p) < 1 \ \& \ P(\mathbf{m})(q) < 1$

The analysis correctly predicts the interaction of *zweifeln-dass* or *doubt-that* with negation. For, the negation of (25a) is $P(\mathbf{m})(p) = 1$, which amounts to Maria’s belief in p . Also, the analysis derives the strong interpretation of *zweifeln-dass* and *zweifeln-ob* (that Maria considers it likely that $\neg p$) by considering the conversational implicature with respect to the alternative *vermuten-dass* ‘suspect-that’. This goes as follows: Fischer assumes the following semantics for *vermuten*:

- (26) $\llbracket x \text{ vermuten dass } p \rrbracket \Leftrightarrow .5 \leq P(x)(p) < 1$

Furthermore, he assumes that *vermuten-dass* is an alternative to both *zweifeln-dass* and *zweifeln-ob*. Given the above assumptions, via scalar implicature, we derive $P(x)(p) < .5$ for *zweifeln-dass* and $0 < P(x)(p) < .5$ for *zweifeln-ob*.

Fischer notes that *zweifeln-ob* is unacceptable under negation, just as in English. This is not semantically derived under his analysis, as $\llbracket x \text{ zweifelt nicht, ob } p \rrbracket \Leftrightarrow P(\mathbf{m})(p) = 1 \text{ or } P(\mathbf{m})(\neg p) = 1$. However, he suggests that this meaning is pragmatically deviant (specifically a violation of the Gricean Maxim of Relevance), as the relevant question typically concerns whether the attitude holder believes p or $\neg p$, not whether they have the complete conviction (of whichever proposition) or not.

There are at least three problems with Fischer (2005). First, The implicature-based analysis relies on the construction-level competition between *zweifeln-ob* and *vermuten-dass*, rather than a lexical competition between the two predicates. Assuming a construction-level competition between *V-whether* and *V-that* elsewhere makes incorrect predictions. For example, suppose *be certain about whether* p is in competition with *believe that* p . Then, given scalar implicature, *be certain about whether* p would implicate ‘ $\neg(\text{believe } p)$ ’, which, together with its literal meaning, would amount to ‘be certain that $\neg p$ ’. This seems to be an incorrect prediction. Second, the analysis of the unacceptability of the negation of *zweifeln-ob* suggests that the predicted semantic content is pragmatically deviant. However, *be convinced (about) whether* has exactly the same semantic content, but without the supposed pragmatic deviance. In the same contexts

in which *be convinced (about) whether* can be used, *not-doubt-whether* is unacceptable. This suggests that Fischer’s pragmatic account cannot fully capture the unacceptability of *not-doubt-whether*. Finally, to the extent that we follow the judgments reported in §2.1, the Fischer-style analysis for *doubt* overgenerates: the analysis cannot account for the unacceptability of PolQvN, AltQ and constituent *wh*-Q under *doubt*. This is so since the analysis treats these cases as involving a point-wise application of the semantics of *zweifeln-dass/doubt-that* to each Hamblin answer of the complement.

Despite the problems, however, Fischer’s (2005) account contains important insights which I will incorporate in my analysis. In particular, in §4, I will propose a weak underlying semantics for *doubt-that* similar to Fischer’s and an implicature-based derivation of the strong reading. At the same time, as we will see, my proposal will be substantially different from Fischer (2005) in important respects. I will not analyse interrogative-embedding cases of *doubt* as involving a point-wise application of the declarative-embedding semantics for *doubt*, thus avoiding the overgeneration pointed out above. Furthermore, the implicature-based account will not rely on problematic assumptions about construction-level alternatives.

3.2 Biezma and Rawlins (2012)

Biezma and Rawlins’s (2012) account is based on the proposal that PolQ complements have a singleton proposition-set denotation, as exemplified in the following:

- (27) $\llbracket \text{whether it is raining} \rrbracket = \{ \text{it is raining} \}$

According to Biezma and Rawlins, the representation of bipolar alternative propositions, e.g. $\{ \text{it is raining}, \neg \text{it is raining} \}$ —commonly associated with the semantics of polar questions after Hamblin (1973)—is attributed to pragmatics, building on earlier proposals along the same lines by Roberts (1996) and Gunlogson (2001) among others. Specifically, in the case of matrix polar questions, the Q-operator that heads the clause is assumed to carry the presupposition that the QUD is a non-singleton and includes the semantic content of its prejacent (e.g. (27)) as its subset. If the polar question is embedded, a coercion mechanism can kick in, which turns a singleton set into the corresponding bipolar set. The coercion operation is driven by the following two statements:

- (28) **Anti-singleton constraint schema** (Biezma and Rawlins, 2012: 393)
For any Q-embedding verb V: $\llbracket V [Q \alpha] \rrbracket$ is defined only if $|\llbracket Q \alpha \rrbracket| > 1$
- (29) **Anti-singleton coercion** (Biezma and Rawlins, 2012: 393)
If $|\llbracket \alpha \rrbracket| = 1$, where α is of type $\langle s, t \rangle$ and denotes $\{ A \}$, then α can be coerced (as a last resort) into the denotation $\{ \lambda w. A(w), \lambda w. \neg A(w) \}$

In contrast to PolQ complements, PolQvN complements and AltQs are analyzed as having two-membered denotations, as follows:

- (30) a. $\llbracket \text{whether or not it is raining} \rrbracket = \{ \text{it is raining}, \neg \text{it is raining} \}$

- b. $\llbracket \text{whether Jo likes coffees} \uparrow \text{ or tea} \downarrow \rrbracket$
 $= \{ \text{Jo likes coffee, Jo likes tea} \}$

This means that the anti-singleton coercion does not occur in these types of complements.

The behavior of dubitative predicates is presented by Biezma and Rawlins (2012) as a piece of evidence for the singleton treatment of polar questions,²⁰ along with other phenomena, such as the behavior of rising declaratives, disjoined polar questions, and answer particles. The argument based on dubitative predicates goes as follows, *assuming* Karttunen’s claim that $\lceil \text{doubt that } p \rceil$ and $\lceil \text{doubt whether } p \rceil$ are equivalent. The supposed equivalence can be naturally accounted for under the proposed analysis. This is so because, according to their compositional semantics based on Alternative Semantics (Hamblin, 1973, Rooth, 1985, 1992, Kratzer and Shimoyama, 2002, Shimoyama, 2006), the denotation in (27) is equivalent to the denotation of a declarative complement clause, as follows:

$$(31) \llbracket \text{that it is raining} \rrbracket = \{ \text{it is raining} \}$$

A similar analysis is not straightforward if a polar question semantically denotes a two-membered bipolar set.

Their analysis furthermore accounts for the selectional restriction of *doubt*. They argue that dubitative predicates like *doubt* “does not differentiate among types of (finite) CPs, but S-selects for singleton alternative sets” (Biezma and Rawlins, 2012: 395). This explains the fact that dubitative verbs are compatible with both declarative complements like (27) and PolQ complements like (31). Furthermore, the proposal accounts for the incompatibility of *doubt* with PolQvN and AltQ complements, whose denotations are two-membered.²¹

At this point, it is easy to see that Biezma and Rawlins (2012) fail to capture Dixon’s (2005) observation about the difference in interpretation between *doubt-that* and *doubt-whether*. In fact, it is impossible for their analysis to capture any difference between the two, as *doubt* combines with the same semantic content in the two cases, i.e., $\llbracket \text{that } p \rrbracket = \llbracket \text{whether } p \rrbracket$. This makes any attempt to explain selectional restriction based on their semantic analysis of *doubt* rather pointless. If the underlying semantic analysis is incomplete, it is not straightforward to evaluate to what extent the analysis is successful in achieving a meaning-driven analysis of the selectional pattern.

²⁰Related claims are made in Rawlins (2008) as well.

²¹Although it is not made explicit, Biezma and Rawlins (2012) presumably assume that dubitative predicates do not trigger the anti-singleton coercion in (30). If the coercion were to apply to a PolQ complement embedded by *doubt*, it would denote a bipolar set, resulting in a situation where it has a semantic value that is equivalent to the corresponding PolQvN complement, contrary to what is intended. Biezma and Rawlins are not explicit about what lexical property of dubitative predicates is responsible for the lack of the coercion operation, but one plausible interpretation of their proposal is that the coercion is triggered if and only if a non-singleton proposition-set is s-selected by the embedding predicate. In other words, a predicate is ‘Q-embedding’ for the purpose of the schema in (28) iff it s-selects for a non-singleton set. According to this view, since dubitative predicates s-select for a singleton set, they do not trigger the anti-singleton coercion.

3.3 Pruitt and Roelofsen (2011)

Pruitt and Roelofsen (2011) have proposed another analysis of the selectional restriction of *doubt*, by combining alternative semantics with the notion of HIGHLIGHTING (Roelofsen and van Gool, 2010, Roelofsen and Farkas, 2015, Theiler, 2020). Just like Biezma and Rawlins (2012), their analysis is set in alternative semantics where a clausal complement denotes a set of propositions as its semantic value, regardless of whether it is declarative or interrogative. Yet, unlike Biezma and Rawlins (2012), Pruitt and Roelofsen treat PolQ complements as having a bipolar, two-membered, denotation while declarative *that* complements as having a singleton denotation. At this level, PolQ complements are treated on a par with PolQvN and AltQ complements. This is exemplified in the following:

- (32) a. $\llbracket \text{whether it is raining} \rrbracket^o = \{\text{it is raining}, \neg \text{it is raining}\}$
 b. $\llbracket \text{whether it is raining or not} \rrbracket^o = \{\text{it is raining}, \neg \text{it is raining}\}$
 c. $\llbracket \text{whether Jo likes coffee} \uparrow \text{ or tea} \downarrow \rrbracket^o = \{\text{Jo likes coffee}, \text{Jo likes tea}\}$
 d. $\llbracket \text{that it is raining} \rrbracket^o = \{\text{it is raining}\}$

This said, what we have in (32) is not the only semantic representation of complements for Pruitt and Roelofsen (2011). In order to analyze the behavior of answer particles *yes/no* to polar questions and to AltQs, Pruitt and Roelofsen crucially assume a separate level of semantic representation from the ORDINARY SEMANTIC VALUES in (henceforth o-values for short) (32), which they call HIGHLIGHTED SEMANTIC VALUES (henceforth: h-values), written with $\llbracket \cdot \rrbracket^h$. These values intuitively correspond to the contents that are explicitly mentioned in the phonological form of the complement, as exemplified in the following (we have equivalent highlighted propositions for the corresponding matrix clauses).²²

- (33) a. $\llbracket \text{whether it is raining} \rrbracket^h = \{\text{it is raining}\}$

²²Highlighted values can be compositionally derived in terms of the notion of LISTS in Ciardelli et al. 2018, as follows:

- (i)
- ```

 / \
 INT/DECL LIST
 / \
 CP1 or CP2

```
- (ii) a.  $\llbracket [\text{CP } C \varphi] \rrbracket^h = \{\llbracket \varphi \rrbracket^o\}$  for both declarative and interrogative C  
 b.  $\llbracket \text{INT LIST} \rrbracket^h = \llbracket \text{LIST} \rrbracket^h$   
 c.  $\llbracket \text{DECL LIST} \rrbracket^h = \{\bigcup \llbracket \text{LIST} \rrbracket^h\}$

Here, the declarative and interrogative C are responsible for the distinct semantics for complements in the o-value. However, they simply project the singleton set of the prejacent proposition in the h-value. The clause-typing operators INT and DECL are in agreement with the CPs in LIST. If the complement doesn't involve a disjunction as in (33a) and (33d), we have a singleton LIST, in which case the contribution of the clause-typing operators in the h-value is vacuous. However, if there is a disjunction as in (33b) and (33c), the INT-operator creates a multiple-membered set in the h-value while the DECL-operator flattens the values into a singleton set.

- b.  $\llbracket \text{whether it is raining or not} \rrbracket^h = \{\text{it is raining}, \neg \text{it is raining}\}$
- c.  $\llbracket \text{whether Jo likes coffee} \uparrow \text{ or tea} \downarrow \rrbracket^h = \{\text{Jo likes coffee}, \text{Jo likes tea}\}$
- d.  $\llbracket \text{that it is raining} \rrbracket^h = \{\text{it is raining}\}$

Their analysis of answer particles states that, for instance, *yes* (a) presupposes that there is exactly one proposition highlighted by the preceding question and (b) affirms this unique proposition if the presupposition is satisfied. This captures the fact that *yes* is a felicitous response to polar questions, such as *Is it raining?*, which highlights exactly one proposition, but not to a PolQvN, such as *Is it raining or not?* and AltQs, such as *Does Jo like coffee or tea?*, which highlight more than one propositions. I will not delve into the details of their analysis of answer particles here. The reader is referred to the relevant discussion in Pruitt and Roelofsen (2011) as well as in Pruitt and Roelofsen (2013), Roelofsen and Farkas (2015) and Farkas and Roelofsen (2019) for refinements and cross-linguistic extensions of the analysis of answer particles based on the notion of highlighting. See also Theiler’s (2020) analysis of the German discourse particle *denn* as an additional empirical motivation for highlighting.

What’s important for our purposes is that Pruitt and Roelofsen (2011) present the interpretation of *doubt* as another empirical motivation for the need for highlighting. They argue that the interpretation of *doubt-whether* calls for an analysis where its semantics is sensitive to the proposition highlighted by its complement. Their argument is based on pairs of examples such as the following:

- (34) a. John doubts whether the door is open.  
b. John doubts whether the door is closed.  
(Pruitt and Roelofsen, 2011: 27, (73))
- (35) a. Ann doubts whether they serve breakfast.  
b. Ann doubts whether they don’t serve breakfast.

Specifically, Pruitt and Roelofsen observe that the a-example and the corresponding b-example in pairs such as the above differ in their truth conditions. For example, if John suspects that the door is open, (34b) can be true but (34a) cannot. Similarly, in a situation where Ann suspects that they serve breakfast, (35b) can be true but (35a) cannot. If *doubt* is only sensitive to the o-value of the complement, the truth-conditional differences cannot be accounted for, as  $\llbracket \text{whether } p \rrbracket^o = \llbracket \text{whether not-}p \rrbracket^o$ . However, if *doubt* is sensitive to the highlighted content, the difference is accounted for, since  $\llbracket \text{whether } p \rrbracket^h \neq \llbracket \text{whether not-}p \rrbracket^h$ .

How does the analysis fare with Dixon’s observations regarding the difference between *doubt-that* and *doubt-whether*? Since Pruitt and Roelofsen (2011) do not present a concrete lexical entry for *doubt*, it is difficult to evaluate their predictions in this regard. However, unlike Biezma and Rawlins (2012), their claim is at least compatible with the possibility that *doubt-that* and *doubt-whether* differ in interpretations. This is so because *doubt* may be sensitive to the o-value (where  $\llbracket \text{that } p \rrbracket^o \neq \llbracket \text{whether } p \rrbracket^o$ ) in addition to the h-value. Then

again, it is left open how such an analysis can be implemented in a concrete lexical entry. For this reason, Pruitt and Roelofsen (2011) fail to give a precise semantic analysis of *doubt*. In addition, just as in the case of Biezma and Rawlins (2012), the incomplete nature of their semantic analysis leaves open how much they are successful in explaining the selectional restriction of *doubt* in terms of its lexical semantics.

## 4 Proposal

In this section, I will propose a concrete semantic analysis of *doubt* with the aim of achieving an account that satisfies the following three desiderata:

1. **Selectional restriction:** The analysis has to capture the selectional restriction of *doubt*, i.e., its compatibility with declarative and PolQ complements, and its incompatibility with other types of complements.
2. **Interpretation:** The analysis has to account for the interpretation of *doubt*, including the fine-grained semantic difference between ‘*doubt-that*’ and ‘*doubt-whether*’.
3. **Meaning-driven analysis of the cross-linguistic pattern:** The semantics of *doubt* has to be such that it accounts for the cross-linguistically general pattern of selectional restrictions exhibited by dubitative predicates, i.e., their compatibility with declarative and answer-mentioning interrogative complements and their incompatibility with constituent *wh*-complements.

As I briefly mentioned in §2, I will not attempt to provide an in-depth analysis of the cross-linguistic variation in selectional restrictions observed in §2.2.

### 4.1 The baseline analysis: $\neg \Box p$

A challenge in formulating a semantic analysis of *doubt* that satisfies the second desideratum concerns how to reconcile the analytical intuition (after Karttunen 1977b) that ‘*doubt that p*’ and ‘*doubt whether p*’ are near-synonymous on the one hand and Dixon’s observations about the fine-grained differences between *doubt-that* and *doubt-whether* on the other. To meet this challenge, I will employ the distinction between the o(rdinary)-value and the h(ighlighted)-value along the lines of Pruitt and Roelofsen (2011) and argue that *doubt* is sensitive to both dimensions of the complement meaning. Since the h-value is the same for ‘*that p*’ and ‘*whether p*’, the aspect of the meaning of *doubt* that is sensitive to the h-value will be synonymous between ‘*doubt that p*’ and ‘*doubt whether p*’. In contrast, since the o-values are different between ‘*that p*’ and ‘*whether p*’, the fine-grained difference between ‘*doubt that p*’ and ‘*doubt whether p*’ can be captured by the aspect of the meaning which is sensitive to the o-value.

Another important challenge concerns the interaction with negation: how can we derive the strong inference that the attitude holder believes the complement when *doubt-that* is negated? One analytical option to meet this challenge

is to adopt an existential semantics for *doubt*, following a similar suggestion by Fischer (2005) and Anand and Hacquard (2013).<sup>23</sup> That is, roughly,  $\lceil x \text{ doubt that } p \rceil$  expresses that  $x$  considers  $\neg p$  possible ( $\Diamond \neg p$ ). Or, equivalently, it is not the case that  $x$  believes  $p$  ( $\neg \Box p$ ). When this is negated, we have:  $x$  believes  $p$  ( $\Box p$ )

This idea is made concrete in the following baseline entry for *doubt*, which involves two presuppositional conditions in addition to the existential doxastic attitude in the assertive component. Ultimately, I will identify two issues with this analysis and propose a refinement based on exhaustification. However, for ease of exposition, I will first discuss to what extent the baseline analysis meets our desiderata for the analysis of *doubt*. The discussion of the issues and the exhaustification-based refinement will be given later in §4.4.

(36) **Lexical entry for *doubt***<sup>24</sup>

- $\llbracket x \text{ doubts } \varphi \rrbracket^o(w)$  presupposes:
  - (i)  $\exists Q \in \text{table} : \llbracket \varphi \rrbracket^o \subseteq Q$ ; and
  - (ii)  $\forall p \in \llbracket \varphi \rrbracket^o : \text{DOX}_x^w \cap p \neq \emptyset$
- If the above presuppositions are met,
 
$$\llbracket x \text{ doubts } \varphi \rrbracket^o(w) = 1 \text{ iff } \text{DOX}_x^w \not\subseteq \bigcup \llbracket \varphi \rrbracket^h$$

Here, *table* refers to the CONVERSATIONAL TABLE in the model of discourse by Farkas and Bruce (2010) and Farkas and Roelofsen (2017), i.e. the stack of proposals made so far in the conversation. Here, a proposal can either be a statement that has been asserted by a conversational participant or a question which has been raised. Either case, a proposal is modelled as a set of propositions, where a statement is a singleton proposition-set and a question is typically a non-singleton set.

Given the assumptions laid out in §3.3, the entry in (36) can be rewritten as follows for a declarative complement  $\lceil \text{that } p \rceil$  and a PolQ complement  $\lceil \text{whether } p \rceil$ :

- (37) a. •  $\llbracket x \text{ doubts that } p \rrbracket^o(w)$  presupposes:
- (i)  $\exists Q \in \text{table} : \{p\} \subseteq Q$ ; and
  - (ii)  $\text{DOX}_x^w \cap p \neq \emptyset$
  - If the above presuppositions are met,
 
$$\llbracket x \text{ doubts that } p \rrbracket^o(w) = 1 \text{ iff } \text{DOX}_x^w \not\subseteq p$$
- b. •  $\llbracket x \text{ doubts whether } p \rrbracket^o(w)$  presupposes:
- (i)  $\exists Q \in \text{table} : \{p, \bar{p}\} \subseteq Q$ ; and

<sup>23</sup>See also Močnik (2017) and Močnik and Abramovitz (2019) for existing proposals to analyze attitudinal predicates (specifically Slovenian *dopuščati* and Koryak *lvək*) as involving existential quantification over worlds compatible with the attitude holder's information state.

<sup>24</sup>In this paper, to avoid clutter, I will use variables  $x$  and  $p$  for both an object language expression and their model-theoretic counterparts.

- (ii)  $\forall p' \in \{p, \bar{p}\} : \text{DOX}_x^w \cap p' \neq \emptyset$
- If the above presuppositions are met,  
 $\llbracket x \text{ doubts whether } p \rrbracket^o(w) = 1$  iff  $\text{DOX}_x^w \not\subseteq p$

Note that (37a) and (37b) are equivalent in their assertions, due to the fact the assertive component of *doubt* is only sensitive to the h-value of the complement and that the h-values of  $\ulcorner \text{that } p \urcorner$  and  $\ulcorner \text{whether } p \urcorner$  are equivalent (i.e.,  $\{p\}$ ). Their presuppositions, however, are distinct as they are sensitive to the complement o-values, which are distinct between  $\ulcorner \text{that } p \urcorner$  and  $\ulcorner \text{whether } p \urcorner$ . In the next section, I will explicate each component of (37) in more detail.

## 4.2 The asserted meaning and presuppositions

I illustrate the analysis starting from the assertive component. As suggested above, the entry analyzes  $\ulcorner \text{doubt that/whether } p \urcorner$  as asserting an existential doxastic attitude toward the negation of the h-value of  $\ulcorner \text{that/whether } p \urcorner$ . At this assertive level,  $\ulcorner \text{doubt that } p \urcorner$  and  $\ulcorner \text{doubt whether } p \urcorner$  are equivalent, thanks to the fact that  $\llbracket \text{that } p \rrbracket^h = \llbracket \text{whether } p \rrbracket^h = \{p\}$ . This captures the analytical intuition due to Karttunen (1977b) that *doubt-that* and *doubt-whether* are equivalent at some level. Furthermore, this also captures the observation that the negation of  $\ulcorner \text{doubt that } p \urcorner$  entails the subject's belief of  $p$ . For, the negation of  $\text{DOX}_x^w \not\subseteq p$  is simply  $\text{DOX}_x^w \subseteq p$ . Now, how can we then capture the unacceptability of the negation of *doubt-whether*? This is due to the interaction between the assertive meaning and the presuppositions, to which I now turn.

According to the analysis presented above,  $\ulcorner \text{doubt that/whether } p \urcorner$  has two presuppositions: (i) a superset of the o-value of the complement is on the conversational table; and (ii) every proposition in the o-value of the complement is compatible with the subject's doxastic state. The first presupposition captures the following contrast repeated from §2.1:

- (6) A: Do they serve scrambled eggs?  
 B: I doubt that/whether they serve scrambled eggs.
- (7) A: (I bet/assume/am sure) they serve scrambled eggs.  
 B: I doubt that/#whether they serve scrambled eggs.

In (6B), since the table contains the question  $\{\text{they serve scrambled eggs}, \neg\text{they serve scrambled eggs}\}$  and this is a superset of both  $\llbracket \text{they serve scrambled eggs} \rrbracket^o$  and  $\llbracket \text{whether they serve scrambled eggs} \rrbracket^o$ , the relevant presupposition is satisfied in both declarative and PolQ cases. On the other hand, in (7B), the table contains the assertion  $\{\text{they serve scrambled eggs}\}$ . This is a superset of  $\llbracket \text{they serve scrambled eggs} \rrbracket^o$  but not of  $\llbracket \text{whether they serve scrambled eggs} \rrbracket^o$ . Thus, the presupposition is satisfied in the declarative variant, but not in the PolQ variant.

Moving on to the second presupposition, it states that the complement proposition is compatible with the subject's beliefs in the case of declarative complements while it states that both the positive and the negative resolution

are compatible with the subject's beliefs in the case of PolQ complements. In the latter case, the presupposition amounts to the subject's uncertainty about the issue expressed by the complement.<sup>25</sup> This uncertainty condition is intuitively reasonable, and has precedence in the analysis of *doubt* by Anand and Hacquard (2013) (although Anand and Hacquard do not discuss *doubt-whether*). In addition, it has the further benefit of predicting the unacceptability of *not-doubt-whether* when it is taken together with the assertion. To see this, consider the prediction for the interpretation of  $\ulcorner x \text{ does not doubt whether } p \urcorner$  below:

- (38) •  $\llbracket x \text{ does not doubt whether } p \rrbracket^o(w)$  presupposes:
- (i)  $\exists Q \in \text{table} : \{p, \bar{p}\} \subseteq Q$
  - (ii)  $\forall p' \in \{p, \bar{p}\} : \text{DOX}_x^w \cap p' \neq \emptyset$
  - If the above presuppositions are met,  
 $\llbracket x \text{ does not doubt whether } p \rrbracket^o(w) = 1$  iff  $\text{DOX}_x^w \subseteq p$

Here, the second presupposition contradicts the assertion, explaining the unacceptability. Note that the same issue does not arise with  $\ulcorner x \text{ does not doubt that } p \urcorner$  since its second presupposition only amounts to  $x$ 's beliefs being compatible with  $p$ , which is consistent with the predicted assertion that  $x$  believes  $p$ .

### 4.3 Selectional restrictions

Let us now see how the analysis captures the selectional restriction of *doubt* and whether the account predicts the cross-linguistically general selectional restriction for dubitative predicates. I have already illustrated that *doubt* as analyzed above is compatible with both declarative and PolQ complements (except when the PolQ case is negated). On the other hand, the analysis correctly predicts that the verb is incompatible with constituent *wh*-complements, given that the h-value only includes the answers that are *mentioned* in the syntactic form of

<sup>25</sup>These implications, however, may not project like typical presuppositions. If the relevant implications are presuppositional, we predict that the following sentences are infelicitous in a context in which it is possible that the addressee is a flat-earthier.

- (i) a. Do you doubt that/whether the earth is round?
- b. If you doubt that/whether the earth is round, consider the scientific evidence.

However, according to native speaker intuitions, these sentences can be used to respond to a potential flat-earthier. To address this issue, one may consider a more complex formulation of the second presupposition, as follows:

- (ii)  $\forall p \in \llbracket \varphi \rrbracket^o \setminus \llbracket \varphi \rrbracket^h : \text{DOX}_x^w \cap p \neq \emptyset$

This presupposition would be trivial in the case of declarative complements (because  $\llbracket \text{that } p \rrbracket^o \setminus \llbracket \text{that } p \rrbracket^h = \emptyset$ ) while it states that the negative resolution is compatible with the subject's beliefs in the case of PolQ complements (because  $\llbracket \text{whether } p \rrbracket^o \setminus \llbracket \text{whether } p \rrbracket^h = \{\bar{p}\}$ ). This presupposition is compatible with the projection data in (i) while it still captures the contradiction of  $\ulcorner \text{not-whether-}p \urcorner$ . The discussion to be presented below will be compatible with this refined version of the second presupposition of *doubt*. A more comprehensive empirical research is needed to identify the exact statement of the presupposition.

the complement. That is, roughly, since no answer of  $\ulcorner \textit{who has passed the test} \urcorner$  is highlighted, the assertion of  $\ulcorner \textit{doubt who has passed the test} \urcorner$ , which depends on the h-value of the complement, is predicted to have a pathological meaning.

Technically, we can formalize this analysis by following Roelofsen et al. (2019) and Roelofsen (2019) and assume that the h-value of an interrogative complement is its ABSTRACT in Groenendijk and Stokhof's (1984) sense.<sup>26</sup> Under this assumption, we have the following for the h-value of a constituent *wh*-complement:

$$(39) \quad \llbracket \textit{who has passed the test} \rrbracket^h = \{ \lambda x_e \lambda w_s. \text{PassedTheTest}_w(x) \}$$

In this case, the assertive component of  $\ulcorner x \textit{ doubts who} \dots \urcorner$  will be trivially true because  $\text{DOX}_x^w$ —which is a set of worlds—is never a subset of the unique member of (39)—which is of type  $\langle e, st \rangle$ . Assuming that unacceptability ensues from this type of logical triviality (e.g., Gajewski, 2002, 2009, Schwarz and Simonenko, 2018, Del Pinal, 2019, Chierchia, 2019), this accounts for the incompatibility between *doubt* and constituent *wh*-complements.

With additional assumptions about highlighting, the analysis also accounts for the incompatibility between *doubt* and PolQvN and AltQ complements. The relevant assumption about PolQvN complements (which follows from the general idea that the h-value includes those answers that are mentioned by the complement) is that they highlight both the positive and negative answer, as follows:

$$(40) \quad \llbracket \textit{whether or not it is raining} \rrbracket^h = \{ \text{it is raining, it is not raining} \}$$

This again predicts contradiction when combined with the proposed semantics for *doubt*. Here is why: since  $\text{DOX}_x^w \not\subseteq \bigcup \{p, \neg p\} \iff \text{DOX}_x^w \not\subseteq W$  (where  $W$  is the set of all worlds), the h-value of the complement in (40) predicts that the assertion of *doubt* + AltQvN is always contradictory.

As for the AltQ complement, we have a similar explanation but with an additional assumption regarding an existential presupposition projected by the complement. Similarly to the PolQvN case above, we assume a two-membered h-value for an AltQ, as follows:

$$(41) \quad \begin{aligned} \llbracket \textit{whether they serve coffee} \uparrow \textit{ or tea} \downarrow \rrbracket^h \\ = \{ \text{they serve coffee, they serve tea} \} \end{aligned}$$

This will then give rise to the following asserted meaning for *doubt*-PolQvN: the attitude holder's doxastic state is compatible with them serving neither coffee nor tea. But, this contradicts the projection of the existential presupposition associated with AltQ, i.e., the presupposition that they serve either coffee or tea projected to the attitude holder's doxastic state.

Note that the analysis utilizes different assumptions about the h-value in the account of the incompatibility with constituent *wh*-complements and in the account of that with PolQvN and AltQ-complements. The former assumes

<sup>26</sup>This view can be made compatible with the compositional recipe for highlighted values in fn. 22 if the sister of the [+wh] complementiser denotes an abstract, among other possibilities.

that the constituent *wh*-complement lacks a highlighted proposition while the latter assumes that the h-value of the PolQvN/AltQ exhausts the logical space (given presupposition). I suggest that this is the key to the account of the cross-linguistic generalization and variation in the selectional restriction.

On the one hand, it is a cross-linguistically general feature of constituent *wh*-complements that they do not mention or highlight any specific answer. This leads to the cross-linguistic fact that dubitative predicates are incompatible with constituent *wh*-complements. On the other hand, there may in principle be language variation in the h-values of answer-mentioning interrogative complements. In particular, it is possible that complements that superficially resemble PolQvN or AltQ in certain languages do not have two-membered h-values which exhaust the (presupposed) logical space. For example, as briefly discussed in §2.2, Mandarin A-not-A questions, as exemplified in (14b) repeated from above, may only contain the positive answer in its h-value.

- (14b) xiaohuang **huaiyi** [ xiaotang shi-bushi xihuan xiaoqiang ].  
 Huang   doubt   Tang   be-NEG.be like   Qiang  
 ‘Huang doubts whether Tang likes Qiang’ (Huang, 2020: 6)

This accords with Hagstrom’s (2006) analysis of the A-not-A question, which essentially treats the negative morpheme as an exponent of the polar question operator. Another piece of evidence against treating A-not-A questions on a par with English PolQvNs is suggested by Huang (2020), who observes that matrix A-not-A questions do not possess the ‘cornering effect’, which is characteristic of English PolQvNs (Biezma and Rawlins, 2012). Although I will not delve into analyses of individual complement types in each language, I suggest that the acceptability of PolQvN/AltQ complements under dubitative predicates in some languages considered in §2.2 is due to a similar reason, i.e., the relevant complement types highlight only a specific answer of the complement.

This line of analysis allows us to meet number 2 and 3 of the desiderata I have posited. Combining the lexical entry of *doubt* together with the English-specific assumptions about the h-values of complement types leads to correct predictions about the selectional restriction. Moreover, the analysis predicts that complementation under a dubitative predicate is possible only if the complement has a non-empty h-value. This entails that, cross-linguistically, a constituent *wh*-complement is not possible under dubitative predicates, as it is a cross-linguistically general feature of this type of complement that they do not highlight a specific answer. At the same time, the analysis leaves open the possibility that languages may vary with respect to which types of answer-mentioning interrogative complement are allowed under a dubitative predicate. Specifically, languages may differ as to whether a complement type possesses a h-value which exhausts the (presupposed) logical space, leading to variation in the possibility of the complement type under a dubitative predicate.



## 4.4 Exhaustification

### 4.4.1 Exhaustification based on ‘scaleless implicature’

So far, I have discussed the baseline analysis of *doubt* based on the idea that the predicate expresses an existential doxastic attitude. The lexical entry is repeated below:

- (36) •  $\llbracket x \text{ doubts } \varphi \rrbracket^o(w)$  presupposes:
- (i)  $\exists Q \in \text{table} : \llbracket \varphi \rrbracket^o \subseteq Q$ ; and
  - (ii)  $\forall p \in \llbracket \varphi \rrbracket^o : \text{DOX}_x^w \cap p \neq \emptyset$
- If the above presuppositions are met,  
 $\llbracket x \text{ doubts } \varphi \rrbracket^o(w) = 1$  iff  $\text{DOX}_x^w \not\subseteq \bigcup \llbracket \varphi \rrbracket^h$

However, there are two significant problems with this entry. One is that the unembedded assertion of  $\ulcorner x \text{ doubts } \varphi \urcorner$  intuitively feels stronger than just the existential statement that  $x$ ’s doxastic state is compatible with not- $\varphi$ . The intuition is rather that the subject considers it *likely* that  $\varphi$  is false, as argued by, e.g., Anand and Hacquard (2013). The other problem is a rather significant one. The entry predicts that the assertion of *doubt-whether* is entailed by its presupposition (specifically the second presupposition). If  $x$ ’s beliefs are compatible with all members of the o-value of *whether*  $p$  (i.e.,  $p$  and not- $p$ ), then it follows that  $x$ ’s beliefs are compatible with not- $p$ .

Both problems are addressed if we replace the assertive component of  $\ulcorner \text{doubt-} \text{that/whether-} p \urcorner$  with a stronger claim, for example, that the attitude holder considers not- $p$  more likely than  $p$ . Not only does this capture the intuition that an unembedded *doubt*-sentence asserts more than just compatibility between the attitude holder’s beliefs and not- $p$ , but it also makes the assertion of *doubt-whether* stronger than its presupposition. Nevertheless, if we simply replace the assertive component in our lexical entry in (36) with the comparative statement, we will lose our account of the verb’s interaction with negation. Clearly, it does not follow from ‘ $x$  doesn’t consider not- $p$  more likely than  $p$ ’ that  $x$  believes  $p$ . Moreover, the negation of the comparative assertion does not contradict the second presupposition in the case of *doubt-whether*, making it impossible to account for the unacceptability of *not-doubt-whether*.

At this point, existing literature on exhaustification provides a crucial insight. What’s relevant in particular is the recent studies on scaleless modal and attitudinal elements due to Deal (2011), Jeretič (2020), Staniszewski (2021), and Mirrazi and Zeijlstra (2021). In these studies, it is argued that certain modal/attitudinal statements (e.g., *ba’iji* in Ecuadorian Siona and negated attitudes in English) are strengthened due to exhaustification, given that there is no stronger scalemate (based on a mechanism proposed by Fox 2007, Bar-Lev and Fox 2020). To illustrate the analysis schematically, let us assume that we have a language in which there is an existential modal  $\Diamond$  but not a scalemate necessity modal. In this language, applying exhaustification to a sentence of

the form ‘ $\Diamond p$ ’ results in a necessity statement. Formally, this is analyzed as follows, with Bar-Lev and Fox’s (2020) exhaustification operator based on both innocent exclusion (IE) and innocent inclusion (II).<sup>27</sup> Following Jeretič (2020), the exhaustification is assumed to trigger subdomain alternatives, i.e., alternatives for the prejacent with subdomains of modal quantification. Here, I write  $\Diamond_C(p)$  as a shorthand for  $\exists w \in C[p(w)]$ , where  $C$  is the modal base of the possibility statement.

$$\begin{aligned}
 (42) \quad & \llbracket \text{EXH}^{\text{IE}+\text{II}} \rrbracket (\{\Diamond_{\{w1\}}p, \Diamond_{\{w2\}}p, \Diamond_{\{w1,w2\}}p\})(\Diamond_{\{w1,w2\}}p) \\
 &= \Diamond_{\{w1\}}p \wedge \Diamond_{\{w2\}}p \wedge \Diamond_{\{w1,w2\}}p \\
 &\Leftrightarrow \Box_{\{w1,w2\}}p
 \end{aligned}$$

This holds because all of the subdomain alternatives are not IE but are II, and hence has to be conjoined to the prejacent as the result of the exhaustification. Crucially, it is necessary that the set of alternatives does not include the stronger scalemate  $\Box_{\{w1,w2\}}p$  in order for this particular strengthening to happen. If  $\Box_{\{w1,w2\}}p$  is present in the set of alternatives, the exhaustification would predict the conjunction of the prejacent and the negation of  $\Box_{\{w1,w2\}}p$ . This is how ‘*may-φ*’ implicates ‘ $\neg$  *must-φ*’ in English. What the literature suggests is that, roughly, in languages where there is no equivalent of *must*, *may* can be strengthened to *must* due to the exhaustification process outlined above.

I suggest that the same process applies in the case of *doubt-that/whether*. That is, the assertion of *doubt-that/whether* predicted by the lexical entry in (36) is equivalent to the possibility statement: there is a world in  $x$ ’s doxastic state in which  $p$  is false. This possibility statement is strengthened by the exhaustification mechanism, due to (a) the presence of the subdomain alternatives corresponding to subsets of the doxastic state and (b) the lack of a stronger scalemate, i.e., an English predicate that expresses the attitude holder’s belief in the negation of the complement.<sup>28</sup> This resolves the two problems identified with our lexical entry for *doubt*. The exhaustification gives rise to an interpretation that is stronger than a simple existential doxastic statement, making the

<sup>27</sup>The relevant exhaustification operator is defined as follows:

- (i)  $\llbracket \text{EXH}^{\text{IE}+\text{II}} \rrbracket (C)(p) := \lambda w. \forall q \in \text{IE}(p, C)[\neg q(w)] \wedge \forall r \in \text{II}(p, C)[r(w)]$ 
  - a.  $\text{IE}(p, C)$   
 $:= \bigcap \{ C' \subseteq C \mid C' \text{ is a max. subset of } C \text{ s.t. } \{\neg q \mid q \in C'\} \cup \{p\} \text{ is consistent} \}$
  - b.  $\text{II}(p, C) :=$   
 $\bigcap \{ C' \subseteq C \mid C' \text{ is a max. subset of } C \text{ s.t. } \{r \mid r \in C'\} \cup \{p\} \cup \{\neg q \mid q \in \text{IE}(p, C)\} \text{ is consistent} \}$

For my purposes, the same results can be obtained by recursive exhaustification in the sense of Fox (2007).

<sup>28</sup>There are at least two putative counterexamples for this claim in English: *disagree* and *disbelieve* (the former suggested by a reviewer for this volume and the latter suggested by D. Özyıldız (p.c.)). For both of these predicates, it is possible that their morphological complexity consisting of the negative prefix *dis* + *agree/agree* make them non-viable candidates for a scalemate of *doubt*, given structural constraints on alternatives (Katzir, 2007). Another possibility specific for *disagree* concerns the difference in argument structure between *doubt* and *disagree*. That is, the argument structure of *disagree* involves a (potentially implicit) comitative argument (*disagree with X*) but *doubt* does not have such an argument, which may lead to their non-scalemate status.

prediction align with our intuitions. Also, with the exhaustification, the assertion is now strictly stronger than the second presupposition in the case of *doubt-whether*.

#### 4.4.2 Pruning

There is, however, one glitch in the analysis so far. If the exhaustification derived a necessity statement that  $x$  believes not- $p$ , it would now contradict the second presupposition, that  $x$  considers  $p$  possible. Fortunately, there is a known solution to the general issue of how to constrain exhaustification when it seems to predict readings that are too strong. In his exhaustification-based account of homogeneity, Bar-Lev (2020) analyzes the non-maximal reading of definite plurals based on the optional pragmatic mechanism of PRUNING of alternatives. That is, the set of alternatives can be reduced to those that are plausible and relevant in the context, giving rise to a weaker exhaustified reading. To see this, suppose that singleton subdomain alternatives are pruned in the exhaustification of a possibility statement. Below, this is exemplified using the modal base including three worlds:  $\{w1, w2, w3\}$  (the alternatives with the strike-through indicates the pruned alternatives):

$$(43) \quad \llbracket \text{EXH}^{\text{IE}+\Pi} \rrbracket (\{ \Diamond_{\{w1\}} p, \Diamond_{\{w2\}} p, \Diamond_{\{w3\}} p, \Diamond_{\{w1, w2\}} p, \Diamond_{\{w2, w3\}} p, \Diamond_{\{w3, w1\}} p, \Diamond_{\{w1, w2, w3\}} p \}) (\Diamond_{\{w1, w2, w3\}} p) \\ = \Diamond_{\{w1, w2\}} p \wedge \Diamond_{\{w2, w3\}} p \wedge \Diamond_{\{w3, w1\}} p \wedge \Diamond_{\{w1, w2, w3\}} p$$

The resulting reading in (43) is stronger than the prejacent, but is weaker than a necessity statement, due to the pruning of the singleton subdomain alternatives. I suggest that such pruning obligatorily happens in the case of  $\ulcorner \text{doubt that/whether } \varphi \urcorner$ , due to the presence of the second presupposition.<sup>29</sup>

#### 4.4.3 Further predictions

The addition of the exhaustification mechanism preserves our account of the interpretation of *not-doubt-that* and the degradedness of *not-doubt-whether*. It furthermore makes a correct prediction about the contrast between positive and negative cases of *doubt*-statements such as the following (suggested to me by F. Staniszewski (p.c.)):<sup>30</sup>

<sup>29</sup>Thus, the semantics of *doubt* (in particular the second presupposition) necessitates at least some amount of pruning. But, can other factors affect how many alternatives are pruned, thus influencing the strength of *doubt*-statements? For this, I follow Bar-Lev (2020) and assume that a pragmatic principle determines the amount of pruning. That is, pruning of alternatives is permitted only if the result of the exhaustification resolves the QUD. In the case of *doubt*, this means that it is possible that further alternatives are pruned (on top of the pruning of alternatives necessitated by the semantics of *doubt*), leading to a weaker statement than would be predicted by just the pruning of singleton alternatives.

<sup>30</sup>An anonymous reviewer to this volume suggested the following example, which is similar to (44a):

- (i) [Context: The game has been played, and the winner has not yet been announced. But given how Mary's team performed, it is obvious that they lost.]

- (44) a. I doubt that Jo's sick, but she might be.  
 b. #I don't doubt that Jo's sick, but she might not be.

The current account correctly predicts this contrast. Even with exhaustification, pruning makes the interpretation of the positive statement  $\lceil I \text{ doubt that } p \rceil$  compatible with the speaker considering  $p$  possible. On the other hand, as argued above, the predicted interpretation of the negative statement  $\lceil I \text{ don't doubt that } p \rceil$  is that the speaker believes  $p$ , given the general assumption that exhaustification only strengthens the overall meaning (Chierchia et al., 2012), and thus  $\text{EXH}^{\text{IE}+\text{II}}$  is not applied in a downward-entailing (DE) context including under negation.<sup>31</sup> Note that contrast is parallel to the contrast in the maximality interpretation of definite plurals between positive and negative environments observed by Bar-Lev (2020). Roughly, in a positive environment, a non-maximal interpretation of a definite plural is possible while, in a negative environment, a maximal interpretation is obligatory. Bar-Lev captures in terms of exhaustification and pruning in positive contexts, definite plurals allow non-maximal interpretations while negative contexts force maximal interpretations.

Furthermore, the exhaustification-based analysis makes correct predictions regarding the natural interpretation of *doubt-that* in the antecedent of conditionals. This is exemplified in the following attested example from a Commercial Drivers License practice test:

- (45) **Question:** If you doubt that you have enough space to safely drive under a bridge or sign, you should ... (**Answer:** drive slowly).  
**Follow-up explanation:** If you are not certain that your vehicle will fit under overhead objects, you should slow down and take a different route, if possible.  
<https://cdl-prep.com/question/if-you-doubt-that-you-have-enough-space-to-safely-drive-under-6340465334943744>

Under the most natural interpretation of this example, *doubt* has an existential reading:  $\Diamond \bar{p}$ , which is also clear from the paraphrase in the follow-up explanation *if you are not certain...*. This is expected under the exhaustification-based analysis since a conditional antecedent is a DE context.

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Mary doesn't (yet) believe that her team lost, but she doubts that they won.

<sup>31</sup>This said, the account does not rule out the possibility that  $\text{EXH}^{\text{IE}+\text{II}}$  is inserted under negation in marked cases. I suggest that this captures marked cases of negated *doubt*-sentences, such as the following (suggested to me by an anonymous NELS reviewer):

- (ii) I don't *doubt* that he runs six minute miles. I don't know him well enough. But I'll believe it when I see it.

Negation of the strengthened reading of *doubt-that/whether* will predict interpretations compatible with this type of data.

## 4.5 Section summary

In this section, I have proposed a lexical entry of *doubt* based on the idea that it asserts the attitude-holder’s existential doxastic attitude towards the negation of the complement (or equivalently: negation of belief of the complement). At this assertive level, *doubt* is sensitive to the h-value of the complement, and thus has the same interpretation with respect to declarative and PolQ complements. On the other hand, at the presuppositional level, *doubt* is sensitive to the o-value of the complement. Thus, the differences in interpretation between *doubt-that* and *doubt-whether* are accounted for on the basis of the presuppositions. I have also discussed how the mechanism of exhaustification derives the intuitive interpretation of ‘*doubt-that/whether*’ in unembedded contexts. Similarly to other scaleless modal/attitudinal elements discussed by Deal (2011), Jeretić (2020), Staniszewski (2021) and Mirrazi and Zeijlstra (2021), the possibility interpretation of *doubt* undergoes strengthening due to the lack of a stronger scalemate. This account captures the fact that the strength of the interpretation of *doubt* is conditioned by the context that embeds it: in an unembedded context, *doubt* receives a strong interpretation, while in DE contexts, such as under negation or in conditional antecedents, it receives a weak, existential, interpretation.

## 5 Conclusions

In this paper, I have argued that the selectional and semantic properties of *doubt*, while being seemingly puzzling at first sight, can be given a proper semantic analysis by integrating the mechanisms of highlighting and exhaustification. This provides further arguments for the utility of these mechanisms in the analysis of attitudes, building on the earlier literature (Pruitt and Roelofsen 2011, Roelofsen 2019 for highlighting; Mirrazi and Zeijlstra 2021 for exhaustification). The present analysis also helps advance the ongoing research programme that aims to give meaning-driven explanations of selectional restrictions for clause-embedding predicates (Uegaki 2015, Mayr 2018, Theiler et al. 2019, Uegaki and Sudo 2019). In particular, the analysis goes beyond existing proposals within the same research programme by extending the empirical coverage to a heretofore unexplained selectional pattern (i.e., compatibility with declarative and answer-mentioning interrogative complements and incompatibility with constituent *wh*-complements) and by taking into account cross-linguistic data in evaluating the exact link between lexical semantics and selectional properties. This said, the current paper leaves much work to be done, especially with respect to the cross-linguistic aspects of the analysis. Specifically, the hypothesized generalization about the selectional restriction of dubitative predicates needs to be evaluated in a more diverse language sample. Furthermore, we need more in-depth analyses of the highlighted value for different complement types in each language, in view of different empirical phenomena that have been argued to be sensitive to highlighting, such as

answer particles, discourse particles and selectional restrictions of emotive factives. Although I have to leave these issues open, I hope to have shown that investigating even a single clause-embedding predicate offers substantial insights into the mechanisms that enter into the selectional and semantic behaviors of clause-embedding predicates and opens up avenues for further theoretical and cross-linguistic investigation of possible links between lexical semantics and selectional restrictions.

## References

- Anand, Pranav and Valentine Hacquard. 2013. Epistemics and attitudes. *Semantics and Pragmatics* 6(8):1–59.
- Bar-Lev, Moshe E. 2020. An Implicature account of Homogeneity and Non-maximality. *Linguistics and Philosophy* .
- Bar-Lev, Moshe E. and Danny Fox. 2020. Free choice, simplification, and Innocent Inclusion. *Natural Language Semantics* 28:175–223.
- Biezma, Maria and Kyle Rawlins. 2012. Responding to alternative and polar questions. *Linguistics and Philosophy* 35(5):361–406.
- Chierchia, Gennaro. 2019. On being trivial: Grammar vs. Logic. Forthcoming in *The Semantic Conception of Logic*.
- Chierchia, Gennaro, Danny Fox, and Benjamin Spector. 2012. Scalar implicature as a grammatical phenomenon. In C. Maienborn, K. von Stechow, and P. Portner, eds., *Semantics: An International Handbook of Natural Language Meaning*, vol. 3, 2297–2332. Berlin: Mouton de Gruyter.
- Ciardelli, Ivano, Jeroen Groenendijk, and Floris Roelofsen. 2018. *Inquisitive Semantics*. Oxford University Press.
- Deal, Amy Rose. 2011. Modals without scales. *Language* 87(3):559–585.
- Del Pinal, Guillermo. 2019. The Logicity of Language: A new take on Triviality, “Ungrammaticality”, and Logical Form. *Noûs* 53(4):785–818.
- Dixon, R. M. W. 2005. *A Semantic Approach to English Grammar*. Oxford: Oxford University Press, 2nd edn.
- Djäv, Kajsa. 2019. *Factive and Assertive Attitude Reports*. Ph.D. thesis, University of Pennsylvania.
- Fagard, Benjamin, Paola Pietrandrea, and Julie Glikman. 2016. Syntactic and semantic aspects of Romance complementizers. In K. Boye and P. Kehayov, eds., *Complementizer Semantics in European Languages*. Berlin, Boston: De Gruyter.

- Farkas, Donka F. and Kim B. Bruce. 2010. On reacting to assertions and polar questions. *Journal of semantics* 27:81–118.
- Farkas, Donka F. and Floris Roelofsen. 2017. Division of labor in the interpretation of declaratives and interrogatives. *Journal of Semantics* 34(2):237–289.
- Farkas, Donka F. and Floris Roelofsen. 2019. Polarity particles revisited. *Semantics and Pragmatics* 12(15).
- Fischer, Markus. 2005. Ein Zweifelsfall: *Zweifeln* im Deutschen. *Linguistische Berichte* 202:127–169.
- Fox, Danny. 2007. Free choice disjunction and the theory of scalar implicatures. In U. Sauerland and P. Stateva, eds., *Presupposition and implicature in compositional semantics*, 71–120. Basingstoke: Palgrave Macmillan.
- Gajewski, Jon. 2002. L-analyticity and natural language. Manuscript, MIT.
- Gajewski, Jon. 2009. L-triviality and grammar. Handout of a talk given in the Logic Colloquium at UConn.
- Ginzburg, J. 1995. Resolving questions, I & II. *Linguistics and Philosophy* 18(5/6):459–527, 567–609.
- Grimshaw, Jane. 1979. Complement selection and the lexicon. *Linguistic inquiry* 10(2):279–326.
- Groenendijk, Jeroen and Martin Stokhof. 1984. *Studies on the Semantics of Questions and the Pragmatics of Answers*. Ph.D. thesis, University of Amsterdam.
- Gunlogson, Christine. 2001. *True to Form: Rising and Falling Declaratives as Questions in English*. Ph.D. thesis, University of California at Santa Cruz.
- Hagstrom, Paul. 2006. A-not-A Questions. In M. Everaert and H. van Riemsdijk, eds., *The Blackwell Companion to Syntax*, 173–213. Malden, MA, USA: Blackwell Publishing.
- Hamblin, Charles L. 1973. Questions in Montague English. *Foundations of Language* 10(1):41–53.
- Huang, C.-T. James. 1991. Modularity and Chinese A-not-A Questions. In *Interdisciplinary Approaches to Language: Essays in Honor of S.-Y. Kuroda*, 305–332. Dordrecht: Kluwer Academic Publishers.
- Huang, Yunchong. 2020. *What Does Huaiyi Mean?: An Investigation into the Semantics of the Dubitative Verb in Mandarin Chinese*. MSc thesis, School of Philosophy, Psychology and Language Sciences, University of Edinburgh.
- Huddleston, Rodney. 1994. The contrast between interrogatives and questions. *Journal of Linguistics* 30(2):411–439.

- Huddleston, Rodney and Geoffrey K Pullum. 2002. *The Cambridge grammar of English*. Cambridge University Press.
- Iyeiri, Yoko. 2009. The historical development of the verb *doubt* and its various patterns of complementation. In U. Römer and R. Schulze, eds., *Studies in Corpus Linguistics*, vol. 35, 153–169. Amsterdam: John Benjamins Publishing Company.
- Jeretič, Paloma. 2020. Modal strengthening in Ecuadorian Siona and the typology of scaleless implicatures. In *Semantics of Under-Represented Languages in the Americas (SULA) 11*, 40.
- Kane, Benjamin, William Gantt, and Aaron Steven White. 2021. Intensional Gaps: relating veridicality, factivity, doxasticity, bouleticity, and neg-raising. In *Proceedings of SALT 31*.
- Karttunen, Lauri. 1977a. Syntax and semantics of questions. *Linguistics and Philosophy* 1:3–44.
- Karttunen, Lauri. 1977b. To doubt whether. In *The CLS Book of Squibs*, 58–59. Chicago, IL: Chicago Linguistic Society.
- Katzir, Roni. 2007. Structurally-defined alternatives. *Linguistics and Philosophy* 30(6):669–690.
- Kratzer, Angelika and Junko Shimoyama. 2002. Indeterminate pronouns: The view from Japanese. In Y. Otsu, ed., *The Third Tokyo Conference on Psycholinguistics*, 1–25.
- Kuno, Susumo. 1973. *The Structure of the Japanese Language*. MIT Press.
- Lahiri, Utpal. 2002. *Questions and answers in embedded contexts*. Oxford University Press.
- Mayr, Clemens. 2018. *Triviality and Interrogative Embedding: Context-Sensitivity, Factivity, and Neg-Raising*. Manuscript, Leibniz-Zentrum Allgemeine Sprachwissenschaft. Available at: <https://semanticsarchive.net/Archive/TA2ZGM3N/embedding.pdf>.
- Mayr, Clemens. 2019. Triviality and interrogative embedding: context sensitivity, factivity, and neg-raising. *Natural Language Semantics* 27(3):227–278.
- McCawley, James D. 1994. Remarks on the syntax of Mandarin yes-no questions. *Journal of East Asian Linguistics* 3(2):179–194.
- Mirrazi, Zahra and Hedde Zeijlstra. 2021. A non-lexical approach to Neg-raising. Paper presented at University of Göttingen.
- Močnik, Maša. 2017. Where Force Matters: Embedding Epistemic Modals under Doxastic Attitudes. In *Proceedings of ESSLLI Student Session 2017*, 173–184.



- Močnik, Maša and Rafael Abramovitz. 2019. Variable-Force Variable-Flavor Attitude Verb in Koryak. In *Proceedings of 22nd Amsterdam Colloquium*.
- Nakau, Minoru. 1973. *Sentential Complementation in Japanese*. Kaitaku-sha.
- Özyıldız, Deniz. 2021. *The Event Structure of Attitudes*. Ph.D. thesis, University of Massachusetts, Amherst.
- Pesetsky, David. 1991. *Zero Syntax Vol. 2*. Unpublished manuscript available at <http://web.mit.edu/linguistics/people/faculty/pesetsky/infin.pdf>.
- Pruitt, Kathryn and Floris Roelofsen. 2011. Disjunctive questions: prosody, syntax, and semantics. Presented at a seminar at the Georg August Universität Göttingen. Available via [projects.illc.uva.nl/inquisitivesemantics](http://projects.illc.uva.nl/inquisitivesemantics).
- Pruitt, Kathryn and Floris Roelofsen. 2013. The interpretation of prosody in disjunctive questions. *Linguistic Inquiry* 44:632–650.
- Rawlins, Kyle. 2008. *(Un)conditionals: an investigation in the syntax and semantics of conditional structures*. Ph.D. thesis, University of California, Santa Cruz.
- Roberts, Craige. 1996. Information structure in discourse. In J. Yoon and A. Kathol, eds., *OSU Working Papers in Linguistics*, vol. 49, 91–136. Ohio State University.
- Roelofsen, Floris. 2019. Surprise for Lauri Karttunen. In C. Condoravdi and T. H. King, eds., *Tokens of Meaning: Papers in Honor of Lauri Karttunen*. CSLI Publications.
- Roelofsen, Floris and Donka F. Farkas. 2015. Polarity particle responses as a window onto the interpretation of questions and assertions. *Language* 91(2):359–414.
- Roelofsen, Floris, Michele Herbstritt, and Maria Aloni. 2019. The \*whether puzzle. In K. von Stechow, M. Zimmermann, and E. Onea, eds., *Questions in Discourse*, 172–197. Brill.
- Roelofsen, Floris and Sam van Gool. 2010. Disjunctive questions, intonation, and highlighting. In M. Aloni, H. Bastiaanse, T. de Jager, and K. Schulz, eds., *Selected Papers from the 17th Amsterdam Colloquium*.
- Rooth, Mats. 1985. *Association with Focus*. Ph.D. thesis, University of Massachusetts, Amherst.
- Rooth, Mats. 1992. A theory of Focus interpretation. *Natural Language Semantics* 1:75–116.
- Schwarz, Bernhard and Alexandra Simonenko. 2018. Factive islands and meaning-driven unacceptability. *Natural Language Semantics* 26(3):253–279.

- Shimoyama, Junko. 2006. Indeterminate phrase quantification in Japanese. *Natural Language Semantics* 14(2):139–173.
- Staniszewski, Frank. 2021. Polarity sensitive weak necessity modals. In *SALT* 31.
- Theiler, Nadine. 2020. *Denn* as a highlighting-sensitive particle. To appear in *Linguistics and Philosophy*.
- Theiler, Nadine, Floris Roelofsen, and Maria Aloni. 2019. Picky predicates: Why *believe* doesn't like interrogative complements, and other puzzles. *Natural Language Semantics* 27(2):95–134.
- Uegaki, Wataru. 2015. *Interpreting questions under attitudes*. Ph.D. thesis, Massachusetts Institute of Technology.
- Uegaki, Wataru and Yasutada Sudo. 2019. The *\*hope-wh* puzzle. *Natural Language Semantics* 27(4):323–356.
- White, Aaron Steven. 2021. On believing and hoping whether. *Semantics and Pragmatics* 21.
- White, Aaron Steven and Kyle Rawlins. 2016. A computational model of S-selection. In *Semantics and linguistic theory*, vol. 26, 641–663.
- White, Aaron Steven and Kyle Rawlins. 2020. Frequency, acceptability, and selection: A case study of clause-embedding. *Glossa: a journal of general linguistics* 5(1):105.
- Yuan, Y. 2014. On the Sense Extension Mechanism and Semantic Construal Strategy of the Chinese Verb *huaiyi*. *Studies in Language and Linguistics* 34(3):1–12.