Question-orientedness and the semantics of clausal complementation

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For my family
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Preface

This book concerns the semantics of clausal complementation, as exemplified in the following pair of English sentences:

(1)  
   a. Alice knows that Peter Sawkins won the 2020 Great British Bake Off.  
   b. Alice knows who won the 2020 Great British Bake Off.

Throughout the book, I will argue for the question-oriented theory of clausal complementation. According to this theory, clause-embedding predicates, such as know in (1), but also wonder and believe, denote a relationship between an individual and a set of propositions, rather than a proposition simpliciter. Following the idea that interrogative complements, such as who won the 2020 Great British Bake Off in (1b), express a set of alternative propositions, the theory straightforwardly accounts for interrogative complementation, as in (1b) above. Declarative complementation, as in (1a), is also treated as a relationship between an individual and a proposition-set. Only, it involves a special case of such a relationship where the complement denotes a singleton set of proposition. The theory is in contrast to the more standard proposition-oriented theory, according to which clause-embedding predicates operate on a single proposition. Unlike in the question-oriented theory, the proposition-oriented theory treats declarative complementation as the basic case while interrogative complementation is analyzed to involve an additional mechanism.

Much of the semantic literature on constructions like (1) assumes the proposition-oriented view, which in turn is built on the tradition in epistemology and philosophy of language that considers attitudinal ascriptions as representing an individual’s relationships to propositions. For this reason, prima facie, the question-oriented theory might appear surprising, and perhaps counterintuitive. Nevertheless, as I will demonstrate in the following chapters, there are empirical and conceptual arguments that favor the question-oriented theory over the proposition-oriented theory. The question-oriented theory provides a unified semantic framework that enables fine-grained semantic analyses of observations about clause-embedding predicates in a number of languages. More specifically, the theory allows precise characterizations of semantic properties of clause-embedding predicates stated in terms of entailment patterns between declarative and interrogative complementation. Moreover, it allows explanations of the selectional restrictions of certain subclasses of clause-embedding predicates (e.g., incompatibility between wonder and declarative complements; incompatibility between hope and interrogative complements). The proposition-oriented theory, on the other hand, turns out to
lack necessary resources to explain these semantic and selectional properties, without further assumptions.

In this preface, I will briefly situate the current work within the historical context of formal semantics, and give a short overview of the content of each chapter.

**Historical context**

Clausal complementation has been a central topic in formal semantics since its earliest days. In fact, one can find *believe-that* sentences in the fragments of English analyzed in the very first incarnations of formal compositional semantics: Lewis (1970) and Montague (1970, 1973). The primary reason for the importance of clausal complementation in the development of semantics is the fact that propositional attitudinal ascriptions provide prime examples of **intensionality**, a core issue in the logical and philosophical analysis of linguistic meaning dating back to Frege (1892). Furthermore, after Hintikka (1962), the possible-world semantics of attitude predicates not only enabled further fruitful investigations into the representation of intensionality in natural language (e.g., Cresswell and von Stechow, 1982, Cresswell, 1985, Stalnaker, 1984), but also provided key insights into subtle but important aspects of attitudinal constructions, such as presupposition projection (e.g., Asher, 1987, Heim, 1992), mood licensing (e.g., Portner, 1997), and NPI-licensing (e.g., von Fintel, 1999). Throughout these developments, it is generally accepted that clause-embedding attitudinal predicates semantically select for propositions, although the model of proposition may be different across theories.¹

In parallel to the development in the analysis of propositional attitudes, the semantic analysis of questions has undergone significant progress throughout the history of formal semantics. Since the early stages, importance of studying questions within semantics has been evident owing to at least two reasons: (a) questions posed an apparent challenge to the semantic framework based on truth conditions, which is designed to deal with statements but not necessarily questions; and (b) understanding the function of questions was thought to provide key insights into the semantic/pragmatic analysis of discourse. One of the earliest and most important contributors in the question semantics is undoubtedly C. L. Hamblin, who wrote the first published version of the so-called **partition semantics** for questions in Hamblin (1958) as well as a separate influential analysis—later known as the **Hamblin semantics**, extending Montague’s (1973) PTQ fragment (Hamblin, 1973). Another pivotal work in the development of question semantics is Karttunen (1977), which enabled a comprehensive compositional treatment of various types of questions with a crucial insight that *wh*-elements are scope-taking operators. The partition semantics originated by (Hamblin, 1958) was further developed by Higginbotham and May (1981) and Groenendijk and Stokhof (1982, 1984). At the same time, another important line of analysis of questions, the **functional analysis** (or the **categorial analysis**) was advanced by Hintikka (1976), Haussser and Zaefferer (1978) and Haussser (1983) among others. The three lines of analysis of question semantics mentioned here—the Hamblin semantics, the partition semantics, and the functional analysis—will be surveyed in Ch. 2. Other early important works

¹Perhaps an important exception is Lewis (1979) who proposed a property-oriented semantics for attitude predicates.
in the semantics of questions, though not necessarily within the tradition of linguistics, include Åqvist (1965), Bromberger (1966), and Belnap and Steel (1976).

The interplay between clausal complementation and questions has been investigated from this initial stage of the development of question semantics. In fact, the early analyses of questions mostly focused on embedded interrogatives (as known as indirect questions), i.e., the interrogative clauses embedded by a clause-embedding predicate like know. This is partly due to methodological reasons. Examining embedded interrogatives allowed semanticists to dissociate the pragmatics of the question speech act from the semantics of interrogative clauses. This is one of the primary reasons why two of the most significant early works on the semantics of questions, i.e. Karttunen (1977) and Groenendijk and Stokhof (1984), focused on embedded interrogatives. There are also other historical reasons why the semantics of embedded interrogatives was a prominent topic around the same period, especially for philosophers. Åqvist (1965) and later Hintikka (1976) developed the imperative-epistemic theory of questions, according to which, roughly, a matrix interrogative of the form "Is it raining?" is analyzed as "Bring it about that I know whether it is raining!" Thus, for them, the analysis of embedded interrogatives is a precursor to the analysis of matrix interrogatives. In addition, as Stanley (2011: Ch. 2) documents, the know-wh construction is discussed among philosophers because of its apparent connections to de re knowledge ascriptions (Quine 1976:863; Kaplan 1989:555; Boër and Lycan 1986).

Thus, in the early stages of formal semantics, there was extensive research on declarative clausal complementation as well as on interrogative clausal complementation. However, there seemed to be less interest in a unified theory that integrates the semantics of declarative and interrogative complementation. That is, few linguists and philosophers in the 60-70’s aimed to construct a unified theory of clausal complementation, in which the proposition-oriented treatment of clause-embedding predicates can be reconciled with their interrogative-embedding behavior. Often, a concrete proposal was made with respect to the proposition-taking denotation of know and its interrogative-embedding behavior. However, there was no extensive examination of the consequences of generalizing the proposal to other clause-embedding predicates. For example, one can find the following footnote in Karttunen (1977):

[...] we should distinguish here between the question embedding verb know\textsubscript{IV/Q} and its that-clause embedding counterpart know\textsubscript{t}. These are distinct lexical items under the proposed analysis and belong to different syntactic categories. To assign proper semantic interpretations to sentences containing know\textsubscript{IV/Q}, we need a meaning postulate that relates their translations [...] in the appropriate way.[...] (Karttunen, 1977: 18, fn. 11)

That is, Karttunen considered a concrete analysis of the relationship between the proposition-taking denotation and the question-taking denotation of know, but he did not discuss the issue of how the analysis can be extended to clause-embedding predicates in general.

One possible reason for this state of affairs is the fact that the semantics of questions by itself contains extremely important and difficult issues. These include topics concerning answerhood, exhaustivity, veridicality, the presupposition of questions, the role of questions in focus interpretation (some of which to be discussed in Ch. 2). Hamblin (1973) and Karttunen (1977) motivated a large body of subsequent literature ad-
dressing these issues, such as Lewis (1982), Groenendijk and Stokhof (1984), Rooth (1985, 1992), Heim (1994), Dayal (1996), and Beck and Rullmann (1999). Studies have focused on these issues surrounding the semantics of interrogative complements and didn’t specifically address the general issue of how declarative and interrogative complementation can be analyzed in a unified manner.

This said, Groenendijk and Stokhof (1984) (G&S) can be taken to be a critical step toward a unified theory of clausal complementation. Under G&S’s semantics, declarative and interrogative complements express the same type of semantic objects. Their intension is a propositional concept while their extension is a proposition.\(^2\) The difference between declarative and interrogative complements lies in whether their extension is world-dependent. An extension of an interrogative clause is a propositional answer of the question that is true in the evaluation world. On the other hand, an extension of a declarative clause is the same proposition regardless of the evaluation world. This setup allows an elegant unified treatment of declarative and interrogative complementation, which can be taken to be a predecessor of the question-oriented semantics to be defended in this book. However, although G&S’s theory is in principle applicable to clause-embedding predicates in general, they do not offer an analysis of an important aspect of the behavior of clause-embedding predicates, such as wonder and believe, i.e., their selectional restrictions. On this issue, they write the following:

> Of course, there are also verbs such as wonder, which take only wh-complements, and verbs such as believe, which take only that-complements. The relevant facts can easily be accounted for by means of syntactic subcategorization or, preferably, in lexical semantics, by means of meaning postulates. (Groenendijk and Stokhof, 1984: 94)

As I will argue in Ch. 1 below, analyses of selectional restrictions that resort to syntactic subcategorization or lexically-specific semantic stipulations, such as meaning postulates or s-selection (Grimshaw, 1979), turn out to be undesirable, as such analyses fail to capture the systematic correlation between lexical semantics and selectional restrictions.

In recent years, a growing body of literature has explored unified theories of clausal complementation that aim to reconcile declarative and interrogative complementation in new ways (e.g., George, 2011, Spector and Egré, 2015, Theiler et al., 2018, 2019, Roberts, 2018). This includes a series of my own work since my PhD thesis (Uegaki, 2015, 2016, Uegaki and Roelofsen, 2018, Uegaki, 2019, Uegaki and Sudo, 2019, Roelofsen and Uegaki, 2020). These studies follow in the footsteps of G&S, but go significantly beyond them in that they make new empirical arguments for their proposal based on in-depth examinations of cross-linguistic evidence and propose explanations for the selectional restrictions of clause-embedding predicates based on their independent lexical semantic properties. The current book is a culmination of my own contribution in this line of research.

At this point, relevance of the current work to the philosophical literature, especially on epistemology and analysis of attitudes, is worth noting. To a large extent, my

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\(^2\)A similar insight can also be found in Lewis (1982) though his treatment is limited to whether-complements.
analysis will stay relatively conservative when it comes to the analysis of knowledge per se. That is, although I will analyze the object-language predicate know as being question-oriented, the metalanguage predicate K representing knowledge remains to be proposition-oriented and will be given a Hintikka-style possible-world semantics. This said, I will also make use of question-oriented metalanguage attitudinal predicates in the analysis of several clause-embedding predicates, including wonder. In this sense, the analysis aligns with Friedman (2013, 2019) in postulating question-directed attitudes that cannot be reduced to multiply-embedded proposition-directed attitudes. The proposal that know is question-oriented might be reminiscent of Schaffer’s (2007) analysis, according to which know is a three-place predicate requiring a subject, a proposition and a question argument. However, the question-oriented semantics to be defended in this book is crucially different from Schaffer’s (2007) analysis in that it analyzes know as requiring a question argument instead of a propositional argument and treats the clausal complement to know itself—whether it is declarative or interrogative—as representing the question argument. Furthermore, the data Schaffer (2007) uses to motivate his view can be accounted for by Groenendijk and Stokhof’s (1984) semantics and a refined representation of contextual restrictions, without resorting to the question argument (Stanley 2011: Ch. 2; Aloni et al. 2013). On the other hand, the data I will use to motivate the question-oriented semantics for know in Ch. 5 cannot be explained away by similar considerations. This said, from a broader perspective, the proposal of this book aligns with Schaffer (2007) in rejecting what Parent (2014) calls the generalized intellectualism championed by Stanley and Williamson (2001), Stanley (2011), according to which ‘knowledge-wh’ is always reduced to ‘knowledge-that’.

Overview of the chapters

Below, I preview the contents of each of the subsequent chapters.

Chapter 1 motivates the overarching project of comparing the proposition-oriented and the question-oriented theory of clausal complementation. This will be done by considering a concrete puzzle for compositional semantics posed by data like (1), repeated below.

(1) a. Alice knows that Peter Sawkins won the 2020 Great British Bake Off.
b. Alice knows who won the 2020 Great British Bake Off.

The examples in (1) show that know can embed a declarative or an interrogative complement. This is puzzling if the semantics of know is constant across the different complementation patterns while a declarative and an interrogative complement denote distinct semantic objects. This puzzle generalizes to all responsive predicates, i.e., those clause-embedding predicates that can embed either a declarative or an interrogative complement. I will outline two lines of solution to this puzzle based on the proposition-oriented and the question-oriented analysis for responsive predicates.

To construct a semantic theory for clausal complementation in general, we have to extend the analyses of responsive predicates to non-responsive predicates, i.e., clause-embedding predicates that are incompatible with either declarative or interrogative complements. To do this, there are two broad approaches that cross-cuts the proposition/question-
oriented divide: one is the uniform approach that applies the proposition/question-oriented semantics uniformly to clause-embedding predicates in general and the other is the eclectic approach, according to which predicates can vary in whether they have a proposition-oriented semantics or a question-oriented semantics. After comparing the relative merits of the uniform approach and the eclectic approach, I will dismiss the latter based on conceptual arguments.

Chapter 2 overviews the theoretical framework employed in the analysis throughout this book, as well as assumptions concerning the semantics of interrogative clauses and interrogative complementation. Based on these theoretical assumptions, I will formalize baseline versions of the proposition-oriented and question-oriented theory, which will be extended in the rest of the chapters in light of fine-grained observations concerning the semantic and selectional properties of clause-embedding predicates.

In Chapter 3, I will move on to rogative predicates, i.e., clause-embedding predicates that only embed interrogative complements, such as wonder and inquire. I will consider concrete analyses of the semantic and selectional properties of these predicates under the question-oriented theory, building on an existing analysis by Ciardelli and Roelofsen (2015). This analysis is compared with a proposition-oriented analysis of rogative predicates stated in terms of semantic decomposition (e.g., wonder as ‘want/wish to know’). Although, at first sight, the proposition-oriented decompositional analysis seems to be as adequate as the question-oriented analysis, close empirical and conceptual examinations reveal that the question-oriented theory is preferable.

Chapter 4 returns to responsive predicates. Both the proposition-oriented and the question-oriented theory can deal with the complementation patterns of responsive predicates (i.e., the fact that they can combine with either declarative or interrogative complements), as I will demonstrate in Chapters 1 and 2. However, given the basic tenets of the two theories, they make distinct predictions about semantic properties that they in principle allow for responsive predicates. These properties can be stated in terms of entailment relationship between a sentence with a declarative complement and a corresponding sentence with an interrogative complement. In Chapter 4, I will focus on one such property, which I will call Q-TO-P entailment. A clause-embedding predicate $V$ is said to be Q-TO-P entailing iff $\langle x \ V s Q \rangle$ (for any subject $x$ and interrogative complement $Q$) entails that there is a propositional answer $p$ to $Q$ such that $\langle x \ V s \ that \ p \rangle$. Crucially, the proposition-oriented theory predicts all responsive predicates to possess this property while the question-oriented theory allows predicates to lack this property. I will identify three classes of responsive predicates/operators from cross-linguistic data that are not Q-to-P entailing: English predicates of relevance (PoRs) (Elliott et al., 2017), Estonian contemplative predicates (Roberts, 2018), and Japanese contemplative particles (Uegaki and Roelofsen, 2018). Presence of these items provide empirical support for the question-oriented theory.

Chapter 5 compares the two theories based on another property of responsive predicates, called reducibility. Roughly, a predicate $V$ is reducible if the interpretation of $V$ with interrogative complements can be paraphrased by Boolean combinations of sentences involving $V$ and declarative complements. The proposition-oriented theory predicts that all responsive predicates are reducible while the question-oriented theory allows for non-reducible predicates. Following the existing literature on reducibility (e.g., George, 2011, Theiler et al., 2018, Uegaki, 2019), I will argue that presu-
sitional responsive predicates such as *know*, *agree*, and *surprise* have non-reducible readings, which can be captured only by the question-oriented theory.

In Chapter 6, I turn to anti-rogative predicates, i.e., clause-embedding predicates that are compatible with declarative complements, but not with interrogative complements (e.g., *believe*, *hope*). At first sight, these predicates might appear more amenable to the proposition-oriented theory than to the question-oriented theory. However, recent literature suggests that several subclasses of anti-rogative predicates can receive attractive analyses under the question-oriented theory. Specifically, these analyses provide semantic explanations for their selectional restrictions, given independent lexical-semantic properties of the predicates. In this chapter, I will outline such question-oriented analyses for two sub-classes of anti-rogative predicates: neg-raising predicates (Theiler et al., 2019) and non-veridical preferential predicates (Uegaki and Sudo, 2019).

Chapter 7 introduces yet another analytical option for the semantics of clausal complementation, which I will call the *predicative view*. According to this view, clausal complements are not semantic arguments of clause-embedding predicates, but rather they act as a predicate that specifies the content of a content-bearing object that fills the internal argument position of the predicates (e.g., Kratzer, 2006, Moulton, 2009). In the first half of the chapter, I will point out that the division between the proposition-oriented theory and the question-oriented theory in fact cross-cuts the division between the predicative view and the traditional, non-predicative, view. Furthermore, it will be shown that the arguments for the question-oriented theory presented in the previous chapters can be reformulated as an argument for the predicative version of the question-oriented theory. In the latter half of the chapter, I will make an argument for the view where at least some clausal complements have to be taken as the internal argument of clause-embedding predicates, based on various data involving the preposition *about* introducing interrogative complements.

Chapter 8 discusses a potential issue regarding the expressive power of the question-oriented theory. Chapters leading up to this demonstrate that the question-oriented theory offers adequate resources to deal with a variety of empirical phenomena that are difficult to analyze under the proposition-oriented theory. However, the situation also causes a concern. Perhaps the question-oriented theory is too powerful, in that it in principle allows cross-linguistically unattested meanings for clause-embedding predicates. In this chapter, I will explore ways to address this concern by considering several concrete cross-linguistic constraints on the semantics of clause-embedding predicates, based on my joint work with Floris Roelofsen (Roelofsen and Uegaki, 2020).

Chapter 9 concludes by summarizing main contributions of the book. In closing, I will discuss several major open issues, with suggestions for research strategies to address these issues.

The book is written so that the reader can follow the chapters in the given order. However, the individual chapters may be read independently as long as the dependency between chapters represented in Figure 1 is taken into account.
Figure 1: Dependency of chapter contents. The arrows indicate that the chapter corresponding to their end point depends on the chapter corresponding to their starting point.

Overlap with existing works

The contents of some of the chapters in this book overlap with those of existing publications written by the author and his collaborators. These overlaps are listed below:

- Chapter 6: Uegaki and Sudo (2019: Sect. 1-3)
- Chapter 7: Uegaki and Sudo (2019: Sect. 5)
- Chapter 8: Roelofsen and Uegaki (2020)

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Bibliography


Chapter 1

**Knowing: the initial puzzle**

1.1 The puzzle of responsive predicates

In the tradition of epistemic logic ([Hintikka, 1962](#)), knowledge is a relationship between an agent and a proposition, i.e., a piece of information that can be true or false in a given situation. The most straightforward semantic analysis of the verb *know* based on this conception of knowledge would be that the verb refers to exactly this individual-proposition relationship. According to this analysis, the subject, the verb, and the declarative complement in a sentence like (1) simply correspond to the knower, the knowledge relationship, and the proposition being known.

(1) Alice knows that the queen is angry.

Let us call this simple compositional semantics for the verb *know* as the **proposition-oriented semantics** for *know*.

Letting $K$ be the knowledge relation in our metalanguage for now, we can formulate the proposition-oriented semantics as follows:¹

$$\text{(2) The proposition-oriented semantics for } know$$

$$[know]^w = \lambda p \lambda x. K_w(x, p)$$

According to this semantics, the translation of *know* takes two arguments, a proposition $p$ and an individual $x$, and "$x$ knows that $p$" has the semantic content represented as $K_w(x, p)$.² The model-theoretic interpretation of $K_w(x, p)$ follows the Hintikkan semantics, as follows, where $\text{Epis}_x^w$ is defined to be the set of worlds compatible with $x$’s knowledge in $w$:

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¹I assume that a linguistic expression is translated into a formula in an intermediate logical language similar to Ty2 ([Gallin, 1975](#)), which then receives a model-theoretic interpretation. Although this is somewhat against the traditional use of the denotation bracket [ ], I use $[\alpha]^w = \chi$ to indicate that the object language expression $\alpha$ is translated into the formula $\chi$. See Ch. 2 on more about background of the machinery I will assume in this book.

²The Quine corner $⌜·⌝$ is used to separate object language strings containing a variable from the metalanguage. To avoid clutter, I use the same variable for the object-language expression and its semantic value in the metalanguage, except I notate object language variables in with an upright font (e.g., $x, p$) and notate metalanguage counterparts in a slanted font (e.g., $x, p$).
(3) \( K_w(x, p) \iff \text{Eps}_x^w \subseteq \{ w \mid p(w) \} \)

This semantics naturally captures the interpretations of know-that sentences, such as (1). We may further assume that \( K_w(x, p) \) presupposes that \( p \) is true in \( w \), capturing the factivity presupposition.

However, the proposition-oriented semantics faces a puzzle when we consider sentences like the following:

(4) Alice \textbf{knows} which girl won the race.

The complement of \textit{know} in (4) is an interrogative clause, in contrast to the declarative clause in (1). What is crucial is the fact that an interrogative clause does not express a proposition, at least under its traditional conception. The semantic content of \textit{which girl won the race} is not a piece of information that can be true or false. Rather, it is a \textit{question} about which girl won the race.\(^3\) I will discuss semantic theories of questions in the next chapter, but regardless of the theory one adopts, questions themselves do not represent propositional information, but they present multiple alternative propositions, each of which can in principle be true or false (Hamblin, 1973, Karttunen, 1977, Krifka, 2011, Dayal, 2016, Ciardelli et al., 2018). This is problematic for the simple semantics in (2). On the one hand, the semantics assumes that the first argument of \textit{know} contributed by the complement is a proposition, corresponding to the object of knowledge. On the other hand, the complement of \textit{know} in (4) contributes a question, a semantic object distinct from a proposition.

This problem is not restricted to the verb \textit{know}, but to a host of clause-embedding predicates that are compatible with both declarative and interrogative complements. Following Lahiri (2002), I will call these predicates \textbf{RESPONSIVE PREDICATES}. Below is a partial list of responsive predicates in English, based on a similar list by Karttunen (1977):

(5) \textbf{List of English responsive predicates}

\begin{itemize}
  \item \textbf{Predicates of retaining knowledge} \hspace{1em} know, be aware, recall, remember, forget
  \item \textbf{Predicates of acquiring knowledge} \hspace{1em} learn, notice, realize, find out, discover
  \item \textbf{Communication predicates} \hspace{1em} tell, report, show, indicate, inform, disclose
  \item \textbf{Decision predicates} \hspace{1em} decide, determine, specify
  \item \textbf{Conjecture predicates} \hspace{1em} guess, predict, bet on, estimate
  \item \textbf{Opinion predicates} \hspace{1em} be certain (about), be convinced (about)
  \item \textbf{Agreement predicates} \hspace{1em} agree (on), concur
  \item \textbf{Relevance predicates} \hspace{1em} matter, be relevant, be important, care, be significant
  \item \textbf{Emotive predicates} \hspace{1em} like, love, hate, be surprised, be annoyed, be happy (about)
\end{itemize}

\(^3\)Following the standard practice in the literature (e.g., Groenendijk and Stokhof, 1984), I use the term ‘INTERROGATIVES’ to refer to syntactic objects having the syntactic properties of interrogative CPs and ‘QUESTIONS’ to refer to semantic objects that have the semantic type of questions, more precisely a set of propositions (see Ch. 2 for more on the semantic type of questions).
1.2. ARGUMENTS AGAINST THE IDIOSYNCRATIC AMBIGUITY THEORY

Each of these predicates presents the same puzzle as outlined above for know. On the one hand, their use with a declarative complement suggests that the predicates denote an individual-proposition relationship. That is, for example, learn denotes the learning relationship between the learner and the learned proposition, predict denotes the prediction relationship between the predictor and the predicted proposition, and so on. On the other hand, such a semantics for the predicates would have difficulty dealing with their use with an interrogative complement, which expresses a question rather than a proposition. How should we reconcile this conflict? Let us call this the PUZZLE OF RESPONSIVE PREDICATES.

Shortly below, I will outline two existing solutions to the puzzle, which the rest of the book will center around. But, before that, let me briefly discuss the possibility that know and other responsive predicates simply exhibit IDIOSYNCRATIC AMBIGUITY.\(^4\) If there are two verbs that happen to be pronounced as know, where one takes a declarative complement and the other takes an interrogative complement, the pair of sentences in (1) and (4) do not present a puzzle. They are simply examples involving different verbs. To my knowledge, there has been no serious attempt to dispel the puzzle along these lines. This said, replying to such a hypothetical attempt enables us to grasp the non-trivial nature of the puzzle.

1.2 Arguments against the idiosyncratic ambiguity theory

The first argument against the idiosyncratic ambiguity theory comes from the intuitive connection between the interpretation of (1) and that of (4). Despite the difference in the types of complements, the interpretations of (1) and (4) intuitively involve the same attitudinal state, i.e., that of knowledge. This is true of sentence-pairs involving other responsive predicates in (5), as follows:

(6) a. Alice learned that the queen was angry.
   b. Alice learned which girl won the race.

(7) a. Alice told me that the queen was angry.
   b. Alice told me which girl won the race.

(8) a. Alice decided that she should go home.
   b. Alice decided whether she should go home.

(9) a. Alice guessed that the queen was angry.
   b. Alice guessed which girl won the race.

(10) a. Alice is certain that the queen is angry.
    b. Alice is certain about which girl won the race.

\(^4\) I contrast IDIOSYNCRATIC AMBIGUITY with SYSTEMATIC AMBIGUITY. The former refers to cases where multiple lexical items are pronounced in the same way, without systematic relationship between their lexical semantics. The latter refers to cases where multiple lexical items have the same pronunciation with systematic lexical semantic relationship (Sennet, 2016). We will consider analyses that treat responsive predicates as involving systematic ambiguity in Sect. 1.3 and 1.4 below.
(11)  a. Alice agrees with me that the queen is angry.
    b. Alice agrees with me on which girl won the race.

(12)  a. It matters to Alice that the queen is angry.
    b. It matters to Alice who won the race.

(13)  a. Alice hated that the queen was angry.
    b. Alice hated which girl won the race.

Each of the above pairs intuitively involves the same kind of attitudinal/communicative state or event, i.e., that of learning, telling, deciding etc. Saying that they simply exhibit ambiguity leaves unexplained the fact that this intuition holds for the class of predicates in (5).

In addition, the class of responsive predicates are fairly constant in their lexical semantics across different languages. For example, the following examples in (14) demonstrate that sitteiru ‘know’, kizuku ‘realize’ and hookoku-suru ‘report’ in Japanese all exhibit the behavior of responsive predicates, i.e., they embed both declarative and interrogative complements:

    John-TOP which girl-NOM won-Q know/realized/reported
    ‘John knows/realized/reported which girl won.’

    John-TOP Mary-NOM won-DECL know/realized/reported
    ‘John knows/realized/reported that Mary girl won.’

The following is the list of responsive predicates in Japanese among the dictionary entries corresponding to the English responsive predicates in (5).\(^5\)

(15)  **List of Japanese responsive predicates**\(^6\)

    **Predicates of retaining knowledge**  si-tteiru (learn-ASP) ‘know’/’be aware’, omoidasu ‘recall’, oboe-teiru (memorize-ASP) ‘remember’, forget ‘wasureru’

    **Predicates of acquiring knowledge**  siru ‘learn’, kizuku ‘notice/realize’, saguri-dasu ‘find out’

\(^5\) The list is constructed by consulting the entries corresponding to the English predicates in (5) on the online English-to-Japanese dictionary **Eijiro on the web** [https://eow.alc.co.jp](https://eow.alc.co.jp), as well as the author’s introspection, to match the correspondence of lexical semantics as faithfully as possible. Among the translations of the English predicates in (5), the following are not responsive:


\(^6\) For items consisting of multiple words, glosses are included in the parentheses. The list of abbreviations used in the gloss are the following:

    (ii) **acc** = accusative case, **asp** = aspectual marker, **cause** = causative marker, **cop** = copula, **lv** = light verb, **nom** = nominative case.
1.2. ARGUMENTS AGAINST THE IDIOSYNCRATIC AMBIGUITY THEORY

Communication predicates  
tutaeru ‘tell’, akirakani-suru (clear-LV) ‘show’, 
simesu ‘indicate’, sir-aseru (know-CAUSE) ‘inform’, abaku ‘reveal’

Decision predicates  

Conjecture predicates  

Opinion predicates  
nitsuite kakushin-o motsu (about conviction-ACC have) ‘be certain/convinced about’

Agreement predicates  
nitsuite doui-suru (about agreement-LV) ‘agree/concur’

Relevance predicates  
nitsuite kansin-ga aru (about interest-NOM be) ‘be relevant’, nitotte zyuyoo-da (for important-COP) ‘be important/significant for (someone)’, kininaru ‘care/matter’

Emotive predicates  
odoroku ‘be surprised’, iratuku ‘be annoyed’, yorokobu ‘be happy/pleased’

The list shows that most of the English responsive predicates in (5) have Japanese counterparts that are also responsive. This fact is quite surprising under the idiosyncratic ambiguity view. It is simply implausible that genetically unrelated languages, such as English and Japanese, share a large class of predicates that exhibit the idiosyncratic ambiguity between the declarative-embedding version and the interrogative-embedding version. The facts at least call for further explanation than just saying that they are ambiguous predicates. Similar data from German, Russian, German Sign Language and French will be discussed in Sect. 1.6.2 below.

Another argument against the idiosyncratic ambiguity view comes from data involving a coordination and gapping, such as the following:

(16) John knows/realized/reported that Ann left and Bill knows/realized/reported which other girls left.

In this example, the first conjunct involves a declarative complement while the latter conjunct involves an interrogative complement. Under the idiosyncratic ambiguity view, the verb in the first conjunct and in the second conjunct have different lexical meanings. It is known that such a configuration does not license gapping or display a zeugmatic effect (Zwicky and Sadock, 1975, Sennet, 2016). This is exemplified in the following sentence:

(17) William ran the Boston Marathon and Brooke ran the New York Marathon. (Sennet, 2016: (42))

The verb ran here is idiosyncratically ambiguous between the interpretation ‘to participate in the race’ and ‘to organize’, but the sentence does not have either one of the following interpretations:

(18) a. ‘William participated in the Boston Marathon and Brooke organized the New York Marathon.’
b. ‘William organized the Boston Marathon and Brooke participated in the New York Marathon.’

In contrast, the gapping in (16) seems to be natural without any zeugmatic effect. This suggests that responsive predicates in (16) do not involve an idiosyncratic ambiguity like that of run in (17).

Now that we have ruled out the possibility that responsive predicates involve idiosyncratic ambiguity, we move on to two approaches to directly tackle the puzzle of responsive predicates. There are two basic approaches to the puzzle. One is to preserve the basic proposition-oriented semantics, and try to account for interrogative complementation by analyzing the semantics of interrogative complements in terms of propositions. The other is to devise a question-oriented semantics building on the data involving interrogative complementation, and try to account for declarative complementation by analyzing the semantics of declarative complements in terms of questions. In Sect. 1.3 and 1.4 below, I will discuss these approaches in detail.

1.3 Proposition-oriented semantics + reduction

The most traditional approach to the semantics of responsive predicates is one that preserves the proposition-oriented semantics. This approach dates back at least to Hintikka (1962) and is also adopted by most of subsequent analyses of question-embedding in the formal semantic literature, such as Karttunen (1977), Heim (1994), Dayal (1996), Beck and Rullmann (1999), Lahiri (2002), and more recently by Spector and Egré (2015) and Cremers (2016). The characteristics of this approach can be summarized as follows:

(19) **Proposition-oriented semantics + reduction**

- Responsive predicates semantically select for propositions.
- The compositional semantics involves a mechanism that reduces the interpretation of an interrogative complement into a proposition.

Existing analyses within this approach differ in the exact formulation of the reduction mechanism. One of the prominent formulations employs an answerhood operator, which maps the question meaning denoted by an interrogative complement to a specific ‘answer’ of the question (Heim, 1994, Dayal, 1996, Beck and Rullmann, 1999, Cremers, 2016). Since I have not introduced any semantic theory of questions, a concrete definition of the answerhood operator cannot be given yet. At this point, let us assume the following informal definition of the answerhood operator Ans, anchored to a specific evaluation world w.

(20) Ans_w := λQ.q, the propositional answer of Q in w

7For similar purposes, Ginzburg (1995) makes use of two coercion operations: one that turns question-type objects into proposition-type objects and one that turns question-type objects into fact-type objects. Although Ginzburg doesn’t make use of the notion of answerhood operators, his analysis can be considered as a subtype of the class of analyses considered here.
This operator takes a question $Q$ (of the question type $q$ to be made more precise in the next chapter) as its input and returns the propositional answer of the question in the evaluation world $w$. In order to evaluate predictions of an analysis based on this operator, we have to make precise what we mean by an ‘answer’ to a question. I will give several versions of the answerhood operator in the next chapter, based on different notions of answerhood discussed in the literature. However, the informal operator in (20) suffices for our purpose here, namely, outlining the difference between proposition-oriented and question-oriented semantics for responsive predicates. Using this operator in (20), we can analyze interrogative-embedding sentences as follows:

\begin{enumerate}
  \item \[ \langle \text{know} \rangle^w = \lambda p \lambda x. K_w(x, p) \]
  \item \[ \langle \text{Alice knows which girl won} \rangle^w \]
    \[ \Leftrightarrow \langle \text{know} \rangle^w(\text{Ans}_w(\langle \text{which girl won} \rangle^w))(a) \]
    \[ \Leftrightarrow K_w(a, \text{Ans}_w(\langle \text{which girl won} \rangle^w)) \]
\end{enumerate}

Under this analysis, the denotation of a responsive predicate, e.g., *know*, takes a proposition as its first argument. The question meaning is turned into a proposition by the $\text{Ans}$-operator, which is then fed to the proposition-taking denotation of the predicate, e.g., the knowledge relation $K$ in the case of *know*. If we assume factivity for *know*, the resulting formula in (21b) presupposes that the propositional answer to $\langle \text{which girl won} \rangle^w$ in $w$ is true in $w$. Assuming further that a propositional answer to any question in $w$ is true in $w$, this presupposition turns out to be trivially met. All in all, (21b) simply states that the knowledge relationship holds between Alice and the propositional answer to $\langle \text{which girl won} \rangle^w$ in the evaluation world.

Another possible compositional implementation of the reduction mechanism would be in terms of a lexical rule that turns a proposition-taking denotation of a responsive predicate to its question-taking counterpart (cf. Spector and Egré, 2015). Following the informal definition of the answerhood operator above, we can define such a lexical rule as follows:

\begin{align}
  f_{\text{Ans}} & := \lambda R_{\langle \text{st,et} \rangle} \lambda Q \lambda x. R(\text{the propositional answer of } Q \text{ in } w)(x) \\
  \lambda Q_q \lambda x. \langle \text{know} \rangle^w(\text{the propositional answer of } Q \text{ in } w)(x)
\end{align}

When this rule applies to $\langle \text{know} \rangle$ defined in (21a), for example, it will yield the following question-taking counterpart:

\begin{align}
  \lambda Q_q \lambda x. \langle \text{know} \rangle^w(\text{the propositional answer of } Q \text{ in } w)(x)
\end{align}

When combined with appropriate arguments, this denotation will derive the same (partial) proposition as in (21b) above. Although an account based on a lexical rule like the one in (22) posits an ambiguity between a proposition-taking denotation and a question-taking denotation of responsive predicates, note that it cannot be considered as an *idiosyncratic* ambiguity theory dismissed in Sect. 1.2. This is so since a lexical rule as in (22) represents a *systematic*, predictable, relationship between a proposition-taking denotation and its question-taking counterpart. In this sense, the account possesses the characteristics of the proposition-oriented approach in (19). The basic denotation of a responsive predicate is a proposition-oriented one, and the lexical rule functions as the reduction mechanism.

Lahiri (2002) proposes yet another compositional implementation of the reduction mechanism, utilizing an LF operation called *interrogative raising*. The operation
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moves an embedded interrogative CP to the left periphery of the matrix clause, leaving a trace of the propositional type, resolving the type-mismatch between the proposition-taking denotation of the embedding responsive predicate and the interrogative complement. The moved CP is further assumed to be interpreted as the restrictor of a matrix quantificational adverb that quantify over propositions.

These different forms of reduction, together with different notions of answerhood (to be reviewed in the next chapter), make distinct empirical predictions regarding the interpretation of embedded questions (see e.g., Spector and Egré 2015, Theiler et al. 2018 for overviews). However, such differences between analyses within the proposition-oriented semantics will be largely irrelevant for the main goals of this book, i.e., the comparison between proposition-oriented and question-oriented theories of attitude predicates. For this reason, throughout this book, when I discuss properties of proposition-oriented semantics, I will assume a formulation utilizing the answerhood operator informally defined in (20) or the associated lexical rule in (22), which will be further refined in the next chapter.

1.4 Question-oriented semantics + trivial questions

The proposition-oriented semantics is not the only available approach to the problem of responsive predicates. Another analytic possibility is to assume that responsive predicates take questions as their first argument, and to analyze declarative complements as having a question-like semantics. I refer to this approach as the QUESTION-ORIENTED SEMANTICS for responsive predicates. From the perspective of the intuitive view that knowledge is modeled as an individual-proposition relationship, stated in the beginning of this chapter, this approach might seem surprising. For, the approach would entail that the verb know does not refer to an individual-proposition relationship, but rather to an individual-question relationship. However, as will be demonstrated in the rest of this chapter, the question-oriented semantics makes sensible predictions for the interpretation of sentences involving know and other responsive predicates. In particular, it offers a solution to the puzzle of responsive predicates that is as empirically adequate as the one offered by the proposition-oriented semantics.

The central tenets of the question-oriented semantics can be summarized as follows:

(24)  Question-oriented semantics + question-like semantics of declaratives

• Responsive predicates semantically select for questions.

• Declarative complements express a semantic object that is of the same type as questions.

Uegaki (2015, 2016) proposes an instance of this approach. According to the analysis, responsive predicates like know take a question as its first argument:

(25)  The question-oriented semantics for know

\[ [\text{know}]^w = \lambda Q x. K_w(x, \text{Ans}_w(Q)) \]

Such a denotation can be directly combined with a question meaning, as follows:
(26) \[ \text{[Alice knows which girl won]} \wedge \]
\[ \Leftrightarrow [\text{[know]} \wedge ([\text{which girl won}])](a) \]
\[ \Leftrightarrow K_w(a, \text{Ans}_w([\text{which girl won}])) \]

The interpretation in (26) is exactly the same as what is predicted in the proposition-oriented semantics in (21b) above.

The question-oriented semantics analyzes declarative complements as denoting a semantic object having the same type as questions. But what kind of questions can declarative complements conceivably express? One theoretical option is to think of them as expressing a trivial question, like the following:

(27) **The question-type object associated with that Mary won:**
the question that has the proposition ‘Mary won’ as its only answer

A quick note about terminology. By the term ‘question’ at this point, I refer to any content that has the same semantic type as the content of an interrogative complement, regardless of the clause type of the syntactic material that expresses it. Thus, under the view outlined in (27), that Mary won expresses a question, albeit a trivial one. This idea will be made more precise once we move to a formal treatment of questions as a set of alternative propositions in the next chapter.

To facilitate illustration, let us tentatively assume an operator Triv that turns a proposition into the corresponding trivial question:

(28) **Triv** := \( \lambda p \text{. } \text{the question that has } p \text{ as its only answer} \)

Just like our definition of Ans above, this is an informal definition given solely for the purposes of the current chapter. A more precise formulation of this operator will be given in the next chapter, once we have a formal theory of questions.

With Triv, we can compositionally derive the interpretation of a declarative-embedding sentence under the question-oriented semantics for know, as follows:

(29) With \( p := \lambda w_s.won_w(m) \)
\[ [\text{Alice knows that Mary won}] \wedge \]
\[ \Leftrightarrow [\text{[know]} \wedge (\text{Triv}(p))](a) \]
\[ \Leftrightarrow K_w(a, \text{Ans}_w(\text{Triv}(p))) \]
\[ \Leftrightarrow K_w(a, p) \]

Note that the end result is equivalent to what we would expect from the proposition-oriented semantics for know. The last step of (29) is guaranteed by the fact that an answer to a trivial question that has \( p \) as its only answer is always \( p \), i.e., \( \text{Ans}_w(\text{Triv}(p)) = p \) for any \( p \) and \( w \).

There are two existing proposals regarding how trivial question interpretations for declarative complements, as in (27), are derived. In Uegaki (2015, 2016), this is done by assuming the traditional propositional interpretations for declarative complements and positing a type-shifter in LF that does the job of Triv. In INQUISITIVE SEMANTICS, on the other hand, the internal composition of both declarative and interrogative clauses is designed to derive a semantic object of the same type (specifically a set of propositions)
as their semantic content (Ciardelli et al., 2013, 2017, Theiler et al., 2018). According to the latter analysis, there is no type-shifter in the LF corresponding to Triv since the trivial question interpretations for declarative clauses are derived as a consequence of the internal composition of the clause.

Thus, a difference between the type-shifting analysis à la Uegaki (2015, 2016) and the Inquisitive Semantics analysis lies in whether a question-type object is assumed to be the basic semantic type of declarative complements. In the type-shift based analysis, a declarative clause by itself expresses a proposition. As such, an extra type-shifting mechanism is needed to convert the proposition into a question-type object. On the other hand, in the Inquisitive Semantics analysis, a declarative complement by itself expresses a question-type object, just like an interrogative complement does. Therefore, there is no need for an extra type-shifting operation.

The difference between the two accounts can be made explicit also in terms of their stand on the semantic distinction between declarative and interrogative complements. The type-shifting analysis maintains the distinction by associating declarative complements with propositions and interrogative complements with questions. On the other hand, the Inquisitive Semantic analysis identifies the semantic types of declarative and interrogative complements. Because of this difference, the two analyses offer distinct analytical possibilities for treating predicates that only embed declarative complements (e.g., believe, hope). I will come back to this point in Sect. 1.6 in the context of a comparison between question-oriented semantics as a general theory for clause-embedding predicates and that as a particular analysis of a sub-class of clause-embedding predicates.

1.5 Initial comparison

The proposition-oriented semantics and the question-oriented semantics sketched in the previous sections both provide a solution to the puzzle of responsive predicates, and make exactly the same predictions about the interpretations of know-that and know-wh sentences. In this section, we will consider two initial arguments for favoring one analysis over the other.

1.5.1 Occam’s razor

At this point, one could make a conceptual argument against the type-shifting version of the question-oriented semantics, based on Occam’s razor. The argument goes as follows. The formulation of the question-oriented semantics in the previous section employs both the Ans-operator and the Triv-operator, the former being a part of the lexical semantics of know (see (25)) and the latter being a syntactically independent
1.5. INITIAL COMPARISON

type-shifter. On the other hand, the proposition-oriented semantics only uses the Ans-operator and does away with the Triv-operator. The difference is clear if we compare the analyses side by side, as follows:

(30)  [[Alice knows that Mary won]] \( w \) ⇔
   a.  \( K_w(a, \lambda w'. \text{won}_w(m)) \)  (proposition-oriented semantics)
   b.  \( K_w(a, \text{Ans}_w(\text{Triv}(\lambda w'. \text{won}_w(m)))) \)  (question-oriented semantics)

(31)  [[Alice knows which girl won]] \( w \) ⇔
   a.  \( K_w(a, \text{Ans}_w(\text{which girl won}_w)) \)  (proposition-oriented semantics)
   b.  \( K_w(a, \text{Ans}_w(\text{which girl won}_w)) \)  (question-oriented semantics)

In the analysis of a know-that sentence, the proposition-oriented semantics does not employ any extra operation, whereas the question-oriented semantics uses Triv as well as Ans, the former turning a proposition into a question-type object and the latter turning that back to a proposition. At the end of the day, given the definition of Ans and Triv, (30a) and (30b) turn out to be equivalent. The analysis of a know-wh sentence, on the other hand, does not differ in terms of the number of extra operations involved. Both employ Ans to turn a question meaning into its answer proposition.

If the interpretations predicted by (30-31) are empirically adequate, the analysis of know-that under the question-oriented semantics in (30b) seems needlessly complicated, compared to the analysis under the proposition-oriented semantics in (30a). If simply positing Ans offers a solution to the puzzle of responsive predicates under the proposition-oriented semantics, why should we consider the question-oriented semantics, which would call for an extra operator in addition to Ans in the analysis of responsive predicates?

This is a reasonable concern. Yet, note that the argument rests on the assumption that the interpretations in (30-31) are indeed empirically adequate. But, are they? Much of the current book is devoted to a series of empirical arguments that demonstrate that the interpretations predicted in (30-31) do not straightforwardly extend to the interpretations of sentences involving responsive predicates in general. In Ch. 5, I will argue that the analysis of know-wh sentences along the lines of (31) is too simplistic. Furthermore, in Ch. 4, I will argue that the analyses outlined in (30-31) cannot capture precise interpretations of sentences containing predicates of relevance, such as care and matter. If it turns out that the analyses in (30-31) are not empirically adequate, the conceptual argument favoring the proposition-oriented analysis is not supported. In fact, in Chapters 4 and 5, I will argue that the correct interpretations of responsive predicates can be captured only under the question-oriented analysis.

1.5.2 Independent arguments for complement uniformity

A separate argument can be made to motivate the question-oriented semantics, in particular, the Inquisitive Semantics analysis. The argument is based on independent grounds for the semantic uniformity of declarative and interrogative complements. If there are independent reasons to treat both declarative and interrogative complements as denoting a question-type object, it is more natural to treat responsive predicates as selecting for a question-type object rather than a proposition.
Proponents of Inquisitive Semantics make several arguments for the semantic uniformity of declarative and interrogative clauses (Ciardelli et al., 2018: Ch. 1). Among them are arguments based on the notions of entailment and logical operations shared between declarative and interrogative clauses. Specifically, they argue that the notion of entailment should be general enough to be applicable not only to a pair of declarative clauses, as in (32), but also to a pair of interrogative clauses, as in (33).

(32)  (Ciardelli et al., 2018: 10)
  a. The number of planets is 8.
  b. The number of planets is even.

(33)  (Ciardelli et al., 2018: 10)
  a. What is the number of planets?
  b. Is the number of planets even?

In order for such a general notion of entailment to be possible, they argue, we have to have an integrated notion of semantic content applicable to both declarative and interrogative clauses.

The argument based on logical operations goes as follows. Logical operations such as conjunction, disjunction and conditionals can apply to declarative clauses, as in (34), as well as to interrogative clauses, as in (35).

(34)  (Ciardelli et al., 2018: 10)
  a. Peter rented a car and Mary booked a hotel.
  b. Peter rented a car or he borrowed one.
  c. If Bill asks Mary out, she will accept.

(35)  (Ciardelli et al., 2018: 11)
  a. Where can we rent a car, and which hotel should we take?
  b. Where can we rent a car, or who might have one that we could borrow?
  c. If Bill asks Mary out, will she accept?

Again, in order to develop a unified semantics of these logical operators applicable to both declarative and interrogative clauses, we would have to have an integrated notion of semantic content for declarative and interrogative clauses.

The theory of Inquisitive Semantics, which is built on the unified analysis of declarative and interrogative meanings as proposition-sets, have a wide range empirical applications, in addition to those discussed above. If the Inquisitive Semantic view on clausal meanings turns out to be correct, the question-oriented semantics for responsive predicates would be a natural choice.

However, the question still remains as to whether there are direct arguments for the question-oriented semantics of responsive predicates. That is, whether behaviors of clause-embedding predicates themselves provide evidence for the question-oriented

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semantics. In this book, I will stay neutral with respect to potential advantages of assuming the semantic uniformity of declarative and interrogative clauses, aside from its consequences for the semantics of clausal complementation. Thus, whatever arguments we might have for the question-oriented semantics of clause-embedding predicates will not presuppose the semantic uniformity of clause types. In this sense, the approach taken in this book is different from that of Ciardelli and Roelofsen (2015) and Ciardelli et al. (2018), who build their question-oriented semantics of clause-embedding predicates based on the central idea that declarative and interrogative complements have a uniform semantics.

To summarize, both of the arguments we have considered in this section in order to tease apart the proposition-oriented semantics and the question-oriented semantics for responsive predicates are inconclusive. To fully investigate the relative advantages of the two approaches, we must (a) determine precise formulations of the theories together with a formally explicit semantic theory of questions and (b) explore their predictions with respect to the wider empirical landscape of the semantics of clausal complementation. These will be the main goals of the rest of the current book. In particular, the next chapter will provide precise formulations of the theoretical approaches and each of the Chapters 3-7 will delve into detailed empirical behaviors of distinct classes of clause-embedding predicates.

Before that, however, it is necessary to introduce an important distinction between possible theoretical approaches which I have not discussed in detail so far, i.e., the distinction between the uniform approach, which adopts a proposition or question-oriented semantics for all clause-embedding predicates; and the eclectic approach, which utilizes proposition-oriented semantics for some predicates and question-oriented semantics for others.

1.6 Uniform vs. eclectic theories

So far, the discussion in this chapter has centered around a particular responsive predicate, i.e., *know*. However, needless to say, full examination of different analytical options should also consider their repercussions for the treatment of the full range of clause-embedding predicates, including responsive predicates other than *know* and non-responsive clause-embedding predicates: ANTI-ROGATIVE PREDICATES (i.e., those that only embed declarative complements) and ROGATIVE PREDICATES (i.e., those that only embed interrogative complements). I will collectively refer to anti-rogative and rogative predicates as PICKY PREDICATES.

At this point, it is useful to make a distinction between what I will refer to as UNIFORM and ECLECTIC theories of clause-embedding predicates. According to the uniform theories, all clause-embedding predicates have the same semantic type and their differences in semantic or selectional properties have to be explained in terms of properties of the predicates other than the types. On the other hand, according to the eclectic theories, different clause-embedding predicates may have different semantic types. Taking
into account this distinction, we can consider the following three (classes of) theories:¹¹

**Uniform proposition-oriented theory:** All clause-embedding predicates have a proposition-oriented semantics.

**Uniform question-oriented theory:** All clause-embedding predicates have a question-oriented semantics.

**Eclectic theories:** Some clause-embedding predicates have a proposition-oriented semantics while the others have a question-oriented semantics. (Note that there are multiple eclectic theories, given multiple options as to which predicates receive a proposition-oriented analysis and which other ones a question-oriented analysis.)

As we will see in the subsequent chapters, my investigation in this book will mostly concern comparison between the two uniform theories described above whereas I will only have limited discussion about eclectic theories. In a nutshell, this is so because, under the assumption that both uniform and eclectic theories can achieve the same empirical coverage, a uniform theory is more explanatory than an eclectic theory. In this section, I will motivate this argument in some detail.

### 1.6.1 Picky predicates: a prima facie problem for the uniform theories

At first glance, the uniform theories seem to face obvious problems with picky predicates. In particular, the uniform proposition-oriented theory seems to have difficulty dealing with rogative predicates, such as *wonder*. Conversely, the uniform question-oriented theory seems to have trouble dealing with anti-rogative predicates, such as *believe*. There are in fact two kinds of problems with these 'picky' predicates: one about their interpretations and the other about their selectional restrictions.

The two problems can be exemplified as follows. Let’s first consider how the uniform proposition-oriented theory would deal with the rogative predicate *wonder*. Under the uniform proposition-oriented theory, the basic denotation of *wonder* has to be a proposition-taking one. However, it is not obvious what such a proposition-taking denotation for *wonder* would look like, given that the predicate doesn’t take a declarative complement to begin with. This is the first problem concerning interpretation. Now, even if we can come up with a suitable proposition-taking denotation for *wonder* that derives correct interpretations for *wonder-wh* sentences, it is still unclear how the analysis can account for the fact that *wonder* is incompatible with declarative complements. After all, if *wonder* has a proposition-taking denotation, a natural expectation is that it embeds a declarative complement. This is the second problem concerning selectional restrictions. Parallel problems arise with the uniform question-oriented theory, but this time with respect to anti-rogative predicates, such as *believe*. First, it is not immediately clear what a question-oriented semantics for an anti-rogative predicate would look like.

¹¹Note that I generally distinguish ‘a theory’ from ‘a semantics’. The former refers to a comprehensive account of the interpretations of clause-embedding predicates in general while the latter refers to a semantic analysis of a particular clause-embedding predicate.
Second, it is not clear why anti-rogative predicates cannot embed interrogative complements, if they have question-oriented semantics.

For eclectic theories, on the other hand, the problems that picky predicates pose are less serious. Specifically, the problem about interpretations will not arise since an eclectic theory can give wonder a question-oriented analysis and believe a proposition-oriented analysis simultaneously. Furthermore, depending on particular compositional assumptions the theory makes with respect to responsive predicates, the selectional restrictions will also be at least partially accounted for. For example, if a theory employs the answerhood operator, but does not commit to any operator in the LF that turns a proposition into a question, the selectional restriction of wonder can be accounted for, once the predicate is given a question-oriented semantics. This is so since, under such a theory, there will be a type mismatch between the question-taking denotation of wonder and the proposition expressed by a declarative complement. The situation is illustrated in the following:

(36) Selectional restriction of wonder under an Ans-based eclectic theory

\[
\begin{align*}
\text{a.} & \quad \langle e, t \rangle \\
\text{know} & \quad \text{CP}^{\text{decl}} \\
\langle s, et \rangle & \quad \langle s, t \rangle \\
\text{Ans} & \quad \text{CP}^{\text{int}} \\
\langle q, st \rangle & \quad q \\
\text{b.} & \quad \langle e, t \rangle \\
\text{wonder} & \quad \text{CP}^{\text{decl}} \\
\langle q, et \rangle & \quad \langle s, t \rangle \\
\text{wonder} & \quad \text{CP}^{\text{int}} \\
\langle q, et \rangle & \quad q
\end{align*}
\]

In (36a), we have the schematic picture of how a theory based on the answerhood operator accounts for the compatibility of responsive predicates like know with both declarative and interrogative complements. In (36b), we see that the eclectic theory considered here predicts interrogative embedding under wonder to naturally occur while declarative embedding under wonder to result in a type mismatch.

Conversely, if a theory employs something along the lines of the Triv-operator, but does not commit to any operator in the LF that turns a question into a proposition, a proposition-oriented semantics of believe will account for its selectional restriction again in terms of type mismatch. This situation can be illustrated as follows:

(37) Selectional restriction of believe under a Triv-based eclectic theory

\[
\begin{align*}
\text{a.} & \quad \langle e, t \rangle \\
\text{know} & \quad \text{CP}^{\text{decl}} \\
\langle q, et \rangle & \quad \langle s, q \rangle \\
\text{Triv} & \quad \text{CP}^{\text{decl}} \\
\langle s, t \rangle & \quad \\
\text{know} & \quad \text{CP}^{\text{int}} \\
\langle q, et \rangle & \quad q
\end{align*}
\]
b. \( (e, t) \) \( \hat{=} \) mismatch!

\[
\begin{array}{c}
\text{believe} \\
\langle st, et \rangle \\
\text{CP}_{decl}
\end{array}
\] 

\[
\begin{array}{c}
\text{believe} \\
\langle st, et \rangle \\
\text{CP}_{int}
\end{array}
\]

It is important to note, though, that the problem of selectional restriction is not fully resolved even in eclectic theories, unless further assumptions are made. Consider an eclectic theory with the answerhood operator again. Such a theory would have difficulty explaining the selectional restriction of \textit{believe} since the presence of the operator should in principle enable \textit{believe} to embed interrogative complements, as in (38) below. A similar problem arises with a theory with the \textit{Triv}-operator with respect to \textit{wonder}, as in (39).

(38) \textit{believe} + \text{CP}_{\text{inq}} \text{ in an Ans-based eclectic theory}

\[
\begin{array}{c}
\text{believe} \\
\langle st, et \rangle \\
\text{Ans} \\
\langle q, st \rangle \\
\text{CP}_{\text{int}} \\
q
\end{array}
\]

(39) \textit{wonder} + \text{CP}_{\text{decl}} \text{ in a Triv-based eclectic theory}

\[
\begin{array}{c}
\text{wonder} \\
\langle q, et \rangle \\
\text{Triv} \\
\langle st, q \rangle \\
\text{CP}_{\text{decl}} \\
\langle s, t \rangle
\end{array}
\]

This remaining issue notwithstanding, the overall picture I have just sketched suggests that eclectic theories offer more promising accounts of picky predicates than the uniform theories. Arguably, this is a central reason why many existing proposals are instances of an eclectic theory. For example, Lahiri (2002) analyzes responsive predicates, such as \textit{know}, as having proposition-oriented semantics while rogative predicates, such as \textit{wonder}, as having question-oriented semantics (cf. also Dayal 2016). Uegaki (2015, 2016) offers another instance of an eclectic theory where anti-rogative predicates have proposition-oriented semantics while responsive and rogative predicates have the question-oriented semantics. Ginzburg (1995) can be considered as a more fine-grained version of eclectic theory, making a type distinction between predicates that select for the proposition-type, the question-type and the fact-type. The variation among these existing eclectic theories is summarized in Table 1.1.

1.6.2 Conceptual challenges for eclectic theories

If eclectic theories are so attractive and in fact standard in the literature, why should one consider uniform theories? The reason for this concerns a conceptual challenge inherent in eclectic theories. Eclectic theories posit a type-theoretic distinction between classes of clause-embedding predicates, and use this distinction to account for the difference in...
selectional restrictions among them. The problem is: an analysis along these lines does not by itself provide an explanation for why certain predicates have the semantic type that they have. In other words, type-based accounts of selectional restrictions within eclectic theories fail to be explanatory since type assignment is essentially a stipulation.

It is in principle possible that this is not a problem but rather a desirable feature of eclectic theories. I myself argued in Uegaki (2015, 2016) that the distinction between anti-rogative and responsive predicates does not correlate with independent lexical semantic properties of predicates, and thus it is appropriate to stipulate it in terms of type-distinction. Nevertheless, the view that takes the arbitrary nature of type assignment as a desirable feature turns out to be too simplistic. Two related arguments can be given against such a view.

**Correlation between lexical semantics and selection**

The first argument comes from empirical observations primarily from English concerning correlations between lexical semantics and selectional restrictions. In the literature, it has been observed that certain lexical semantic properties of predicates (or combinations thereof) at least partially predict their selectional properties. Below are some examples.\(^{13}\)

\[(40) \textbf{Correlations between lexical semantics and selectional restrictions} \]

a. **Veridical** predicates (i.e., ones that imply that their complement is true) describing the subject’s doxastic or epistemic state (e.g., *know, remember*) always select for both declarative and interrogative complements. (Ginzburg, 1995, Sæbø, 2007, Êgré, 2008).

\(^{12}\)On the other hand, Uegaki (2015, 2016) treats the distinction between responsive and rogative predicates as inherently lexical semantic. We will turn to this argument in Ch. 3.

\(^{13}\)Another well-known correlation between the lexical semantics and selectional restriction of clause-embedding predicates concerns emotive factives and their incompatibility with *whether*-complements. This can be stated as follows:

(i) **Veridical** predicates expressing preferences (e.g., *be happy, annoy*) take constituent interrogative complements but not “*whether*-complements (e.g., *It annoys Mary whether Bill left*). (Karttunen, 1977, Abels, 2004, Sæbø, 2007, Romero, 2015, Roelofsen, 2019)

I do not include this in the list in (40) since it does not concern the three-way distinction between anti-rogatives, responsives, and rogatives under discussion here.
b. **Non-veridical** predicates expressing **preferences** (e.g., *want, hope*) never select for interrogative complements (e.g., *Mary hopes who left*). (Uegaki and Sudo, 2019)

c. ‘Neg-raising’ predicates (e.g., *think, believe*) never select for interrogative complements (e.g., *Mary thinks who left*). (Zuber, 1982, Theiler et al., 2019, Mayr, 2019)

d. Among predicates that take interrogative complements, those implying **belief** in the existence of a true answer to the issue expressed by their complement but **ignorance** as to which of the answers is true (e.g., *wonder, investigate*) never take declarative complements. (Ciardelli and Roelofsen, 2015, Uegaki, 2015, 2016)

These correlations suggest that there is a systematic link between the lexical semantics of clause-embedding predicates and their selectional restrictions (although see White 2021 for a more nuanced view). Accounting for the selectional restrictions in terms of unexplained distinction in semantic types fails to capture such a link.

**Cross-linguistic stability in selection**

The previous argument concerns observations within specific languages suggesting correlation between lexical semantics and selectional properties. **Mayr (2018, 2019)** makes another (although related) argument against the type-based explanation, based on cross-linguistic stability in selectional restrictions for clause-embedding predicates with corresponding lexical semantics. This point is already touched on earlier in relation to the non-ambiguity of responsive predicates, but can be extended to non-responsive, picky, predicates as well. **Mayr (2018)** shows that equivalents of *believe* and *know* in German, Russian, German Sign Language and French exhibit the same contrast in selectional patterns as English *believe* and *know*:

(41) **German**

a. Hans weiß / glaubt, dass Maria raucht.
   Hans knows / believes that Maria smokes

b. Hans weiß / *glaubt, ob Maria raucht.
   Hans knows / believes whether Maria smokes

(42) **Russian**

a. Ivan znaet / dumet čto Maša kurit.
   Ivan knows / believes that Maša smokes

b. Ivan znaet / *dumet Maša li kurit.
   Ivan knows / believes Maša whether smokes

(43) **German Sign Language**

a. ix-a **WEISS / GLAUBT IX-b** RAUCHT.
   (s)he knows / believes (s)he smokes

b. ix-a **WEISS / *GLAUBT OB IX-b RAUCHT.**
   (s)he knows / believes whether (s)he smokes
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(44) French

a. Jean sait / croit que Marie fumet.
   Jean knows / believes that Marie smokes

b. Jean sait / *croit si Marie fumet.
   Jean knows / believes whether Marie smokes

To this we can add a similar contrast in Japanese:

(45) Japanese

a. Taro-wa Hanako-ga tabako-o suu-to shitteiru / shinjiteiru.
   Taro-TOP Hanako-NOM cigarette-ACC smoke-C_{decl} know / believe

b. Taro-wa Hanako-ga tabako-o suu-ka shitteiru / *shinjiteiru.
   Taro-TOP Hanako-NOM cigarette-ACC smoke-C_{int} know / believe

Needless to say, the small collection of data given here by itself doesn’t tell us much. We need more systematic cross-linguistic empirical work to evaluate the extent to which the meaning-selection correlations as listed in the previous section hold across typologically diverse selection of languages. This said, the apparent cross-linguistic stability of selectional restrictions calls for a theory that links lexical semantics and selection. It is not straightforward how such links can be established under the view where selection is rooted in arbitrary type assignment.

1.6.3 **Explaining the selectional restrictions within the uniform theories**

Above, we have seen that eclectic theories face a conceptual challenge, i.e., they cannot give an explanatory account of the link between lexical semantics and selectional restrictions. However, such explanatory inadequacy alone should not be considered as a reason to prefer the uniform theories to the eclectic theories if the latter can account for the wider range of empirical facts than the former. After all, in Section 1.6.1, we have seen that the eclectic theories can at least partially account for the interpretations and selectional restrictions of picky predicates while the uniform theories have troubles accounting for them.

Nevertheless, in recent years, there have been a number of proposals that employ uniform theories to account for the interpretations and selectional restrictions of picky predicates. For example, within Inquisitive Semantics—a uniform question-oriented theory—Ciardelli and Roelofsen (2015) propose an analysis of *wonder* that accounts for both its interpretation and selectional restriction. Theiler et al. (2019) and Mayr (2019) have independently proposed analyses of neg-raising anti-rogative predicates (e.g., *believe, think*) that account for their incompatibility with interrogative complements making use of uniform question-oriented theories. This line of analysis is extended by Uegaki and Sudo (2019) to cover the selectional restriction of non-veridical preferential predicates like *hope*.

I will discuss these proposals in some detail in Ch. 3 (for rogative predicates like *wonder*) and in Ch. 6 (for anti-rogative predicates), but the general structure of the analyses goes as follows. As the analyses are set in a uniform theory, declarative and interrogative clauses have the same semantic type and all clause-embedding predicates
can in principle be semantically combined with either clause type. However, combinations of certain lexical-semantic properties that an embedding predicate may possess and semantic properties characteristic of a specific clause type lead to systematic logical triviality (either contradiction or tautology). Systematic logical triviality is independently argued to give rise to unacceptability (Gajewski 2002, Chierchia 2013, Del Pinal 2019; cf. Schwarz and Simonenko 2018). Thus, an analysis along these lines explain why predicates having certain lexical semantic properties are incompatible with a complement of a specific type.

The details of how logical triviality is derived in each analysis will be discussed in later chapters. What is important for our purposes here is that these analyses are designed to explain the kind of correlations between lexical semantics and selectional restrictions exemplified in (40). For example, Theiler et al. (2019) and Mayr (2019) explain the link in (40c), suggesting that neg-raising predicates are incompatible with interrogative complements because the semantic property underlying the neg-raising behavior gives rise to a logically trivial meaning when it is taken together with the non-informative nature of interrogative complements.

Such meaning-driven analyses of picky predicates within the uniform theories have not achieved the full empirical coverage. For example, there are anti-rogative predicates which do not fall in the classes that have been treated by Theiler et al. (2019), Mayr (2019) or Uegaki and Sudo (2019). Nevertheless, the success of the meaning-driven analyses targeting subclasses of picky predicates suggests that picky predicates are not unsurmountable challenges for the uniform theories, despite their initial appearances. Furthermore, if a meaning-driven analysis of picky predicates within a uniform theory is successful, it can provide a more explanatory account than a type-based analysis can. Specifically, a meaning-driven analysis will enable us to answer why the meaning-selection correlations in (40) hold (and why they are cross-linguistically stable) whereas a type-based analysis within eclectic theories won’t, at least in a straightforward fashion.

All in all, if a uniform theory of clause-embedding predicates is empirically possible at all, it ought to be preferred over an eclectic theory, due to the conceptual challenges associated with the arbitrary nature of type assignment. And, as we have just seen, there is a promising prospect for a uniform theory is indeed empirically possible; uniform theories can at least partially deal with picky predicates—the classes of predicates that seemed to be prima facie problematic for the theories. For this reason, my strategy in this book is to focus on the two uniform theories and explore the extent to which they can achieve an overall account of the semantics of clause-embedding predicates in general. Although I will ultimately have to leave some questions open, investigating the limits of the uniform theories will prove to be highly informative as we try to approach a comprehensive semantic theory of clause-embedding predicates.

1.7 Chapter summary

In this chapter, I have introduced the puzzle of responsive predicates, i.e., how predicates such as know can embed both declarative and interrogative complements, given that the two types of complements appear to express different types of semantic objects: propositions and questions. Two general approaches to the problem are outlined:
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proposition-oriented semantics + reduction and question-oriented semantics + trivial questions.

The comparison between these two analyses for responsive predicates is contextualized within two types of semantic theories of clause-embedding predicates in general: uniform theories, which treat all clause-embedding predicates as selecting for the same type of semantic object (as their clausal argument) and eclectic theories, which treat different classes of clause-embedding predicates as selecting for different types. Importantly, eclectic theories do not provide explanations for why certain predicates have the semantic type they do. This conceptual challenge with eclectic theories leads us to explore the limits of the uniform theories, which are, in the context of this book, the uniform proposition-oriented theory and the uniform question-oriented theory.
Bibliography


Chapter 2

Theoretical framework and the baseline analysis of interrogative complements

2.1 Introduction

The previous chapter has introduced the primary goal of this book, i.e., comparing the proposition-oriented and question-oriented semantics for clausal complementation. In this section, I will discuss several background assumptions concerning the semantic framework as well as the ‘baseline’ analysis of interrogative complementation. Based on these background notions, I will provide formal implementations of the proposition-oriented and the question-oriented theory that are compatible with the baseline analysis. The baseline analysis is so-called because, in the rest of the book, I will be revising it under both theories, in view of further data involving a number of embedding predicates. In other words, this chapter will offer the starting point for both the proposition-oriented and the question-oriented theory, whose empirical and theoretical validity will be explored throughout the book.

The rest of this chapter is structured as follows. In Sect. 2.2, I will introduce the foundational theoretical framework I will adopt throughout this book, including basic assumptions about the semantic metalanguage, formal composition, variable binding, and presuppositions. In Sect. 2.3, I will introduce three possible semantic representations for questions: functions, proposition-sets, and partitions, and will motivate my own choice of utilizing proposition-sets as the representation of questions in the rest of the book. In Sect. 2.4, I will move on to the notion of answerhood, which we have to examine to formalize the semantics of interrogative complementation. In particular, I will investigate issues of exhaustivity, the uniqueness/existential presupposition of interrogative complements, and veridicality. Assumptions concerning these issues will be consolidated into a single baseline schema for the interpretation of interrogative complementation at the end of the section. Based on these theoretical backdrops, in Sect. 2.5,
I will formalize both the proposition-oriented theory and the question-oriented theory of clausal complementation, which were introduced in informal terms in Ch. 1. Sect. 2.6 presents a concrete internal compositional analysis of interrogative clauses that is compatible with the assumptions laid out in this chapter.

## 2.2 The semantic framework

### 2.2.1 The semantic metalanguage and model-theoretic interpretation

As the foundational theoretical framework, I will follow Heim and Kratzer (1998) and other current formal semantic literature based on the minimalist grammars in assuming that semantics operates on the syntactic level of Logi\(c\)al Form (LF). An LF is a syntactic representation of a sentence derived in syntax, independently of semantics.

Semantics maps LFs to their interpretations. I assume that semantics first translates an LF into an expression in the semantic metalanguage. The metalanguage translation of an LF unambiguously represents its model-theoretic interpretation. As the metalanguage, I use a formal language similar to Ty2 (a higher-order type-theoretic language with two sorts of individual types, i.e., \(e\) and \(s\) and the \(\lambda\)-abstraction; Gallin 1975) sometimes mixed with set-theoretic notations. A metalanguage sentence receives a model-theoretic interpretation in a model consisting of the set of individuals \(D\), the set of worlds \(W\) and the interpretation function \(I\) that maps constants in the metalanguage to their model-theoretic interpretations. We also use \(\text{types}\) to categorize metalanguage formulae and their denotations. Here is the inventory of types and their domains:

1. **Semantic types**
   a. \(e, t\) and \(s\) are semantic types.
   b. If \(\sigma\) and \(\tau\) are semantic types, then \(\langle \sigma, \tau \rangle\) is a semantic type.
   c. Nothing else is a semantic type.

2. **Semantic denotation domains**
   a. \(D_e := D\)
   b. \(D_t := \{1, 0\}\)
   c. \(D_s := W\)
   d. For any semantic types \(\sigma\) and \(\tau\), \(D_{\langle \sigma, \tau \rangle}\) is the set of all functions from \(D_\sigma\) to \(D_\tau\).

Despite the two-step process of the semantic interpretation, in the actual discussion of the analysis of linguistic phenomena, I will sometimes only discuss how linguistic expressions can be translated to metalanguage formulae, assuming that the interpretations of the metalanguage formulae are transparent. Also, I will be rather sloppy in terminology/notation and write the metalanguage translation for an object language expression \(\alpha\) at a given world \(w\) as \(\llbracket \alpha \rrbracket^w\) and call it the denotation or extension of \(\alpha\) in \(w\). Similarly, I write the function that maps a world \(w\) to \(\alpha\)’s denotation at \(w\) as \(\llbracket \alpha \rrbracket\) (without the \(w\) superscript), and call it the intension of \(\alpha\).
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2.2.2 Type-driven compositional interpretation

Given a hierarchical structure of an LF, semantics recursively interprets the structure in a compositional fashion, using lexical entries that provide the translations for atomic expressions, or the 'leaves' of the tree, and a limited set of composition rules that determine how the translation of a non-terminal node is derived from the translations of its daughters. Specific examples of compositional rules will be introduced later.

I employ an extensional semantic system, where each lexical item is assigned the extensional semantic value, i.e., what it denotes in a given possible world. Thus, lexical entries determine the denotations of lexical items in the following ways:

\[(3)\]

- a. \([\text{Haruo}]^w = h\)
- b. \([\text{babbles}]^w = \lambda x_e . \text{babble}_w(x)\)

The lexical entry in (3a) determines that the translation of the proper name Haruo in \(w\) is \(h\), the metalanguage expression denoting the individual Haruo. On the other hand, (3b) determines that the verb babbles is translated into a function that maps any individual-denoting term \(x\) to the metalanguage sentence \(\text{babble}_w(x)\). The subscript \(e\) to the variable \(x\) in (3b) represents the type of the domain which the variable can range over.

Compositional rules include the following two versions of functional application.

\[(4)\]

- a. Functional Application (FA)
  For all \(w \in W\), if the node \(\alpha\) has \(\{\beta, \gamma\}\) as the set of its daughters and \([\beta]^w \in D_s\) and \([\gamma]^w \in D_{(\pi, \tau)}\), then \([\alpha]^w = [\gamma]^w([\beta]^w)\)

- b. Intensional Functional Application (IFA)
  For all \(w \in W\), if the node \(\alpha\) has \(\{\beta, \gamma\}\) as the set of its daughters and \([\beta]^w \in D_s\) and \([\gamma]^w \in D_{(\pi, \tau)}\), then \([\alpha]^w = [\gamma]^w(\lambda w'. [\beta]^w)\)

Using Functional Application (FA) defined in (4a), we can derive the truth conditions of the LF in (5) as in (6):

\[(5)\]

\[
\begin{array}{c}
\text{Haruo} \quad e \\
\text{babbles} \quad \langle e, t \rangle
\end{array}
\]

\[(6)\]

\([5]^w \iff \text{babble}_w(h)\)

Note that syntactic labels for nodes in an LF structure are not necessary for a semantic interpretation. So, I will write syntactic category labels in LFs only when the labels help an illustration. Otherwise, I will either write in the semantic types of the nodes, as in (5), or simply write in the place-holder ‘·’.

The Intensional Functional Application (IFA) is used to combine an intensional predicate with its complement. For example, the following LF structure is interpreted using the IFA to combine thinks and its complement Haruo babbles.

\[1\]I set aside the contribution of tense in this book.
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(7) \[ Juri: e \langle e, t \rangle \text{thinks:} \langle st, et \rangle t \]
Haruo: \[ e \text{ babbles:} \langle e, t \rangle \]

Assuming the denotation of \textit{think} in (8), \textit{think} and its complement \textit{Haruo babbles} are composed by IFA, yielding the interpretation in (9).

(8) \[ \llbracket \text{thinks} \rrbracket^w = \lambda p_{(x,t)} \lambda x.e. \text{think}_w(x, p) \]
(9) \[ \llbracket \text{think Haruo babbles} \rrbracket^w = \lambda x_e. \text{think}_w(x, \lambda w'. \llbracket \text{Haruo babbles} \rrbracket^{w'}) = \lambda x_e. \text{think}_w(x, \lambda w'. \text{babble}_w'(h)) \]

This function is further combined with the interpretation of the subject \textit{Juri} via FA, and thus the following truth conditions for the whole LF are derived.

(10) \[ \llbracket (7) \rrbracket^w \leftrightarrow \text{think}_w(j, \lambda w'. \text{babble}_w'(h)) \]

2.2.3 Interpretation of variables and predicate abstraction

I will assume that pronouns and traces carry indices at LF, and are interpreted with respect to an assignment function, which is a function from natural numbers to members of \( D \). An assignment function serves as another parameter of interpretation along with the evaluation world. For example, the interpretation of \textit{she} with respect to the assignment function \( g \) (and world \( w \)) would be the following, for any natural number \( i \):

(11) \[ \llbracket \text{she}_i \rrbracket^w.g = g(i) \]

When the pronoun is \textit{free}, i.e., it is not co-indexed with a c-commanding operator in the syntax, pronouns like (11) pick up its referent according to the contextually available assignment function. On the other hand, when the pronouns is \textit{bound}, i.e. it is co-indexed with a c-commanding operator in the syntax, as in (12), it is assumed that a \textit{binder index} is introduced immediately below the binding operator, as shown in the LF in (13).

(12) Every girl\textsubscript{7} wrote to her\textsubscript{7} mother.

\footnote{I disregard the \( \phi \)-features (i.e., the gender and number features) of pronouns here.}
Following Heim and Kratzer (1998), I assume that a binder index is created at LF by a phrasal movement, and that the movement leaves a type e trace co-indexed with the binder index. In the case of (13), the movement of the quantifier every girl leaves a trace indexed as 7, and also creates the binder index 7 immediately below its landing site.

The branching node containing a binder index is interpreted according to the rule of Predicate Abstraction, defined as follows:

(14) Predicate Abstraction (PA)

For all $w \in W$ and assignment functions $g \in D^N$, if the node $\alpha$ has a binder index $i$ and $\beta$ as its daughters, then $\langle \alpha \rangle_w^g = \lambda x. \langle \beta \rangle_w^g [x/i]$

This rule effectively creates a $\lambda$-abstract where the pronouns co-indexed with the binder index are ‘replaced’ with the variable bound by the $\lambda$-operator. Traces have the same semantics as pronouns, i.e., they receive interpretations with respect to the assignment function. With this setup, the denotation of the sister constituent of every girl in (13) will be the following predicate:

(15) $\langle 7 \ [t_7 \ \text{wrote to} \ \text{her}_7 \ \text{mother}\rangle \rangle^w_g = \lambda x. \langle t_7 \ \text{wrote to} \ \text{her}_7 \ \text{mother}\rangle^w_g [x/7]$

$= \lambda x. \text{wroteTo}_w(x, \text{motherOf}_w(x))$

Given the denotation of every girl as in (16), we can derive the truth conditions in (17), which involve the bound interpretation of the pronoun.

(16) $\langle \text{every girl}\rangle^w = \lambda P.(e,t). \forall x[ \text{girl}_w(x) \rightarrow P(x)]$

(17) $\langle (13) \rangle^w \iff \forall x[ \text{girl}_w(x) \rightarrow \text{wroteTo}_w(x, \text{motherOf}_w(x))]$

### 2.2.4 Presuppositions

Some expressions are presuppositional, i.e., their interpretations are defined only if certain conditions are met. For example, under the Frege-Strawson analysis, a definite description refers to the unique entity satisfying the description if there is a unique entity
that satisfies the description; otherwise the definite description is extensionless. That is, the definite description the king of France has the following interpretation.

(18) \[ \text{the king of France}^w = \begin{cases} \lambda x[\text{king}_w(x, \text{France})] & \text{if } \exists! x[\text{king}_w(x, \text{France})] \\ \text{undefined} & \text{otherwise} \end{cases} \]

To derive the presuppositionality of definite descriptions, the definite determiner is treated as denoting a PARTIAL FUNCTION of the following form:

(19) \[ \text{the}^w = \lambda P(x). \begin{cases} \lambda x[P(x)] & \text{if } \exists! x[P(x)] \\ \text{undefined} & \text{otherwise} \end{cases} \]

I will sometimes use an alternative notation for partial functions as follows following Heim and Kratzer (1998).

(20) \[ \text{the}^w = \lambda P(x). \begin{cases} \lambda x[P(x)] & \text{if } \exists! x[P(x)] \\ \text{undefined} & \text{otherwise} \end{cases} \]

In the latter notation, \( \lambda \alpha : \pi(\alpha). \varphi \) refers to a partial function which returns a defined value only if \( \pi(\alpha) \) holds of the input argument \( \alpha \).

Having introduced presuppositions, we need to specify how presuppositions are inherited in each compositional rule. FA is revised below so that the semantic value of the branching node is defined only if the semantic values of both of the daughter nodes are defined (Heim and Kratzer, 1998: 49). (The added condition is underlined.)

(21) \textbf{Functional Application (FA; revised)}

For all \( w \in W \) and assignment functions \( g \in D^N \), if the node \( \alpha \) has \( \{ \beta, \gamma \} \) as the set of its daughters and \( \beta^w.g \in D_\sigma \) and \( \gamma^w.g \in D_{(\sigma, \tau)} \), \( \alpha^w.g \) is defined if both \( \beta^w.g \) and \( \gamma^w.g \) are. In this case, \( \alpha^w.g = \gamma^w.g(\beta^w.g) \)

PA, on the other hand, is revised so that the result is a partial function, as shown in the following (Heim and Kratzer, 1998: 106):

(22) \textbf{Predicate Abstraction (PA; revised)}

For all \( w \in W \) and assignment functions \( g \in D^N \), if the node \( \alpha \) has a binder index \( i \) and \( \beta \) as its daughters, then

\[ \alpha^w.g = \lambda x. \begin{cases} \beta^w.g[x/i] & \text{if } \beta^w.g[x/i] \text{ is defined} \\ \text{undefined} & \text{otherwise} \end{cases} \]

In order to redefine IFA, we need a notion of intensions of sentences that may have presuppositions. An intension of a sentence \( \varphi \) under an assignment function \( g \), \( \varphi^g \) can be defined as follows in a way parallel to the revised definition of PA above.

(23) \textbf{Intension}

For all assignment functions \( g \in D^N \),

\[ \varphi^g := \lambda w^g. \begin{cases} \varphi^w.g & \text{if } \varphi^w.g \text{ is defined} \\ \text{undefined} & \text{otherwise} \end{cases} \]

IFA is revised as follows using this revised notion of intensions:

(24) \textbf{Intensional Functional Application (IFA; revised)}

For all \( w \in W \) and assignment functions \( g \in D^N \), if the node \( \alpha \) has \( \{ \beta, \gamma \} \) as the set of its daughters, \( \alpha^w.g \) is defined if both \( \beta^g \) and \( \gamma^g \) are and \( \beta^w.g \in D_\sigma \) and \( \gamma^w.g \in D_{(\sigma, \tau)} \). In this case, \( \alpha^w.g = \gamma^w.g(\beta^g) \)
I call a sentence $\varphi$ a presupposition failure in $w$ if $[\varphi]^w$ is undefined.

### 2.3 The semantic theory of questions

In this section, I will outline the semantics of interrogative clauses based on which I will investigate the semantics of clause-embedding predicates throughout this book. Specifically, I will present the view that question meanings are represented as sets of propositions. In addition to the proposition-set representation, this section also deals with two other possible semantic representations for questions, i.e., functional representation and partition representation. I will compare the proposition-set representation with these two other representations based on empirical and methodological considerations, and argue that the proposition-set representation is the most suitable for the purposes of this book.

#### 2.3.1 Three representations for question meanings

As Krifka (2011) notes, there are three prominent model-theoretic analyses of questions, corresponding to the following three kinds of representations: the functional representation, the proposition-set representation, and the partition representation. These three representations are illustrated with the example *Who sang?* in the following:

(25) **Who sang?**

a. **Functional representation:**
   \[ \lambda x. \lambda w. s \ (w (x)) \]

b. **Proposition-set representation:**
   \[ \lambda p. \exists x [ p = \lambda w. s \ (w (x))] \]

c. **Partition representation:**
   \[ \lambda w. \lambda x. [ \lambda x. s (w (x)) = \lambda x. s (w (x))] \]

Below, I will illustrate how these semantic objects intuitively represent question meanings.

The functional representation  The basic intuition behind the functional representation is that questions represent a proposition with a ‘missing piece’, where the missing piece corresponds to the $wh$-phrase in the case of a $wh$-question. If this missing piece is ‘filled’ one way or the other, the sentence becomes an answer to the question. As such, the functional representation of *who sang* is such a function that takes any individual into the corresponding ‘answer’ proposition which states that the individual sang. I include in this category the representation of questions as ‘open sentences’, i.e., sentences with a free variable in the place of the $wh$-phrase(s) since the functional representation and open sentences are in one-to-one correspondence: An open sentence can be mapped to the corresponding functional representation by a $\lambda$-abstraction of the free variables while a functional representation can be mapped to the corresponding open sentence by applying the function to an arbitrary free variable. Within the modern
semantics, the open sentence/function approach is advocated by Hausser and Zaefferer (1978), Hausser (1983), Hintikka (1976), Berman (1991) and more recently by Jacobson (2016) and Xiang (2020).

In the functional approach, the propositional answers are something that are derived by applying the functional representation to members of its domain. The members of the domain of the functional representation correspond to TERM ANSWERS, such as the answer Ann in response to Who sang?. In other words, the approach takes term answers as the basic form of answers, and propositional answers are derived by applying the functional question denotation to the term answers.

The proposition-set representation The proposition-set approach follows the idea that the semantic value of a question represents the set of their possible answers. Thus, in the case of who sang, the proposition-set representation is the set of propositions of the form x sang, where x is any individual. Thus, if Ann and Bill are the only individuals, the proposition-set representation of Who sang? would look like {'Ann sang', ‘Bill sang’}.

This kind of representation is most famously defended by Hamblin (1973) and Karttunen (1977) although they differ in the internal composition of interrogative clauses. The proposition-set representation is assumed in a number of prominent semantic studies of embedded-questions including Dayal (1996), Beck and Rullmann (1999), Lahiri (2002), George (2011), and Spector and Egré (2015). Another version of the approach has been advocated as INQUISITIVE SEMANTICS by Ciardelli et al. (2013, 2018), where one of the primary refinements being the downward-closure of proposition sets.

The partition representation Finally, the partition representation follows the idea (dating back to Hamblin 1958) that questions partition the whole logical space into mutually exclusive possibilities. The function in (25c) maps worlds to particular ‘cells’ (of type ⟨s, t⟩) in the partition, each of which completely determines who sang and who didn’t sing. Equivalently, (25c) is an equivalence relation that relates two worlds if and only if the set of individuals who sang in the two worlds are the same. Thus, given an arbitrary world, (25c) returns the ‘strongly exhaustive’ answer of the question in that world, e.g., Alice sang and no one else did (see Sect. 2.4 below for an overview on exhaustivity). The difference between the proposition-set representation and the partition representation is depicted in Figure 2.1. The partition approach is put forth by Hamblin (1958) and developed in a greater detail by Higginbotham and May (1981) and Groenendijk and Stokhof (1982, 1984).

3In Sect. 2.4, I will refine the treatment and include the proposition ‘Ann and Bill sang’ to this set.

4Another difference between Hamblin (1973) and Karttunen (1977) is that Hamblin (1973) includes false answers in the set while Karttunen (1977) only includes true answers. Furthermore, the treatment of the answer corresponding to No one sang for Who sang? differs. What I will call the proposition-set representation does not share these properties with Karttunen’s denotation. That is, the proposition-set includes false answers.

5A proposition-set Q is DOWNWARD-CLOSED iff for any propositions p and p′, if p ∈ Q and p′ ⊂ p, then p′ ∈ Q. See Ciardelli and Roelofsen (2017) for empirical motivations for assuming downward-closure in the proposition-set representation of question meanings.
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2.3.2 Relationship between the three representations

Of the three representations, the functional representation is the most expressive and the partition representation is the least expressive. The proposition-set representation has an intermediate strength of expressiveness (Krifka, 2011). In other words, we can construct a function that maps a functional representation to the corresponding proposition-set representation, but not vice versa. Similarly, we can construct a function that maps a proposition-set representation to the corresponding partition representation, but not vice versa. Overall, the following mapping relations hold among the three representations.

(26) Possibility of mapping between different representations

Functional representation \( \not\rightarrow \) Proposition-set \( \not\rightarrow \) Partition

Let me illustrate this in more detail. The mapping from functional representations to proposition-set representations is given in (27):

(27) Mapping from functional representations to proposition-set representations

If \( F \) is a functional representation of a question,
then \( \{ F(x) \mid x \in \text{dom}(F) \} \) is its proposition-set representation. (Krifka, 2011: 1760)

On the other hand, it is impossible to derive a functional representation from a proposition-set representation. In other words, there cannot be an inverse function of (27). This is so since there can be different functional representations that map to the same proposition-set representation. For example, the two functions in (28a) correspond to the same proposition-set in (28b).

(28) a. Functional representation:

- \( \lambda x \in \{a, b\} \lambda w. \text{sang}_w(x) \)
• \( \lambda p \in \{ \lambda w.\text{sang}_w(a), \lambda w.\text{sang}_w(b) \} \lambda w.p(w) \)

b. **Proposition-set representation:**
   • \( \{ \lambda w.\text{sang}_w(a), \lambda w.\text{sang}_w(b) \} \)

The two functional representations in (28a) are collapsed into the single proposition-set representation. This is roughly because of the following fact: the functional representation transparently preserves which ‘part’ of an answer corresponds to the \( wh \)-phrase and which part doesn’t. For example, the two functions in (28a) transparently represent the following two interrogative sentences.

(29)  
   a. Who among Ann and Bill sang?  
   b. Which happened: Ann sang and Bill sang?

This kind of distinction is lost in the proposition-set representation because it does not provide information about which part of an answer corresponds to the \( wh \)-phrase.

Next, let us move on to the relationship between the proposition-set representation and the partition representation. Proposition-set representations can be mapped to partition representations in the way given in (30).

(30) **Mapping from proposition-set representations to partition representations**

If \( Q \) is a proposition-set representation of a question, then \( \lambda w\lambda w'.\forall p \in Q[p(w) = p(w')] \) is its partition representation.

In contrast, we cannot determine a proposition-set representation given a partition representation. Multiple proposition-sets may correspond to a single partition, as in the following case.

(31)  
   a. **Proposition-set representation:**
      • \( \{ A, B \} \)
      • \( \{ \neg A, \neg B \} \)
   
   b. **Partition representation:**
      • \( \lambda w\lambda w'.[A(w) = A(w') \land B(w) = B(w')] \)

Here, we have distinct sets of propositions, one being a set of ‘positive’ propositions while the other being a set of ‘negative’ propositions. However, the partition corresponding to these sets turns out to be the same one in (31b), i.e., the partition that compartmentalizes the logical space into four cells: one where both \( A \) and \( B \) holds, one where only \( A \) holds, one where \( B \) holds, and one where neither \( A \) nor \( B \) holds (see Figure 2.1(b)).

### 2.3.3 Motivation for the proposition-set representation

Now that we have grasped the theoretical differences between the three semantic representations for questions, let us ask ourselves if there are empirical arguments for favoring one representation over the others. Here, I will put forward an argument for the proposition-set representation, based on an empirical consideration regarding the exhaustivity of embedded questions, and a methodological preference for the weakest representation that is empirically adequate.
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Exhaustivity  To start, I will introduce the notion of exhaustivity. Consider the example in (32) below:

(32) Alice knows which students sang.

How much true information about the question ‘which students sang’ does Alice have to know in order for (32) to be true? Does it suffice for Alice to know for one student-singer that they sang? Or, does she have to know for all student-singers that they sang? Does she have to know in addition for all non-singing students that they didn’t sing? This is the issue of exhaustivity in questions.

In the literature, at least three levels of exhaustivity are discussed as theoretical possibilities: MENTION-SOME, WEAK EXHAUSTIVITY and STRONG EXHAUSTIVITY. Interpretations of (32) having these different levels of exhaustivity correspond to the following paraphrases, assuming that only Ann and Bill sang in the evaluation world:

(33) Situation: Only Ann and Bill sang.
   a. The mention-some (MS) reading of (32) ‘Alice knows that Ann sang or Alice knows that Bill sang.’
   b. The weakly-exhaustive (WE) reading of (32) ‘Alice knows that Ann and Bill sang.’
   c. The strongly-exhaustive (SE) reading of (32) ‘Ann knows that Ann and Bill sang and no one else sang.’

Two remarks are in order at this point. Firstly, there is disagreement in the literature regarding whether an MS reading is empirically available for a sentence like (32). According to some authors (e.g., Groenendijk and Stokhof 1984), an MS reading is in principle possible for all interrogative clauses given an appropriate pragmatic context while others (George, 2011, Fox, 2013, Xiang, 2016) argue that MS readings are licensed only when an existential quantifier or a possibility modal is present in the clause, as in the following examples:

(34)  a. Alice knows where she can buy an Italian newspaper.
   b. Alice knows which books some of the students read.

Later in Section 2.4, I will survey existing treatments of exhaustivity in the context of the analysis of answerhood, including an account of the distribution of MS readings due to Fox (2013) and Xiang (2016).

Secondly, some recent studies note the presence of an additional truth-condition for know-wh sentences, referred to as FALSE-ANSWER SENSITIVITY (FAS). This requirement is discussed in the context of exhaustivity of embedded questions by Klinedinst and Rothschild (2011), Uegaki (2015), Cremers (2016), Cremers and Chemla (2016), but the relevant observation can be found in earlier literature (Groenendijk and Stokhof, 1984, Berman, 1991, Preuss, 2001, Spector, 2005, George, 2011). The condition requires it not to be the case that the subject believes a false answer to the embedded question. In the case of (32), the readings in (33) together with the false-answer sensitivity (FAS) would look like the following:

6I will consider the situation in which no one sang in Sect. 2.4.
(35) Situation: Only Ann and Bill sang.
   a. The MS+F AS reading of (32)
      ‘Alice knows that Ann sang or Alice knows that Bill sang, and for any other
      student, it is not the case that she believes that they sang.’
   b. The WE+F AS reading of (32)
      ‘Alice knows that Ann and Bill sang, and for any other student, it is not the
      case that she believes that they sang.’

In the case of the SE reading, adding the F AS does not strengthen the reading since
the F AS is already entailed by it. In this book, I will consider the F AS as an additional
condition observed throughout the different levels of exhaustivity. Ch. 5 will be devoted
to a more detailed empirical discussion about the F AS and its theoretical implications.
Until then, we leave aside the issue of F AS and restrict our attention to the three possible
readings in (33).

Exhaustivity and the semantic representation of questions Exhaustivity of em-
bedded questions is relevant for our purposes here because the empirical patterns con-
cerning exhaustivity enable us to tease apart the different semantic representations of
question meanings. In the literature, crucial observations of the empirical patterns and
 corresponding arguments for choosing a semantic representation have been made in
particular by Groenendijk and Stokhof (1984), Heim (1994) and Beck and Rullmann
(1999). Thus, I will briefly review these three studies in turn. In the end, I will endorse
the view by Heim (1994) and Beck and Rullmann (1999) that partitions cannot be the
only representation of questions.

Groenendijk and Stokhof (1984) argue that know-wh sentences have SE readings,
contra earlier literature that assumes WE readings, most prominently Karttunen
(1977). The claim is based on the validity of the the following types of inferences:

(36)   a. Alice knows which students sang. Chris did not sing.
       ⇒ Alice knows that Chris did not sing.
   b. Alice knows which students sang.
       ⇒ Alice knows which students did not sing.

These inferences are valid only under the SE reading of the know-wh sentence in the
premise. Given this observation, Groenendijk and Stokhof (1984) motivate the parti-
tion representation for question meanings, arguing against the proposition-set view by,
among others, Hamblin (1973) and Karttunen (1977). The reason is that a cell in a
partition provides an SE answer (e.g., ‘Ann and Bill sang but Chris didn’t’) while a
proposition in a proposition-set (e.g., ‘Ann and Bill sang’) can be weaker than a SE
answer.

In response to the above argument by Groenendijk and Stokhof (1984), Heim (1994)
defends the proposition-set semantics for questions by making the following two points.

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7 I use the ‘⇒’ symbol to indicate that entailment holds at the empirical level.
8 Groenendijk and Stokhof (1984) further motivates their semantics based on the possibility of the ‘de
dicto’ reading of know-wh sentences. In Sect. 2.6 below, I will adopt a different analysis of ‘de re’/‘de dicto’
ambiguity, inspired by Beck and Rullmann (1999).
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First, a SE reading can be derived from a proposition-set denotation of questions. Second, there are predicates that seem to clearly allow WE readings, which can be captured in a proposition-set semantics but not by a partition semantics.

The first point is already obvious from the comparison between the proposition-set and partition representation in Sect. 2.3.2 above. Given a proposition-set representation, a partition representation can be derived, a cell of which corresponds to a SE answer of the question. This means that the intuitive validity of the inferences in (36) does not by itself rule out the proposition-set view. It is possible that, at least under one reading of the premises in (36), the proposition-set denoted by the interrogative clause is converted into a partition, licensing the SE reading.

The second point is exemplified by the interpretation of an interrogative complement under surprise, as in the following:

(37) SITUATION: Alice expected all of Ann, Bill and Chris to sing. It turned out that Ann and Bill sang and Chris didn’t.

Alice was surprised by who sang. JUDGMENT: FALSE

The fact that (37) sounds false given the situation (at least under one reading of the sentence) suggests that the complement of (37) receives a MS or WE reading (i.e., MS: ‘Alice was surprised that Ann sang or she was surprised that Bill sang’) rather than the SE reading (i.e., ‘Alice was surprised that Ann and Bill sang and Chris didn’t’). We can conclude from this observation that either the MA or the WE reading has to be in principle available for (37). The claim here is not that an SE reading is unavailable in (37). It is possible that (37) sounds true under one of the readings, suggesting that an SE reading is available. Klinedinst and Rothschild (2011) and Cremers and Chemla (2017) report experimental results showing that SE readings are in fact available below surprise and other emotive factives. See also Theiler (2014) for a relevant observation that a sentence like (37) is ambiguous between a weak ‘literal’ reading and a strong ‘inferential’ reading.

Under the partition representation, since each cell in a partition represents a complete resolution of the question, only SE answers are available. This means that the partition representation cannot account for the availability of the MA or WE reading of (37). Furthermore, the partition representation cannot be converted to other representations since it is the least expressive representation.

On the other hand, both functional and proposition-set representations can account for the data. The non-exhaustive answers required to account for the data in (37) are available in the set of propositions themselves in the proposition-set representation.

9The exact method by which Heim (1994) derives a SE answer from a proposition-set denotation differs from the function from proposition-sets to partitions in (30). Heim assumes the proposition-set denotation as in (i), and utilizes the function in (ii) to derive the SE reading.

(i) \[ \text{[which student sang]} = \lambda w_\cdot \{ p \mid \exists x[p = \lambda w_\cdot\text{sang}_w(x) \land \text{sang}_w(x) \land \text{student}_w(x)] \} \]

(ii) \[ \text{Ans2}(w) = \lambda Q_{(s,(st,t))}\lambda w_\cdot\cap Q(w) = \cap Q(w) \]

This analysis is designed to derive a ‘de dicto’ reading of which-questions, predicting that SE answers and ‘de dicto’ readings necessarily co-occur (as also predicted by Groenendijk and Stokhof 1984). Since this prediction is not completely uncontroversial (Beck and Rullmann, 1999), I will assume the function in (30) which is independent of the ‘de re’/‘de dicto’ distinction, rather than Heim’s (ii).
Also, the functional representation can be converted to such a proposition-set representation using the mapping in (27). Note that the availability of the SE reading (in addition to the WE/MS reading) is not a problem for these representations since they can be converted to the partition representation using the mappings in (30).

Hence, there is an empirical argument favoring the functional and the proposition-set representation of question meanings over the partition representation.

Comparing the functional and proposition-set representation  Is there an empirical argument favoring either one of the functional and proposition-set representation? Krifka (2001, 2011) argues that the behavior of answer particles in response to polar questions and alternative questions, as exemplified below, can only be captured in the functional representation.

(38) A: Did Bill leave?  
    B: Yes / He did (leave).

(39) A: Did Bill leave, or not?  
    B: *Yes / He did (leave).

The argument goes as follows. The questions in (38A) and (39A) are equivalent in the proposition-set representation. This makes it difficult for the proposition-set approach to capture the contrast in the felicity of answer particles. However, the two questions can be represented differently in the functional approach, as follows:

\[
\begin{align*}
((38A)) & = \lambda f_{t,t} \in \{\lambda t.t, \lambda t.\neg t\}. f(left_w(b)) \\
((39A)) & = \lambda p_{s,t} \in \{\lambda w'.left_{w'}(b), \lambda w'.\neg left_{w'}(b)\}. p(w)
\end{align*}
\]

Under this view, assuming (a) that the particles yes/no refer to the unary truth functions \(\lambda t.t/\lambda t.\neg t\), and (b) that a question-answer pair is felicitous only when the denotation of the answer is in the domain of the function represented by the question, we can understand the contrast between (38) and (39). In (38), yes is felicitous because \(\lambda t.t\) is in the domain of (40), but this is not the case in (39).

However, this argument by Krifka assumes a particular analysis of answer particles, and the phenomenon can be captured under the proposition-set approach if we have a different view on answer particles. An example of such a view has been proposed by Roelofsen and Farkas (2015), who propose that the particles are anaphorically dependent on propositions highlighted by the question. The question in (38) only highlights the positive proposition ‘Bill left’ while (39) highlights both the positive and the negative proposition, i.e., ‘Bill left’ and ‘Bill didn’t leave’. The presence of the two highlighted propositions in (39) makes a yes-response ambiguous, resulting in an infelicity as a stand-alone response. Roelofsen and Farkas (2015) develop a model of highlighting that is compatible with the proposition-set representation of questions, in particular, inquisitive semantics. Thus, I conclude that the behavior of answer particles does not provide strong evidence in favor of the functional approach over the proposition-set approach.

Berman’s (1991) analysis of the quantificational variability effect (QVE), as exemplified below, crucially relies on the functional representation.
Alice mostly knows who passed the test.
≈ ‘For most of the individuals who passed the test, Alice knows that they did.’

Roughly, according to Berman’s (1991) analysis, (42) is analyzed as involving an LF structure like (43), where the predicate derived from the functional representation of the wh-complement serves as the restrictor of the adverbial quantifier.

(43) MOST$_x$ [$x$ passed the test] [Alice knows that $x$ passed the test]

The analysis has been reformulated using proposition-set representations by Lahiri (1991, 2002), Beck and Sharvit (2002) and Cremers (2016). According to this reformulation, again very roughly, the LF of (42) would look like the following:

(44) MOST$_p$ [$p$ is a true member of the proposition-set representation of ‘who passed the test’] [Alice knows that $p$]

If this reformulation is successful, QVE is sufficiently accounted for by the proposition-set analysis and thus does not necessitate a functional representation of questions. However, in a recent paper, Xiang (2020) points out an empirical problem with the analysis of QVE along the lines of (44), based on earlier observations by Schwarz (1994) and Williams (2000). The problem concerns QVE involving a non-divisive predicate in the complement, such as follows:

(45) Jenny knows for the most part which students formed the bassoon quintet.

Under the analysis along the lines of (44), (45) would have an LF as follows:

(46) MOST$_p$ [$p$ is a true member of the proposition-set representation of ‘which students formed the bassoon quintet’] [Jenny knows that $p$]

This LF does not correctly capture the truth conditions of (45). To see why, suppose that the students $a$, $b$, $c$, $d$ and $e$ formed the bassoon quintet. Then, we have only one proposition that satisfies the restrictor in (46), i.e., the proposition that $a \oplus b \oplus c \oplus d \oplus e$ formed the bassoon quintet. But then, in order for (46) to be true, Jenny has to know this proposition. This does not match the intuitive interpretation. Intuitively, (45) can be true even if Jenny only knows that $a \oplus b \oplus c$ were among the group of students who formed the quintet. This is problematic for the analysis of QVE based on proposition-sets. Employing the functional representation, on the other hand, one can derive the correct truth conditions of (45) by hypothesizing an LF such as the following:

(47) MOST$_x$ [$x$ is an atomic individual among the true term answer to ‘which students formed the bassoon quintet’] [Jenny knows that $x$ is in the group of students who formed the bassoon quintet]

Based on this and another empirical argument concerning cross-linguistic restrictions on free relatives (Caponigro, 2003), Xiang (2020) proposes an original theory of question semantics based on the functional representation.

All in all, the possibility of WE/MS readings provides empirical evidence against the partition representation of questions (or more precisely, against an analysis that


---

$^{10}$A predicate $P$ is divisive iff $\forall x [P(x) \rightarrow \forall y \leq x [y \in Dom(P) \rightarrow P(y)]]$
only makes use of the partition representation). On top of this, Xiang’s (2020) arguments based on QVE point to the necessity of the functional representation. Thus, if we follow Xiang (2020), a comprehensive semantic analysis of the interrogative-embedding phenomena will require a functional analysis of questions. Nevertheless, in this book, I will employ the proposition-set representation for questions. This choice is due to practical reasons associated with the selection of empirical phenomena to be discussed in the book. Although exhaustivity—which necessitates a representation as rich as proposition-sets—will be a core basis of my analysis to be presented in Ch. 5, QVE—which necessitates a functional representation—will not be covered in the rest of the book. For this reason, as far as the empirical phenomena to be covered in this book are concerned, the proposition-set representation is the least expressive while being empirically adequate. At the same time, I would like to emphasize that the analyses to be considered in this book are ultimately compatible with the possibility that the semantics of embedded questions require the functional representation. This is due to the fact that the proposition-set representation is less expressive than the functional representation. The theory to be presented in the rest of the book can be recast in a theory with the functional representation for questions. Specifically, in all cases where a clause-embedding predicate selects for a proposition-set, we can consider the proposition-set to be derived by a functional representation of questions via the operation in (27) above.

Hence, I will henceforth assume that the semantic representation of an interrogative clause, such as who sang, looks like the following:

\[
\text{\textit{who sang}} = \lambda p(x,s,t). \exists x[p = \lambda w_s \text{. sang}_w(x)] \}
\]

I will mostly use the set notation in the second line rather than the lambda-abstracted notation in the first line, following the common practice in the literature. I will discuss more about what the variable \(x\) in a representation like (48) can range over and the issue of the ‘\(\text{de re’}/\text{de dicto}’ ambiguity in \(\text{which-NP}\) questions in Sect. 2.4. I will use the term \textit{answers} (to a question) to refer to the individual propositions contained in the proposition-set representation of questions.

### 2.4 Issues on answerhood: exhaustivity, uniqueness/existential presupposition and veridicality

In the previous chapter, I represented the interpretation of a know-\textit{wh} sentence as in (49), using the informal definition of the answerhood operator \(\text{Ans}\) in (50).

\[
\text{\textit{Alice knows who sang}} \iff K_w(a, \text{Ans}_w([\text{who sang}]_w))
\]

\[
\text{Ans}_w := \lambda Q_q. \text{the propositional answer of } Q \text{ in } w
\]

But, what exactly counts as ‘the propositional answer’ of a question? Now that we have a formal theory of question meanings as proposition-sets, we are in a position to address this issue and give a precise definition of the answerhood operator.

In fact, we have touched on the issue of answerhood in the discussion of exhaustivity in Sect. 2.3.3, i.e., how much information Alice has to know for (49) to be true.
Exhaustivity plays a large role in determining the content of the answerhood operator, along with the uniqueness/existential presupposition associated with wh-complements and the notion of veridicality. In this section, I will survey existing approaches to answerhood and conclude with a concrete formulation of answerhood due to Fox (2013) and Xiang (2016).

My discussion in this section concerns the notion of answerhood in the semantic representation like (49), which we will need either under the proposition-oriented or under the question-oriented theory of clausal embedding. Thus, the formulations of answerhood I discuss in this section are purely at the level of the metalinguistic representation which will in principle be compatible with either theory. In Sect. 2.5, I will reformulate the proposition-oriented and the question-oriented analysis of (49) given the discussion in this section. Based on this, analyses in the subsequent chapters will be developed.

2.4.1 Weakly-exhaustive and strongly-exhaustive answerhood

Recall from Sect. 2.3.3 that an interrogative-embedding sentence like (51) has been argued to have at least two readings paraphrased in (52): a weakly-exhaustive (WE) reading and a strongly-exhaustive (SE) reading. (I will set aside mention-some readings until the next section.)

(51) Alice knows who sang.
(52) SITUATION: Only Ann and Bill sang.
   a. The weakly-exhaustive (WE) reading of (51)
      ‘Alice knows that Ann and Bill sang.’
   b. The strongly-exhaustive (SE) reading of (51)
      ‘Ann knows that Ann and Bill sang and no one else sang.’

Given the proposition-set representation for the interrogative complement in (53), we can analyze the WE readings of (51) using the answerhood operator, given in (54) below:

(53) \[ [\text{who sang}]^w = \{ p(x,t) \mid \exists x[p = \lambda w'.\text{sang}_w(x)] \} \]
(54) \[ \text{Ans}_w := \lambda Q \cdot \lambda w.\forall p \in Q[p(w) \rightarrow p(w')] \] (first pass)

In prose, Ans takes a proposition-set \( Q \) and returns the proposition that states that all propositions that are true in \( Q \) are true.

As for the SE reading, I assume that it is derived by an additional exhaustification operator, defined as follows:

(55) \[ \text{Exh}_Q(p) := \lambda w.[\text{Ans}_w(Q) = p] \] (Spector and Egré 2015:1747; cf. Heim 1994)

To illustrate, suppose that we have \([\text{who sang}]^w = \{ A, B, C \}\) and that \( A \) and \( B \) are true but \( C \) is false in \( w \). In this case, the WE and SE answers of the question can be derived as follows:

(56) a. \( \text{Ans}_w([\text{who sang}]^w) = A \land B \)
   b. \( \text{Exh}_{(A,B,C)}(\text{Ans}_w([\text{who sang}]^w)) = A \land B \land \neg C \)
Accordingly, the semantic representation of the WE reading and the SE reading of (51) looks like the following:

(57)  
a.  $K_w(a, \text{Ans}_w([\text{who sang}]^w)) \iff K_w(a, A \land B)$  
b.  $K_w(a, \text{Exh}_{A,B,C}(\text{Ans}_w([\text{who sang}]^w))) \iff K_w(a, A \land B \land \neg C)$

These precisely correspond to the readings paraphrased in (52). However, it turns out that simply adopting these two operators fail to capture three aspects of the interpretations of interrogative-embedding sentences generally: existential/uniqueness presuppositions, the possibility of mention-some readings, and the possibility of non-veridicality. I will discuss these issues in turn in the next subsections.

2.4.2 The existential/uniqueness presupposition and Dayal (1996)

The discussion in the previous section has ignored an important aspect of the interpretation of interrogative-embedding sentences, i.e. their presuppositions. To illustrate the phenomenon, let us reconsider the following example repeated from above, but, this time, assuming a background situation where no one sang.

(51)  Alice knows who sang.

Intuitively, the example sounds infelicitous in such a situation, suggesting that (51) has the EXISTENTIAL PRESUPPOSITION that someone sang. Furthermore, importantly, the content of the presupposition carried by wh-complements depends on the morphosyntax of the wh-phrase. Specifically, when the wh-phrase is a singular which-phrase, the presupposition requires uniqueness, not just existence. For instance, (58a) carries the UNIQUENESS PRESUPPOSITION that exactly one girl sang. This contrasts with its minimal variant with the plural-which clause in (58b), which only presupposes existence of a girl who sang.

(58)  
a.  Alice knows which girl sang.  $\text{presup} \rightarrow \text{Exactly one girl sang}.$
   
b.  Alice knows which girls sang.  $\text{presup} \rightarrow \text{At least one girl sang}.$

The nature of such existential/uniqueness presuppositions (EP/UP) of wh-clauses is extensively studied in the semantic literature (Keenan and Hull 1973, Karttunen and Peters 1976, Comorovski 1996, Dayal 1996, a.o.). In this section, I will survey prominent proposals in the current literature and give a concrete treatment of the EP/UP to be assumed in the rest of the book.

Dayal (1996) offers an influential analysis of the EP/UP in terms of the so-called MAXIMALITY PRESUPPOSITION associated with a version of answerhood operator. In Dayal (1996), wh-complements merge with her version of the answerhood operator, which we label $\text{AnsD}$, defined below.

(59)  
a.  $\text{AnsD}_w := \lambda Q_{(st,t)} : \exists p[p \in \text{Max}_{\text{inf}}(Q)(w)], \forall p[p \in \text{Max}_{\text{inf}}(Q)(w)]$
   
b.  $\text{Max}_{\text{inf}}(Q)(w) := \{ p \mid p \in Q \land p(w) \land \forall q[q \in Q \land q(w) \rightarrow p \subseteq q] \}$

$\text{AnsD}$ roughly acts as a definite determiner over propositions. It carries the presupposition that there is a maximally informative true answer in the set of propositions it
combines with, and picks out such a maximally informative true answer. Hereafter, I will refer to the presupposition of \( \text{Ans} \) as the **MAXIMALITY PRESUPPOSITION**, and the proposition that the \( \text{AnsD} \)-operator returns from a question as the **DAYAL-ANSWER** of the question (in contrast to a plain **ANSWER**, which is any proposition that is a member of the question denotation). If we assume that a singular-which question denotes a set of mutually-independent ‘atomic’ answers, as in (60), this treatment captures the UP associated with it.\(^{12}\)

\[
(60) \quad \llbracket \text{which girl sang} \rrbracket^w = \begin{cases} 
\lambda w'. \text{girl}_{w'}(a) \land \text{sang}_{w'}(a), \\
\lambda w'. \text{girl}_{w'}(b) \land \text{sang}_{w'}(b), \\
\lambda w'. \text{girl}_{w'}(c) \land \text{sang}_{w'}(c)
\end{cases} \quad (= Q)
\]

This is so because, for every \( w \) and every set \( Q \) of mutually-independent propositions, \( \text{Ans}^w_{\text{D}}(Q) \) is defined only if exactly one of \( Q \)'s members is true in \( w \). According to this analysis, example (58a) is analyzed as in (61):

\[
(61) \quad \llbracket \text{Alice knows which girl sang} \rrbracket^w = K_w (a, \text{AnsD}^w_{\text{D}}(Q))
\]

The interpretation presented in (61) is defined only if \( \text{Ans}^w_{\text{D}}(Q) \) is defined, which holds just in case exactly one student smokes in \( w \), the matrix evaluation world. The \( \text{AnsD} \)-operator further enables a uniform treatment of the UP of singular-which questions and the EP of plural/simplex-wh questions, under the assumption that plural/simplex wh-phrases are number-neutral. This is so since the maximality presupposition is satisfied for proposition-sets that are closed under conjunction as long as there is a true answer in the set.\(^{13}\)

At the assertive level, \( \text{AnsD} \) predicts a WE reading since \( \text{Max}_{\text{inf}}(Q, w) \) is simply the unique true answer in the case of questions with a UP, and the conjunction of all true answers otherwise. The SE answer can be derived by applying Exh on top of the \( \text{AnsD} \)-operator, as follows:

\[
(62) \quad K_w (a, \text{Exh}_Q (\text{AnsD}^w_{\text{D}}(Q)))
\]

Thus, the answerhood operator introduced in the previous subsection can be amended with the maximality presupposition, yielding \( \text{AnsD} \), predicting the correct EP/UP for the basic sentences like (51, 58) above.

\(^{11}\)This is so since a morphologically singular NP denotes a set of atomic individuals (Sharvy, 1980, Link, 1983), and that a which-phrase ‘ranges over’ the denotation of the NP. This results in the set of propositions corresponding to these atomic individuals as the denotation of the whole clause. This is true both under the Karttunen-style and under the Hamblin-style compositional semantics for wh-clauses. See Sect. 2.6 for details of the subclausal composition of wh-complements I assume in this book.

\(^{12}\)Here, I represent the question denotation as having the ‘de dicto’ reading, with the world index of the NP-part of the which-phrase bound by the lambda introducing the world-dependence. See Sect. 2.6 for more on the subclausal composition of which-complements, including the treatment of ‘de re’ and ‘de dicto’ readings of which-questions following Beck and Rullmann (1999).

\(^{13}\)See Elliott et al. (2018), Alonso-Ovalle and Rouillard (2019), Xiang (2019), Maldonado (2020) for recent discussion on the role of the morphosyntactic number of wh-phrases in the semantics of wh-questions and its relation to the so-called ‘higher-order’ readings.
2.4.3 Mention-some and re-evaluation of the source of the UP/EP

Semantic and pragmatic approaches to mention-some

One obvious problem with the analysis we have so far—in terms of AnsD and ExH—is the presence of mention-some (MS) readings, which is exemplified as the salient reading of the following sentence:

(63) Alice knows where one can buy an Italian newspaper.

There is a debate in the literature concerning the nature of the MS reading. Specifically, scholars disagree on whether the MS reading has to be captured in semantics or in pragmatics. In the semantic approach (Groenendijk and Stokhof 1984:Sect. 6.5.3; George 2011; Fox 2013; Theiler 2014; Xiang 2016), the embedded interrogative in (63) under its MS reading has a semantic content that is distinct from its WE or SE reading. On the other hand, the pragmatic approach (Groenendijk and Stokhof 1984:Sect. 6.5.2; van Rooij 2004) claims that the embedded interrogative in (63) under its MS reading has the same semantic content as its WE or SE reading, but receives a weak interpretation due to a pragmatic mechanism. More specifically, Groenendijk and Stokhof (1984:Sect. 6.5.2) hypothesize that questions that allow MS interpretations are those questions whose speaker’s pragmatic goals are achieved by partial answers. For example, in the following discourse, typically, the questioner’s pragmatic goal is to find some place in the neighborhood where she can get gas. Thus, even though the question semantically has an SE reading, the partial answer in B suffices to achieve this goal.

(64) A: Where can I get gas around here?  
    B: At the Shell on Memorial Drive.

One of the arguments against the pragmatic approach offered by Groenendijk and Stokhof (1984) themselves and by George (2011) comes from embedded examples of mention-some questions, as in (63). The MS reading of (63) has distinct truth-conditions from its SE readings. In the pragmatic approach, the difference in truth conditions can only be captured if the pragmatic considerations affect the semantic interpretation of the embedded clause, contrary to the standard assumption that pragmatics does not feed the compositional semantic interpretation.\(^{14}\)

The George/Fox challenge and weak maximality

Another line of objection against the pragmatic approach comes from the observation that MS readings are syntactically restricted (George, 2011, Fox, 2013, Xiang, 2016). The following example is from Fox (2013):

(65) **Situation:** There was no gas in the Boston area for a couple of days (say...the aftermath of a storm). Josh got a huge tank truck and delivered gas to various gas stations.

   a. Where can we get gas?  \((✓ \text{MS})\)

---

\(^{14}\)However, see van Rooij (2004) for a pragmatic account of embedded mention-some questions with a theory where semantic evaluation is sensitive to the relative utility of information states.
b. Where did Josh deliver gas? (*MS)

The two sentences in (65) are contextually equivalent. Thus, if a *wh*-question receives an MS reading when certain pragmatic conditions are met, both sentences in (65) should behave equally with respect to whether they allow an MS reading. Empirically, there seems to be a contrast in (65): (65a) easily receives an MS reading, but (65b) doesn’t.

Fox (2013) argues that the difference in the availability of an MS reading between (65a) and (65b) is rooted in whether the proposition-set denoted by the question is guaranteed to contain a *unique* maximally informative true member. This difference is captured in the following representations of the two questions in (65), assuming that there are only three gas stations: A, B and C:

\[
\langle (66) \rangle
\]

\[
\begin{align*}
\text{a. } &\llbracket (65a) \rrbracket^w = \left\{ \begin{array}{ll}
\Diamond (a \wedge b \wedge c) \\
\Diamond (a \wedge b), \Diamond (b \wedge c), \Diamond (c \wedge a) \\
\Diamond a, \Diamond b, \Diamond c \\
\end{array} \right. \\
\text{ (a: ‘we get gas at A’; b: ‘we get gas at B’; c: ‘we get gas at C’) }
\end{align*}
\]

\[
\begin{align*}
\text{b. } &\llbracket (65b) \rrbracket^w = \left\{ \begin{array}{ll}
a' \wedge b' \wedge c' \\
a' \wedge b', b' \wedge c', c' \wedge a' \\
a', b', c' \\
\end{array} \right. \\
\text{ (a: ‘Josh delivered gas to A’; b: ‘Josh delivered gas to B’; c: ‘Josh delivered gas to C’) }
\end{align*}
\]

Note that (66a) is not closed under conjunction, but (66b) is. As a result, in (66a), the existence of a unique maximally true member is not guaranteed because, for example, \(\Diamond a\) and \(\Diamond b\) can both be true (Josh delivered gas to these two stations) and \(\Diamond (a \wedge b)\) be false (as, say, station A and B are too far apart and we can only travel to one of the two locations). On the other hand, existence of a unique maximally informative true member is guaranteed in (66b). Whichever propositions that entails that Josh delivered gas to all the locations he did suffices as such a member. So, in the situation where Josh delivered gas to A and B and nowhere else, \(a' \wedge b'\) is such an answer.

Why does this difference matter for the availability of an MS reading? Fox’s (2013) proposal, in a nutshell, is that the notion of answerhood has to be stated in terms of the *set* of maximally informative true propositions (i.e., those propositions that are not entailed by any other true propositions in the question denotation). If this set contains multiple members, we obtain an MS reading, as in (65a). If the set is a singleton, as in (65b), we obtain a non-MS reading. Formally, the analysis is formulated using a new answerhood operator, which we label \(\text{AnsF}\):

\[
\langle (67) \rangle
\]

\[
\begin{align*}
\text{a. } &\text{AnsF}_w := \lambda Q_{(st,t)} : \exists p[p \in \text{Max}_{\text{inf}}^\text{weak}(Q)(w)] : \{ p \mid p \in \text{Max}_{\text{inf}}^\text{weak}(Q)(w) \} \\
\text{b. } &\text{Max}_{\text{inf}}^\text{weak}(Q)(w) := \{ p \mid p \in Q \wedge p(w) \wedge \forall q[(q \in Q \wedge q(w)) \rightarrow q \not\subseteq p] \}
\end{align*}
\]

\[\text{15} \text{Compositionally, Fox (2013) derives the representations in (66a) by having a distributive operator over locations scope below the possibility modal, yielding a set of propositions that is not closed under conjunction. In contrast, (65b), which doesn’t contain a possibility modal or an existential quantifier scopeing over the distributivity over locations, yields a proposition set that is closed under conjunction. A consequence for this is that (65a) can receive a non-MS reading if the distributivity operator scopes above the possibility modal.} \]
Given a proposition-set $Q$, this answerhood operator yields a set of maximally informative true members of $Q$, presupposing that such a set is non-empty. The semantics of interrogative-embedding sentence in general is then stated in terms of existential quantification over the answers generated by $\text{AnsF}$, as follows:

\[(68) \quad \[w \mathcal{V} \mathcal{C} \mathcal{P}_{int}] w = \lambda x. \exists p \in \text{AnsF}_w(Q) \land \mathcal{V}_w(p)(x)\]

An SE reading can be derived by applying EXH to $p$, just as in the previous subsections (I leave open the question of how this is done compositionally).

As a result, we predict an MS reading when $\text{AnsF}$ outputs a non-singleton set and a non-MS reading when it outputs a singleton set. For example, we have the following representations for sentences that embed the questions in (65), assuming that, as in the hypothetical situation considered above, $\Diamond a$, $\Diamond b$, and $a \land b$ are true but $\Diamond (a \land b)$ is false in $w$.

\[(69) \quad \begin{align*}
(a) & \quad [\text{Alice knows where we can get gas}]^w \\
& \quad \Leftrightarrow \exists p[p \in \text{AnsF}_w(\Diamond a \land b) \land K_w(a, p)] \\
& \quad \Leftrightarrow \exists p[p \in \{\Diamond a, \Diamond b\} \land K_w(a, p)] \\
& \quad \Leftrightarrow K_w(a, \Diamond a) \lor K_w(a, \Diamond b)
\end{align*}
\]

\[(b) & \quad [\text{Alice knows where Josh delivered gas}]^w \\
& \quad \Leftrightarrow \exists p[p \in \text{AnsF}_w(\Diamond (a \land b)) \land K_w(a, p)] \\
& \quad \Leftrightarrow \exists p[p \in \{a \land b\} \land K_w(a, p)] \\
& \quad \Leftrightarrow K_w(a, a \land b)
\]

The analysis offers an elegant uniform treatment of MS and non-MS readings (see also Xiang 2016 for further development of this line of analysis). At the same time, however, by replacing $\text{AnsD}$ with $\text{AnsF}$, we effectively lose Dayal’s (1996) analysis of the UP. The presupposition imposed by $\text{AnsF}$ is quite weak, and is satisfied as long as there is a maximally informative true answer. This presupposition is satisfied for singular which-questions even if multiple members of the question denotation are true. This means that we are in a dilemma. On the one hand, we would like to keep the maximality presupposition from $\text{AnsD}$ to preserve the analysis of the UP. On the other hand, we would like to adopt $\text{AnsF}$ to incorporate the analysis of MS readings.

The local-triggering analysis of UP/EP

Schwarz et al. (2020) provide a solution to the dilemma by combining $\text{AnsF}$ with an analysis of the UP/EP where the maximality presupposition is triggered by each proposition in the question denotation. This analysis of the UP/EP—which I will refer to as the local-triggering analysis—is developed by Uegaki (2018, 2020) and Hirsch and Schwarz (2019) independently. According to the analysis, a singular which-clause has a question denotation like the following:

\[(70) \quad \{ \lambda w' : \exists x[\text{girl}_{w'}(x) \land \text{sang}_{w'}(x)] \land \text{girl}_{w'}(y) \land \text{sang}_{w'}(y) \mid y \in D_c \}
\]

Each member of this set presupposes that exactly one girl sang, and asserts that a particular girl sang. The nature of the presupposition carried by the answers depends on the
number morphology of the \textit{wh}-phrase. Specifically, if the \textit{wh}-phrase is plural-\textit{which} or number-neutral, we have an EP (see Sect. 2.6 for the subclausal composition that derive this effect):

\begin{equation}
\text{[which girls sang]}_w = \{ \lambda w' : \exists x [\text{girls}_{w'}(x) \land \text{sang}_{w'}(x)] \land \text{girls}_{w'}(y) \land \text{sang}_{w'}(y) \mid y \in D_c \}
\end{equation}

Below, I will briefly discuss independent motivations for the local-triggering analysis of the EP/UP. Before that, let us see how combining the analysis with AnsF offers a solution to the dilemma pointed out in the previous section. First, the combination of the analysis with AnsF correctly captures the UP of singular-\textit{which} questions. This is so since the UP carried by each propositional member of the question is projected by the presupposition of AnsF:

\begin{equation}
\text{AnsF}_w(\text{[which girl sang]}_w) \text{ presupposes that:}
\end{equation}
\begin{equation}
\exists p [\exists p \in \text{MAX}_{\text{weak}}(\text{[which girl sang]}_w) \land p(w)]
\end{equation}
\begin{equation}
\Leftrightarrow \text{[which girl sang]}_w \text{ has a maximally informative true answer in } w
\end{equation}
\begin{equation}
\Leftrightarrow \text{the UP carried by each member of } \text{[which girl sang]}_w \text{ is satisfied in } w
\end{equation}

At the same time, the mention-some example discussed in the previous subsection—(65a) where \textit{we can get gas}—can be correctly analyzed \textit{not} to have a UP. This is so because the presupposition carried by each member of the question denotation is existential, i.e., ‘there is a place where we can get gas’. And so, the presupposition projected by AnsF will also be existential:

\begin{equation}
\text{AnsF}_w(\text{[where we can get gas]}_w) \text{ presupposes that:}
\end{equation}
\begin{equation}
\exists p [\exists p \in \text{MAX}_{\text{weak}}(\text{[where we can get gas]}_w) \land p(w)]
\end{equation}
\begin{equation}
\Leftrightarrow \text{[where we can get gas]}_w \text{ has a maximally informative true answer in } w
\end{equation}
\begin{equation}
\Leftrightarrow \text{the EP carried by each member of } \text{[where we can get gas]}_w \text{ is satisfied in } w
\end{equation}

Turning to motivations for the local-triggering analysis of the EP/UP, consider the following example by Schwarz et al. (2020):

\begin{equation}
\text{In which town was Shakespeare born or did Bach die?}
\end{equation}

If we apply AnsD to derive the presupposition of this sentence, we will predict the following presupposition.

\begin{equation}
[\exists x [\text{bornIn}(s, x)] \land \neg \exists y [\text{dieIn}(b, y)]] \lor [\neg \exists x [\text{bornIn}(s, x)] \land \exists y [\text{dieIn}(b, y)]]
\end{equation}

Here’s why. Assuming that the question denotation is the union of those of the disjunct questions, it will be the union of the set of propositions of the form ‘Shakespeare was born in city x’ and those of the form ‘Bach died in city y’. The presuppositional requirement of AnsD—that there is a unique strongest true answer—can be satisfied for this set only if there is a \textit{unique} city where Shakespeare was born and there is no city where Bach died or there is a \textit{unique} city where Bach died and there is no city where Shakespeare was born. This is clearly an incorrect prediction. The example rather intuitively presupposes the following:

\begin{equation}
\exists x [\text{bornIn}(s, x)] \land \exists y [\text{dieIn}(b, y)]
\end{equation}
This fact suggests that distinct UPs are triggered within the two disjuncts in (74) and projected universally by or. Schwarz et al. (2020) argue that this behavior of the UP is naturally explained under the local-triggering analysis.

Uegaki (2018, 2020) offers a separate argument for the local-triggering analysis, based on the projection of the EP/UP from under various non-veridical interrogative-embedding predicates. Since we have not yet touched on non-veridical predicates in this book (see Sect. 2.4.5 below), the argument cannot be replicated in detail here. In essence, the argument goes as follows. When a singular-which interrogative is embedded under non-veridical predicates, its UP projects in a way different from when it is embedded under veridical predicates like know. This is exemplified in the following with be certain and agree:

(77) a. Alice knows which girl sang.  
\[ \text{presup} \Rightarrow \text{Exactly one girl sang.} \]

b. Alice is certain (about) which girl sang.  
\[ \text{presup} \Rightarrow \text{Alice believes that exactly one girl sang.} \]

c. Alice agrees with Kim on which girl sang.  
\[ \text{presup} \Rightarrow \text{Alice and Kim believe that exactly one girl sang.} \]

Uegaki (2020) shows that these projection patterns are puzzling under the view where the UP is triggered by AnsD. Rather, the projection patterns are parallel to what we observe for presuppositions triggered within the interrogative clause, as in the presupposition for the definite DP the unicorn in the following examples:

(78) a. Alice knows who caught the unicorn.  
\[ \text{presup} \Rightarrow \text{There is a unique unicorn.} \]

b. Alice is certain (about) who caught the unicorn.  
\[ \text{presup} \Rightarrow \text{Alice believes that there is a unique unicorn.} \]

c. Alice agrees with Kim on which girl sang.  
\[ \text{presup} \Rightarrow \text{Alice and Kim believe that there is a unique unicorn.} \]

Based on the parallel between (77) and (78), Uegaki argues that each member of the question denotation carries the UP/EP, just like how each member of the denotation of who caught the unicorn presupposes existence of a unique unicorn.

To summarize, the semantic analysis of MS questions along the lines of Fox (2013), Xiang (2016) requires us to adopt a weaker variant of AnsD—AnsF—which only presupposes existence of a maximally informative true answer in the question denotation. This move forces us to abandon Dayal’s (1996) analysis of the UP of singular-which interrogatives. However, AnsF can be coupled with an alternative analysis of the UP—the local-triggering analysis (Uegaki, 2018, 2020, Hirsch and Schwarz, 2019, Schwarz et al., 2020)—which has independent empirical motivations.

### 2.4.4 Exhaustivity neutrality

In the previous sections, I have gone through the literature on the exhaustivity and the UP/EP of interrogative clauses. According to the analysis we ended up with, the in-
2.4. ISSUES ON ANSWERHOOD

The interpretation of the sentence “Alice knows Q” can be represented in the following two ways:

\begin{align*}
(79) \quad & a. \exists p \in \text{AnsF}_w(Q)[K_w(a, p)] \quad \text{(WE/MS)} \\
& b. \exists p \in \text{AnsF}_w(Q)[K_w(a, \text{Exh}_Q(p))] \quad \text{(SE)}
\end{align*}

Each member of Q here carries the maximality presupposition, following the local-triggering theory of the EP/UP.

Although these representations accurately capture the range of interpretations with respect to exhaustivity and the UP/EP, as we have seen in the previous sections, these are somewhat involved representations that are slightly cumbersome to read and interpret. Luckily, this problem with the exposition is avoided due to the fact that exhaustivity and the UP/EP will not play a major role in the discussion in the subsequent chapters.

In fact, we can restrict our attention to what I will call EXHAUSTIVITY NEUTRAL interrogative complements for most chapters of the book, for which we can simplify the representations considerably.

An EXHAUSTIVITY-NEUTRAL interrogative complement is a complement that denotes a set of mutually-exclusive propositions. Examples of exhaustivity-neutral complements include polar interrogatives such as whether Mary sang and wh-interrogatives whose propositional answers are guaranteed to be mutually exclusive, such as, who won the 2020 Great British Bake Off, who Alice is married to (assuming monogamy), which girl initiated the group call, and what is the square root of 9. Exhaustivity-neutral complements are useful for our purposes because, for them, all levels of exhaustivity (MS, WE, and SE) coincide. Focusing on exhaustivity-neutral complements allows us to simplify the semantic representation considerably due to the following equivalence:

\begin{align*}
(80) \quad & \exists p \in \text{AnsF}_w(Q)[V_w(x, p)] \iff \exists p \in \text{AnsF}_w(Q)[V_w(x, \text{Exh}_Q(p))] \\
& \iff V_w(x, \text{AnsD}_w(Q))
\end{align*}

This means that, as long as we are dealing with an exhaustivity-neutral interrogative complement, we can simplify the semantic representation of an interrogative-embedding sentence with the formula on the one on the bottom line of (80) in terms of AnsD.

In the remainder of this book, I will generally use exhaustivity-neutral interrogative complements in examples, and employ the semantic representation in the right-hand side of (80) as our baseline semantic analysis. This will significantly simplify the semantic representations in our discussion, while keeping the underlying theory compatible with the possibility of different levels of exhaustivity. An exception will be Ch. 5, where the central empirical issue concerns readings of non-exhaustivity-neutral complements (more specifically, so-called ‘false-answer sensitive’ readings of responsive predicates). There, my analysis will be based on the full analysis of exhaustivity given in (79) above, together with the analysis of veridicality due to Spector and Egré (2015) to be discussed in the next section. This said, throughout the book, formal details related to the issue of exhaustivity will be minimized for expository purposes.

\textsuperscript{16}Rough proof: for any exhaustivity-neutral Q, any p ∈ Q, and any w, p = ExhQ(p). This guarantees the equivalence in the first line of (80). For any exhaustivity-neutral Q and any w, AnsF_w(Q) = {AnsD_w(Q)}. This guarantees the equivalence in the second line.
2.4.5 Non-veridicality and Spector and Egré (2015)

There is an important aspect of the formulation of the answerhood operators in the previous sections which has not been highlighted so far. The operators predict interrogative-embedding sentences to be always veridical, i.e., relating the agent to a true answer of the question. I will refer to a predicate as interrogative-veridical iff it gives rise to this inference.\footnote{More precisely, following Theiler et al. (2018), interrogative-veridicality can be defined as follows:}

\begin{enumerate}
  \item A predicate \( V \) is interrogative-veridical if and only if for every exhaustivity-neutral interrogative complement \( Q \) and any answer \( p \) to \( Q \): \( \forall x \Vs Q \& p \Rightarrow \forall x \Vs p \).
\end{enumerate}

This is so since both \( \AnsD \) and \( \AnsF \) pick out a true answer or a set thereof.

This prediction seems to be harmless as long as we are dealing with predicates such as \textit{know}, \textit{remember}, and \textit{be surprised}. These predicates always relate agents to true answers of the question:

\begin{enumerate}
  \item Alice knows which girl won the first prize.
    \( \Rightarrow \) ‘Alice knows that \( p \)', where \( p \) is the true answer to ‘which girl won the first prize’.
  \item Alice remembers which girl won the first prize.
    \( \Rightarrow \) ‘Alice remembers that \( p \)', where \( p \) is the true answer to ‘which girl won the first prize’.
  \item Alice was surprised which girl won the first prize.
    \( \Rightarrow \) ‘Alice was surprised that \( p \)', where \( p \) is the true answer to ‘which girl won the first prize’.
\end{enumerate}

Moreover, it has been argued by Karttunen (1977) and Groenendijk and Stokhof (1984) that this line of prediction is borne out by communication predicates that are not declarative-veridical (i.e., they don’t entail the truth of the declarative complement), such as \textit{tell} and \textit{report}. The following examples suggest that these predicates are interrogative-veridical although they are not declarative-veridical.

\begin{enumerate}
  \item Alice told us which girl won the first prize.
    \textit{Seems to imply}: ‘Alice told us that \( p \), where \( p \) is the true answer to ‘which girl won the first prize’.
\end{enumerate}

\footnote{More precisely, following Theiler et al. (2018), interrogative-veridicality can be defined as follows:}

\begin{enumerate}
  \item Alice knows where one can buy an Italian newspaper.
  \item Alice knows that one can buy an Italian newspaper at Paperworld.
\end{enumerate}

Suppose Italian newspapers are sold at both Paperworld and Newstopia, but Alice only knows that they are sold at Newstopia and ignorant about Paperworld. Then, the following sentence is intuitively false:

\begin{enumerate}
  \item Alice knows that one can buy an Italian newspaper at Paperworld.
\end{enumerate}

This shows that the inference of the form ‘\( \forall x \Vs Q \& p \Rightarrow \forall x \Vs p \)’ can be invalid with \textit{know} if we didn’t restrict \( Q \) to exhaustivity-neutral complements. Because of this restriction, I use singular-\textit{which} complements in examples in this subsection.
b. Alice reported which girl won the first prize.
   
   *Seems to imply:* ‘Alice reported that $p$, where $p$ is the true answer to ‘which girl won the first prize’.’

(83)  

a. Alice told us that Bonnie won the first prize.
   $\not\Rightarrow$ Bonnie won the first prize.  
   b. Alice reported that Bonnie won the first prize.
   $\not\Rightarrow$ Bonnie won the first prize.

This behavior is predicted if the predicates take as their internal argument the propositions returned by the answerhood operators $\text{AnsD}/\text{AnsF}$, evaluated in the matrix evaluation world. So far, it appears to be a welcome consequence that the account predicts interrogative-veridicality regardless of the predicate.

However, further examination shows that this is not in fact a welcome prediction. *Tsohatzidis (1993)* and *Spector and Egré (2015)* observe that communication predicates are not always veridical when they embed interrogative complements. This can be illustrated by the following examples:

(84)  

a. Old John told us whom he saw in the fog, but it turned out that he was mistaken (the person he saw was Mr. Smith, not Mr. Brown). (*Tsohatzidis, 1993*: 272)  
   b. Every day, the meteorologists tell the population where it will rain the following day, but they are often wrong. (*Spector and Egré, 2015*: 1737)  
   c. Alice reported which girl won the first prize, but her report turned out to be incorrect.

Moreover, it is also evident that there are other predicates that are non-veridical with respect to interrogative complements. Examples of such predicates include *guess* and *be certain*.

(85)  

a. Alice guessed which girl won.
   $\not\Rightarrow$: Alice guessed that $p$, where $p$ is the true answer of the question which girl won.  
   b. Alice is certain about which girl won.
   $\not\Rightarrow$: Alice is certain that $p$, where $p$ is the true answer of the question which girl won.

Note that these predicates are also non-veridical with respect to declarative complements:

(86)  

a. Alice guessed that Bonnie won.
   $\not\Rightarrow$: Bonnie won.  
   b. Alice is certain that Bonnie won.
   $\not\Rightarrow$: Bonnie won.

Based on these data, *Spector and Egré (2015)* propose the **Veridicality Uniformity generalization** for responsive predicates, which is stated as follows:

(87) **Veridicality uniformity generalization** (*Spector and Egré, 2015*)

All responsive predicates are uniform in veridicality. That is, they are either:
both declarative-veridical and interrogative-veridical; or

neither declarative-veridical nor interrogative-veridical.

All predicates we have considered in this section satisfy this generalization. Specifically, 
know, remember and surprise are veridical with respect to both types of complements and be certain and guess are non-veridical with respect to both types of complements. Spector and Egré (2015) analyze tell and other communication predicates as ambiguous between veridical and non-veridical readings, satisfying the generalization under each reading.18

In Ch. 4, I will argue that a class of responsive predicates called predicates of relevance (e.g. care, matter) constitute counterexamples to this generalization, following Elliott et al. (2017) and Theiler et al. (2018). Specifically, I will argue that the predicates of relevance are not interrogative-veridical while being declarative-veridical. This said, the generalization as well as Spector and Egré’s (2015) analysis based on it will form an important part of the baseline analysis, which we will seek to extend in the subsequent chapters.

Driven by the generalization in (87), Spector and Egré (2015) propose an analysis where a sentence of the form “x Vs Q” is roughly analyzed as ‘There is a potential answer p to Q such that x Vs that p’. This analysis correctly captures the implication from declarative-veridicality to interrogative-veridicality. This is so because, if a predicate V is declarative-veridical, then the potential answer to the question Q that can serve as a witness in the existential statement ‘There is a potential answer p to Q such that x Vs that p’ has to be true.19

The original technical formulation of Spector and Egré’s (2015) analysis is somewhat involved due to complications arising from issues of exhaustivity. However, as long as we are restricting our attention to exhaustivity-neutral complements as discussed in the previous section, we can simplify the formulation as follows:20

\[
\begin{align*}
\text{[x Vs Q]}^w \iff \exists w'[V_w(x, \text{AnsD}_{w'}(Q))] \\
\end{align*}
\]

In words, “x Vs Q” is true in w iff there is a world w’ such that x Vs the Dayal-answer to Q in w’. The analysis will look like the following with concrete sentences:

\[
\begin{align*}
\text{[Alice knows which girl won]}^w \iff \exists w'[K_w(a, \text{AnsD}_{w'}(Q))] \\
\text{[Alice guessed which girl won]}^w \iff \exists w'[\text{guess}_{w'}(a, \text{AnsD}_{w'}(Q))] \\
\end{align*}
\]

A veridical interpretation is correctly predicted for (89a), given that the metalanguage predicate K is veridical, i.e., K_w(a, p) entails that p is true in w for any p. It follow from the veridicality of K that K_w(a, \text{AnsD}_{w'}(Q)) entails that \text{AnsD}_{w'}(Q)—the answer

18See Uegaki (2015: 158–9) for a possible analysis of why the veridical reading is preferred over the non-veridical reading in interrogative-embedding, based on the pragmatic principle of Strongest Meaning Hypothesis (Dalrymple et al., 1998). See also Theiler et al. (2018: fn.41) for an issue with treating communication predicates as lexically ambiguous between veridical and non-veridical readings.

19Spector and Egré’s (2015) analysis does not capture the implication from interrogative-veridicality to declarative-veridicality. See Theiler et al. (2018) for a hypothetical predicate that is non-declarative-veridical and interrogative-veridical and yet predicted to be possible by Spector and Egré (2015).

20See Uegaki (2020) for a local-triggering analysis of the UP/EP set within the Spector and Egré style analysis.
known by Alice—is true in \( w \). On the other hand, a non-veridical interpretation is predicted for (89b), again correctly. Since \( \text{guess} \) is not declarative-veridical, \( \text{guess}_w(a, p) \) is compatible with \( p \) being false in \( w \). Thus, \( \text{guess}_w(a, \text{AnsD}_w(Q)) \) does not entail that \( \text{AnsD}_w(Q) \)—the relevant answer being guessed by Alice—is true in \( w \).

Thus, existentially quantifying over possible answers as in (88) provides a reasonable analysis of veridicality and non-veridicality. However, if we go beyond exhaustivity-neutral complements, the existential semantics as it stands has one problematic consequence: we lose an analysis of the WE reading for veridical predicates (Spector and Egré, 2015: 1761-5). To see this, consider the following truth conditions for a know-wh sentence with a non-exhaustivity-neutral complement:

\[(90) \quad [\text{Alice knows which girls among Bonnie, Cathy and Dana sang}]^{w_0} \iff \exists w'[K_{w_0}(a, \text{AnsD}_{w'}([\text{which girls among Bonnie, Cathy and Dana sang}]^{w_0}))]\]

Suppose that, in the evaluation world \( w_0 \), Bonnie and Cathy sang and Dana didn’t, and in a separate world \( w_1 \), only Bonnie sang and Cathy and Dana didn’t. Given this setup, the Dayal-answers in \( w_0 \) and \( w_1 \) can be described as follows:

\[(91) \quad Q := [\text{which girls among Bonnie, Cathy and Dana sang}]^{w_0} = \{B, C, D, B \land C, C \land D, D \land B, B \land C \land D\}\]

- a. \( \text{AnsD}_{w_0}(Q) = B \land C \) (the WE answer of \( Q \) in \( w_0 \))
- b. \( \text{AnsD}_{w_1}(Q) = B \) (a MS answer of \( Q \) in \( w_0 \))

The veridicality of \( K \) requires its propositional argument to be true in the evaluation world. In the case of (90), this means that \( \text{AnsD}_{w_0}(Q) \) has to be true in \( w_0 \). The issue is that not only \( \text{AnsD}_{w_0}(Q) \), which represents the WE answer of \( Q \) in \( w_0 \), but also \( \text{AnsD}_{w_1}(Q) \), which is merely an MS answer of \( Q \) in \( w_0 \), satisfies this requirement. Thus, for example, (90) is predicted to be true if Alice only knows that Bonnie sang, contrary to the intuitive judgment that the sentence is perceived to be true only if Alice knows that both Bonnie and Cathy sang.

To resolve this technical issue, I stipulate that the metalanguage predicate \( K \) not only entails its propositional argument to be true, but also that its exhaustification is true (see Spector and Egré 2015 for a similar solution). This stipulation is stated as follows:

\[(92) \quad \text{For any } w, w', x \text{ and } Q, K_w(x, \text{AnsD}_{w'}(Q)) \text{ entails } \text{Exh}_Q(\text{AnsD}_{w'}(Q))(w)\]

This means that a semantic representation of a know-wh sentence like (90) is true only if the exhaustification of the relevant Dayal-answer is true. In the example at hand, the stipulation entails that Alice knowing \( \text{AnsD}_{w_1} \) in (91b) doesn’t make (90) true since the exhaustification of \( \text{AnsD}_{w_1} \) is not true in \( w_0 \). I assume that the same stipulation applies for all factive predicates. Since providing a unified semantics for different levels of exhaustivity in embedded questions is not the main purpose of the current book, I will not attempt to derive this stipulation from independent principles. Though, see Fox (2020) for a solution to this issue based on an analysis of presupposition projection under the trivalent model for presuppositions. I will provide a more detailed discussion of the role of exhaustification in Ch. 5, including a review of Fox (2020).
2.4.6 Section summary

In this section, I have outlined three issues pertaining to the notion of answerhood—exhaustivity, existential/uniqueness presuppositions (EP/UP), and veridicality—all of which we need to understand in order to determine the baseline semantic analysis of interrogative complements.

As for the issue of exhaustivity, my conclusion is to adopt Fox’s (2013) analysis, which enables us to uniformly capture both MS and WE readings. The SE reading is derived by exhaustifying the relevant answer. The difference between the three levels of exhaustivity, however, will not be featured prominently in the rest of the book since I will mostly focus on cases where the interrogative complement is exhaustivity-neutral, i.e., it denotes a set of mutually-exclusive propositions. Given exhaustivity-neutrality, the semantic representation of an interrogative-embedding sentence under Fox’s (2013) analysis will be equivalent to that under Dayal’s (1996) analysis. The EP/UP of interrogative complements is assumed to arise from the presupposition carried by each propositional member of the question denotation, following the local-triggering analysis of the EP/UP (Uegaki, 2018, 2020, Hirsch and Schwarz, 2019, Schwarz et al., 2020). Finally, I will follow Spector and Egré (2015) in the treatment of veridicality in the baseline analysis. That is, I will treat interrogative-embedding sentences to be analyzed as involving existential quantification over suitable answers. Doing so enables us to have a uniform treatment of both veridical and non-veridical predicates.

All in all, we have the following as the baseline semantic analysis for sentences of the form \( \langle x \text{ Vs } Q \rangle \), with an exhaustivity-neutral complement \( Q \) which locally triggers the UP/EP:

\[
\text{(93) The baseline semantic analysis of interrogative-embedding sentences}
\]

\[
[x \text{ Vs } Q]^w \iff \exists w' [V_w(x, \text{AnsD}_w(Q))]
\]

Assuming the exhaustivity-neutrality of \( Q \), this analysis provides a reasonable starting point for our investigation while doing justice to the current literature on the semantics of interrogative complements.

2.5 Reformulating the theories in Chapter 1

Now that we have a baseline analysis of the interpretation of interrogative-embedding sentences, we are in a position to formalize the two approaches to the semantic composition of declarative and interrogative complementation, introduced in the previous chapter: the proposition-oriented and the question-oriented theory. In this section, I will offer concrete implementations of the approaches using two responsive predicates—\textit{know} and \textit{guess}—as examples, and discuss challenges for each theory associated with non-responsive predicates, to be discussed in later chapters.

2.5.1 Proposition-oriented theory

The basic features of the proposition-oriented analysis for responsive predicates are repeated below from Ch. 1:
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(94) **Features of the proposition-oriented semantics**

- Responsive predicates semantically select for propositions.
- The compositional semantics involves a mechanism that reduces the interpretation of an interrogative complement into a proposition.

To implement this analysis, let us start with the first feature, i.e. the semantics for responsive predicates that select for propositions. The standard semantics for attitude predicates transparently reflecting the Hintikkan semantics, as in (95) below, straightforwardly satisfies this feature:

\[
\begin{align*}
\text{know}^w & = \lambda p (s, t, x, \text{K}_w(x, p)) \\
\text{guess}^w & = \lambda p (s, t, x, \text{guess}_w(x, p))
\end{align*}
\]

When these denotations are combined with the (again standard) propositional analysis of declarative complements, exemplified in (96), we derive appropriate truth conditions for the declarative-embedding sentences, as in (97).

\[
\begin{align*}
\text{that Bonnie won the prize}^w & = \lambda w . \text{won}_w(b) \\
\text{Alice knows that Bonnie won the prize}^w & \iff \text{K}_w(a, \lambda w'. \text{won}_w'(b)) \\
\text{Alice guessed that Bonnie won the prize}^w & \iff \text{guess}_w(a, \lambda w'. \text{won}_w'(b))
\end{align*}
\]

Moving on to the second feature in (94), we need a suitable mechanism for reducing the interpretation of an interrogative complement—which we decided to model as a proposition set as exemplified in (98)—to a proposition.

\[
\begin{align*}
\text{which girl won the prize}^w & = \{ w' : \exists x [ \text{girl}_w'(x) \land \text{won}_w'(x) ] \land \text{girl}_w(y) \land \text{won}_w(y) \mid y \in D_e \}
\end{align*}
\]

Recall that the resulting semantic representation for an interrogative-embedding sentence involves existential quantification over possible answers (see (93) above). Given this, a straightforward way to implement the reduction is to follow Spector and Egré (2015) and utilize a lexical rule, as follows:

\[
\begin{align*}
[f_{\text{Ans}}]^w & = \lambda R(s, t, x, \text{Q}_w) \exists w' [ R(\text{AnsD}_w'(Q))(x) ]
\end{align*}
\]

This lexical rule takes a proposition-taking denotation of a clause-embedding predicate, such as those in (95), and returns a question-taking counterpart that encodes question-to-proposition reduction in terms of AnsD.

With (99), we can compositionally derive the appropriate interpretations of sentences involving interrogative complements under responsive predicates, within the proposition-oriented analysis:
Hence, the concrete implementation of the proposition-oriented theory outlined above successfully derives the interpretations of interrogative-embedding sentences, assumed in the baseline analysis.

As discussed in the previous chapter, the theory faces challenges with respect to non-responsive predicates. First, since the lexical rule $f_{\text{Ans}}$ in (99) can in principle turn any proposition-taking denotation to a question-taking one, we expect it to derive a question-taking variant of an anti-rogative predicate, as exemplified with think in the following:

$$ [f_{\text{Ans}} \text{[think]}] = \lambda Q_{[st,t]} \lambda x. \exists w'[\text{think}_{w'}(\text{AnsD}_{w'}(Q))(x)] $$

In other words, the compositional semantics under the proposition-oriented theory predicts interrogative-complementation to be in principle possible under anti-rogative predicates. This calls for an explanation for why anti-rogative predicates like think cannot embed interrogative complements. Secondly, the proposition-oriented theory also has difficulty dealing with rogative predicates, such as wonder. Here, the problem is two-fold: (a) it is unclear what the proposition-oriented semantics for wonder would look like; (b) even if a proposition-oriented semantics for wonder turns out to be possible, it is unclear how its selectional restriction is accounted for. The latter issue will be discussed further in Ch. 3.

### 2.5.2 Question-oriented theory

Let us now consider the implementation of the question-oriented theory. Just as in the previous subsection, we will start by reviewing the basic features of the question-oriented analysis for responsive predicates, repeated below:

$$ \text{Question-oriented semantics} + \text{question-like semantics of declaratives} $$

- Responsive predicates semantically select for questions.
- Declarative complements express a semantic object that is of the same type as questions.

In view of the baseline analysis of interrogative complements, the question-oriented semantics for know and guess can be defined as follows:

$$ \begin{align*}
(103) \quad & [\text{know}]^w = \lambda Q_{[st,t]} \lambda w. \exists w'[\text{guess}_{w'}(x, \text{AnsD}_{w'}(Q))] \\
& [\text{guess}]^w = \lambda Q_{[st,t]} \lambda w. \exists w'[\text{guess}_{w'}(x, \text{AnsD}_{w'}(Q))]
\end{align*} $$

Together with the proposition-set denotation for interrogative complements repeated below, we can straightforwardly derive the interpretations predicted in the baseline analysis, as shown in (104):

$$ \begin{align*}
(98) \quad & [\text{which girl won the prize}]^w = \{ \lambda w' : \exists x (\text{girl}_{w'}(x) \land \text{won}_{w'}(x)), \text{girl}_{w'}(y) \land \text{won}_{w'}(y) \mid y \in D_w \} \\
(104) \quad & \begin{align*}
& [\text{Alice knows which girl won the prize}]^w \\
& \leftrightarrow [\text{know}]^w([\text{which girl won the prize}]^w(a)) \\
& \leftrightarrow \exists w'[\text{guess}_{w'}(a, \text{AnsD}_{w'}([\text{which girl won the prize}]^w))]
\end{align*}
\end{align*} $$
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b. \[ \langle \text{Alice guessed which girl won the prize} \rangle^w \]
\[ \iff \langle \text{guess} \rangle^w (\langle \text{which girl won the prize} \rangle^w) (a) \]
\[ \iff \exists u' \langle \text{guess}_u, (a, \text{AnsD}_{u'} (\langle \text{which girl won the prize} \rangle^u)) \rangle \]

At this point, it is worth emphasizing an important difference between the proposition-oriented derivation and the question-oriented derivation of the interpretation of V-wh sentences. Even though the end results of the compositional derivations for know/guess-wh under the two theories are the same, the derivations crucially differ in whether AnsD is assumed to be a part of the general compositional mechanism or not. Specifically, under the proposition-oriented analysis, the derivation of the interpretation of a V-wh sentence necessarily involves AnsD as part of the type-shifter \( f_{\text{Ans}} \). On the other hand, AnsD is not a necessary part of a compositional derivation of V-wh sentences under the question-oriented analysis. AnsD are there in (104) because the lexical denotations of the verbs know and guess are analyzed to contain AnsD. However, this is not a necessary feature of the question-oriented theory. The theory in principle allows for a question-oriented denotation of a clause-embedding predicate which does not contain AnsD. In fact, in Chapters 3 and 4, I will argue that such a denotation is required for rogative predicates like wonder and certain classes of responsive predicates, including predicates of relevance such as matter and care.

Let us now turn to the second feature in (102)—the treatment of declarative complements as having the same semantic type as questions. In Ch. 1, this was ensured by the Triv-operator, which turns a proposition into a ‘trivial’ question. We can now give a more formal definition of this operator, as follows:

\[
\text{(105)} \quad \text{Triv} = \lambda p_{st}. \{ \ p \ \} = \text{Ident} \quad \text{(cf. Partee 1987)}
\]

This operator turns a proposition as its input and returns the singleton set having the input as its only member. Use of such a type-shifter is not entirely new in formal semantics. The type-\( e \) variant of this type-shifter has been posited by Partee (1987) and referred to as Ident as part of her analysis of the range of interpretations for noun phrases. Following this, I will refer to this type-shifter as Ident from now on.

Compositionally, we can assume that Ident is in fact the semantic contribution of the declarative complementizer. This will guarantee that declarative complements always denote a (singleton) proposition-set. An alternative option is to overhaul sub-clausal compositional semantics along the lines of Ciardelli et al. (2017) and revise the semantics of lexical items so that the clausal denotation is always of type \( \langle s, t \rangle \). Although I will pursue the first option to make exposition conservative and simple, the question-oriented theory I will develop in this book can in principle be implemented with the sub-clausal composition along the lines of Ciardelli et al. (2017).

Based on the definition of Ident in (105) and the assumption that the declarative complementizer contributes Ident, we can compositionally drive the declarative-embedding sentences with know and guess as follows:

\[
\text{(106) a. } \langle \text{Alice knows that (=Ident) Bonnie won the prize} \rangle^w \\
\iff \langle \text{know} \rangle^w (\langle \text{Ident} \rangle^w (\langle \text{Bonnie won the prize} \rangle^w)) (a) \\
\iff \langle \text{know} \rangle^w (\{ (\langle \text{Bonnie won the prize} \rangle^w) \}) (a)
\]
\( \Leftrightarrow \exists w' [K_w(a, \text{AnsD}_w(\{\lambda w_s.\text{won}(b)\}))] \)

\( \Leftrightarrow K_w(a, \lambda w_s.\text{won}(b)) \)

b. \( [[\text{Alice guessed that}(=\text{Ident}) \text{Bonnie won the prize}]]^w \)
\( \Leftrightarrow [[\text{guessed}]]^w([[\text{Ident}]]^w([[\text{Bonnie won the prize}]]^w))(a) \)
\( \Leftrightarrow [[\text{guessed}]]^w(\{[[\text{Bonnie won the prize}]]^w\})(a) \)
\( \Leftrightarrow \exists w'[\text{guess}_w(a, \text{AnsD}_w(\{\lambda w_s.\text{won}(b)\}))) \]
\( \Leftrightarrow \text{guess}_w(a, \lambda w_s.\text{won}(b)) \)

The last step in each of the above derivations is guaranteed by the fact that \( \text{AnsD}_w(\{p\}) = p \) for any \( w \) and \( p \) that satisfy the presupposition of \( \text{AnsD} \).

Just like the proposition-oriented theory, the theory has at least prima facie difficulty dealing with non-responsive predicates. First, given the fact that declarative complements are represented as a set of propositions, it is at least not straightforward why there exist rogative predicates, which can only take interrogative complements. Anti-rogative predicates also present challenges with respect to their interpretations and selectional restrictions: how we capture their interpretations under the analysis where their denotations are question-oriented and how we explain the fact that they cannot take interrogative complements. Anti-rogative predicates will be the focus of Ch. 6.

### 2.6 The internal composition of interrogative complements

Since the goal of the current book is to compare the proposition-oriented theory and the question-oriented theory of the semantics of clausal complementation, the internal composition of interrogative complements is not our primary concern. In fact, any compositional analysis of interrogative complements suffices for our purposes, as long as it derives the local-triggering of the UP/EP discussed in Sect. 2.4.3. In this section, I will provide a sketch of such a compositional analysis I have previously proposed in Uegaki (2020), which derives a set of partial propositions through the projection of presupposition from a definite-like semantics for \( \text{which-NPs} \).

The analysis follows the insights of Rullmann and Beck (1998) (R&B), who roughly treat the semantics of \( \text{which-complements} \) as follows:

\[
(107) \quad [[\text{which student smokes}]] = \{\text{‘the student } a \text{ smokes’}, \text{‘the student } b \text{ smokes’}, \text{‘the student } c \text{ smokes’}, \ldots\}
\]

R&B compositionally derive this using a definite-like semantics for \( \text{which-NPs} \). As a result of the definiteness, each answer in (107) presupposes existence of a student. Note that the UP/EP we are after is stronger than the presupposition captured in (107). Rather than ‘there is a student’, we want each answer of the complement denotation to presuppose that there is a unique student \( \text{smoker} \). To achieve this, I roughly treat the denotation of a \( \text{wh}-\text{complement} \) as follows, i.e., a set of propositions each identifying an individual with the student smoker.

\[21\text{ A majority of this section is taken from Uegaki (2020).}\]
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(108) \[ \text{[which student smokes]} = \{ a \text{ is the student who smokes, } b \text{ is the student who smokes,...} \} \]

Formally, this is derived by assuming an LF that looks like the following:

(109)

\[
\begin{array}{c}
\text{2} \\
\text{CP} \\
\text{which} \\
\text{1} \\
\text{C'} \\
\text{[+]wh} \\
\text{p} \\
\text{WHICH} \\
\text{1} \\
\text{student smokes}
\end{array}
\]

This structure follows the LF-based rendition of Karttunen’s (1977) analysis of questions by Heim (2016) and Dayal (2016), together with the additional assumption that the lower copy of \text{which} is realized in the LF as the operator \text{WHICH}, defined shortly below. Furthermore, following Beck and Rullmann (1999), the NP-part of a which-phrase is left downstairs to allow both the \text{de re} and \text{de dicto} readings via world-indexing on the NP. (See Hirsch and Schwarz 2019 for an analysis along the same lines.)

The translations of lexical items in (109) are given below, with the definition of the operator \text{σ} in (111), akin to Link’s (1983) \text{σ}-operator.

(110)

a. \[ \text{[which]} = \lambda P(x,t), \exists x[P(x)] \]

b. \[ \text{[C[+]wh]} = \lambda P(x,t), [\lambda q(x,t). p = q] \]

c. \[ \text{[WHICH]} = \lambda P(x,t), \lambda Q(x,t), i = \sigma(\lambda x. P(x) \land Q(x)) \]

(111) \[ \sigma := \lambda P(x,t): \exists x[P(x) \land \forall y[P(y) \rightarrow y \leq x]], \lambda x[P(x) \land \forall y[P(y) \rightarrow y \leq x]] \]

Hence, the structure in (109) is translated as in (112), and each answer of the question (112) represents has the presupposition in (113) projected from \text{σ}.

(112) \[ \text{[[[109]]]} = \lambda p. \exists z[P = \lambda w. [z = \sigma(\lambda x. \text{student}_w(x) \land \text{smoke}_w(x))]] \]

(113) \[ \exists x[\text{student}_w(x) \land \text{smoke}_w(x) \land \forall y[\text{student}_w(y) \land \text{smoke}_w(y) \rightarrow y \leq x]] \]

Since student only ranges over singular individuals, (113) effectively states that there is only one student smoker. Overall, this correctly derives the UP/EP as the presupposition of each answer. Note that this would not be possible under Rullmann and Beck’s (1998) original analysis, since it is designed to only predict existential presupposition with respect to the extension of the NP in which-NPs.

The analysis sketched above concerns which-complements, and its prediction with respect to complements involving a simplex whom-phrase (e.g., who smokes) depends on the definition of the whom-operator, whom, in the lower copy position. Following Dayal’s (1996) insight, the fact that simplex whom-complements only presuppose existence (and not uniqueness) is captured by treating whom as number-neutral, as follows:

\[ \text{In order for whom to take scope over the materials in the TP, it has to be assumed that a whom-phrase internally merges to a projection below CP before internally merging to the specifier of CP.} \]
(114) \([\text{who}]^w = \lambda P_e, t. \ i = \sigma (\lambda \cdot \text{human}^*_w(x) \land P(x))\)

2.7 Chapter summary

In this section, I have introduced the semantic framework, within which I will develop both the proposition-oriented and the question-oriented theories for clausal complementation in subsequent chapters. I have furthermore discussed the ‘baseline’ semantic analysis of questions and sentences involving interrogative complements, building on current literature on the treatment of exhaustivity, the existential/uniqueness presupposition and veridicality. In view of the baseline analysis, I have also substantiated the formal details of the proposition-oriented theory and the question-oriented theory introduced in the previous chapter.
Bibliography


Elliott, Patrick D., Andreea C. Nicolae, and Uli Sauerland. 2018. Who and what do *who* and *what* range over cross-linguistically?

Fox, Danny. 2013. Mention-some readings. Ms. MIT and HUJI.

Fox, Danny. 2020. Pointwise exhaustification and the semantics of question embedding. Manuscript, MIT.


Chapter 3

Wondering: a clear case of question-orientation?

3.1 Introduction

In Ch. 1, I introduced two theories of the semantics of clause-embedding predicates—the PROPOSITION-ORIENTED THEORY and the QUESTION-ORIENTED THEORY—and considered how they deal with the basic behavior of responsive predicates, i.e., those predicates that can embed either a declarative or an interrogative complement. The tentative conclusion of the chapter was that responsive predicates can be adequately analyzed either as having a proposition-oriented semantics or a question-oriented semantics. In other words, at this point, responsive predicates seem to be compatible with either of the two semantic theories of clausal complementation. I will revisit responsive predicates in the following chapters, and investigate whether the two theories can correctly capture aspects of the meaning of (sentences involving) responsive predicates that have not been discussed so far.

In this chapter, we will have a brief detour from responsive predicates, and examine whether the behavior of picky predicates can help us resolve the choice between the two approaches. Non-responsive clause-embedding predicates can be divided into two classes: ROGATIVE PREDICATES, i.e., those predicates that only embed interrogative complements (e.g., wonder, investigate) and ANTI-ROGATIVE PREDICATES, i.e., those predicates that only embed declarative complements (e.g., believe, hope). In this chapter, I will focus on rogative predicates and postpone the discussion of anti-rogative predicates until Ch. 6.

The reason for focusing on rogative predicates at this early stage of the book is because they prima facie offer a clear case of question-orientation. Intuitively, wondering is an attitude directed toward a question (see e.g., Friedman 2013 for an in-depth argument to this effect within epistemology; see also Carruthers 2018, Friedman 2019 for relevant discussion in philosophy). If this is true, it seems natural that we need a question-oriented theory of clause-embedding predicates to accommodate predicates like wonder. In this chapter, I will examine if this line of argument is warranted by com-
paring an existing question-oriented semantics for rogative predicates and its alternative formulated within the proposition-oriented theory. To preview the conclusion, I will argue that a proper analysis of rogative predicates indeed calls for a question-oriented semantics. However, we will also see that the argument is not as straightforward as it initially appears, in view of the possibility of a decompositional analysis under the proposition-oriented theory.

The rest of the chapter is structured as follows. In Sect. 3.2, I introduce the class of English rogative predicates, and select wonder and ask as representativerogative predicates to consider in the chapter. In Sect. 3.3, I discuss a question-oriented semantics for wonder and ask building on Ciardelli and Roelofsen (2015), who provide an adequate analysis of their interpretation and selectional restriction. We then consider a proposition-oriented semantics for rogatives in Sect. 3.4, based on the idea that they can be decomposed into multiple proposition-oriented predicates, e.g., wonder is analyzed as want-to-know. I will argue that the decompositional analysis faces empirical and conceptual problems, despite its prima facie plausibility.

3.2 Rogative predicates

As introduced above, rogative predicates are those clause-embedding predicates that only embed interrogative complements. An example of such a predicate in English is wonder, as in the following examples:

(1) a. Alice wondered whether Bob showed to the party.
   b. *Alice wondered that Bob showed to the party.

Other examples of rogative predicates are listed below, where they are divided into two classes, INQUISITIVE PREDICATES (the term after Karttunen 1977) and ROGATIVE SPEECH ACT PREDICATES, according to their intuitive lexical semantics:

(2) Rogative predicates
   a. inquisitive predicates: wonder, investigate, be interested (in), be curious (about), be agnostic (about)
   b. rogative speech act predicates: ask, inquire, query, question.

An analysis of rogative predicates ideally should account for two aspects of their empirical behavior: their interpretations and selectional restrictions. Below, I will discuss how these two aspects of the behavior of rogative predicates are accounted for under the question-oriented theory and the proposition-oriented theory in turn. To avoid discussing the nitty gritty of the lexical semantics of individual predicates, I will just give analyses of two representative examples from the two classes in (2): wonder and ask, and use them as a proof of concept for the analysis of rogative predicates in general, both under the question-oriented and the proposition-oriented theory.

---

1One can include predicates of dependency (e.g., depend on) in the class of rogative predicates (Karttunen, 1977), as they select interrogative complements both in the subject and in the object position. See Theiler et al. (2019) for a recent question-oriented analysis of the predicates of dependency.
3.3 Question-oriented semantics for rogative predicates

3.3.1 A question-oriented semantics for wonder

A question-oriented semantics for wonder is proposed by Ciardelli and Roelofsen (2015) within the framework of Inquisitive Semantics. In this section, I present a rendition of their proposal that is made to fit the overall theoretical framework of the current book. In Ciardelli and Roelofsen 2015, the semantics of wonder is analyzed as the conjunction of uncertainty and ‘entertaining’ of a question, the latter of which is represented with the new modality $E$ in the metalanguage:

$$\text{The question-oriented semantics for wonder}$$

$$\llbracket \text{wonder} \rrbracket^w = \lambda Q (s,t, t) \lambda x_e. \neg \exists w' [B_w(x, \text{Ans}D_w (Q))] \land E_w(x, Q)$$

The $B$ (belief) modality is analyzed along the lines of the Hintikkan analysis, as follows:

$$\text{Definition: the belief modality, } B$$

$$B_w(x, p) \iff \text{DOX}_w^x \subseteq p$$

What does it mean for an agent to ‘entertain’ a question? In Ciardelli and Roelofsen (2015), this is captured by introducing so-called inquisitive states in the model, which are sets of propositions that would resolve all the question an agent has. Formally, the inquisitive state is defined as follows:

$$\text{Definition: inquisitive states, INQ}$$

For each world $w \in W$ and each agent $a \in D$, $\text{INQ}_a^w$ (i.e., the inquisitive state of $a$ in $w$)

- is a downward-closed set$^2$ of propositions that settle the questions that $a$ has in $w$, and
- satisfies the constraint: $\bigcup \text{INQ}_a^w = \text{DOX}_w^x$.

As a simple example, suppose $a$’s doxastic state is $\{w_1, w_2, w_3\}$, and $a$ has a question about whether the actual world is in the set $\{w_1, w_2\}$ or in $\{w_2, w_3\}$. Then, $a$’s inquisitive state would be the set of propositions consisting of: $\{w_1, w_2\}$, $\{w_2, w_3\}$, $\{w_1\}$, $\{w_2\}$, and $\{w_3\}$. Because of the downward closure condition in (5), the set not only includes the propositions $\{w_1, w_2\}$, $\{w_2, w_3\}$, but also the (singleton) propositions that entail these propositions. The set also satisfies the second condition, i.e., that the inquisitive state covers the doxastic state.

The entertainment modality, $E$ is defined in terms of an agent’s inquisitive state, as follows:

$$\text{Definition: the entertainment modality, } E$$

$$E_w(x, Q) \iff \forall p \in \text{INQ}_x^w \exists p' \in Q [p \subseteq p']$$

In other words, $a$ entertains $Q$ in $w$ iff, once the questions $a$ has in mind in $w$ are resolved, $Q$ is also resolved.

Together with the uncertainty condition, the analysis captures the intuitive meaning of wonder. To see this in an example, let’s assume the following model with the logical

---

$^2$A proposition-set $S$ is downward-closed iff for all $p \in S$, if $p' \subseteq p$, then $p' \in S$. 
space $W$ consisting of four worlds, $B$ the proposition that Bonnie showed up, and $C$ the proposition that Carol showed up.

(7) a. $W = \{w_{bc}, w_b, w_c, w_∅\}$
   b. $B = \{w_{bc}, w_b\}$
   c. $C = \{w_{bc}, w_c\}$

Now consider the three inquisitive states for Alice in (8) (with ↓ indicating downward closure), and the example sentence in (9):

(8) a. $\text{INQ}_1^w a = \{\{w_{bc}, w_b\}, \{w_c, w_∅\}\} \downarrow$ ‘Did B show up or not?’
   b. $\text{INQ}_2^w a = \{\{w_{bc}, w_c\}, \{w_b, w_∅\}\} \downarrow$ ‘Did C show up or not?’
   c. $\text{INQ}_3^w a = \{\{w_{bc}\}, \{w_b\}\} \downarrow$ ‘Did both B and C show up or only B?’

where $Q^↓ := \{p | p ⊆ q$ for some $q ∈ Q\}$

(9) ‘Alice wonders whether Bonnie showed up’
   $⇔ \neg \exists w′[B_w(a, \text{Ans}_D w′(\{B, \overline{B}\})) \land E_w(a, \{B, \overline{B}\})]$  

With $\text{INQ}_1^w a$ in (8a), all questions that Alice has in mind are resolved once she is certain about whether Bonnie showed up or not. With $\text{INQ}_2^w a$ in (8b), all questions she has resolved once she is certain about whether Carol showed up or not. With $\text{INQ}_3^w a$ in (8c), she believes that Bonnie showed up, and is entertaining the issue of whether Carol showed up as well. Our semantics predicts (9) to be true if $\text{INQ}_1^w a$ represents Alice’s inquisitive state, but false if $\text{INQ}_2^w a$ or $\text{INQ}_3^w a$ does. In the case of $\text{INQ}_2^w a$, the entertainment condition—the second conjunct of (9)—is violated while in the case of $\text{INQ}_3^w a$, the uncertainty condition—the first conjunct of (9)—is violated.

### 3.3.2 The selectional restriction of wonder

The question-oriented semantics for wonder in (3) also accounts for its selectional restrictions. The account is based on the fact that the meaning of a wonder-that sentence is predicted to be contradictory, given the semantics of wonder in (3) and the singleton-set semantics for declarative complements. This can be illustrated with the following example, where it is assumed that $[\text{that Bob showed up}]^w = \text{Ident}(B) = \{B\}$:

(10) ‘Alice wonders that Bob showed up’

$⇔ \neg \exists w′[B_w(a, \text{Ans}_D w′(\{B, \overline{B}\})) \land E_w(a, \{B, \overline{B}\})]$

$⇔ \neg B_w(a, B) \land E_w(a, \{B\})$

This meaning is contradictory because of the following equivalence to the second conjunct.\(^3\)

(11) $E_w(a, \{B\}) ⇔ \forall p′ ∈ \text{INQ}_2^w[p′ ⊆ B]$

$⇔ \bigcup \text{INQ}_2^w ⊆ B$

$⇔ \text{DOX}_2^w ⊆ B$

$⇔ B_w(a, B)$

\(^3\)Informal proof of the second line: the $⇒$ direction is obvious. The $⇐$ direction holds because, if $\bigcup \text{INQ}_2^w ⊆ B$ holds, no matter what the set of propositions in $\text{INQ}_2^w$ are, all the propositions in $\text{INQ}_2^w$ are contained in $B$. 

3.3. QUESTION-ORIENTED SEMANTICS FOR ROGATIVE PREDICATES

An additional assumption of the account is the idea that logical triviality (either tautology or contradiction) systematically arising from logical vocabulary in a sentence leads to unacceptability (Barwise and Cooper 1981, Gajewski 2002, 2009, Chierchia 2013, 2019, Schwarz and Simonenko 2018, Del Pinal 2019, a.o.). Given this assumption, the unacceptability of a wonder-that sentence is accounted for by the systematic contradiction arising from logical words, i.e., wonder and the type-shifter Ident.\(^4\)

### 3.3.3 A question-oriented semantics for ask

Turning now to rogative speech act predicates like ask, I argue that the ignorance and the entertainment conditions involved in the analysis of wonder in (3) are also present in their lexical semantics. More specifically, I argue that (a) ask encodes the sincerity condition of the question speech act (Searle, 1969), and that (b) the sincerity condition requires the asker to be wondering about the question (in Ciardelli and Roelofsen’s sense), i.e., they are uncertain about the answer to the question and they are entertaining it.\(^6\) When the complement of ask is a declarative complement, the (lexical encoding of) the sincerity condition cannot be satisfied because the ignorance condition and the entertainment condition contradict with each other, resulting in the logical triviality. All in all, the explanation for the selectional restriction for wonder essentially carries over to ask.

To wrap up, the question-oriented semantics is capable of accounting for the interpretation of wonder and ask. Notably, we have also seen that the question-oriented semantics can provide semantic explanations for the selectional restrictions of these predicates, despite the initial appearance of a problem discussed in Ch. 1. Although I will not investigate in complete detail whether the analyses outlined here for wonder and ask can be extended to rogative predicates in general, they provide us with a promising outlook since the two subclasses of rogative predicates listed in (2) intuitively form a cohesive semantic class. It is reasonable to assume that the combination of the ignorance condition and the entertainment condition constitutes a ‘core’ of the lexical semantics of rogative predicates in general.

\(^4\)Several authors cited here make a stronger claim that logical triviality results in ungrammaticality while others, notably Schwarz and Simonenko (2018), claim that it leads merely to unacceptability. In this book, I stay agnostic about this issue and take a weaker stand, assuming that logical triviality leads to unacceptability which in principle subsumes ungrammaticality.

\(^5\)An issue remains as to how to determine the class of logical words that are relevant for this mechanism. Gajewski’s (2002) characterization of logical words (following van Benthem’s (1989) earlier work) in terms of permutation invariance fails to classify attitude verbs like wonder as a part of the logical vocabulary. For, the denotations of attitude verbs are dependent on the evaluation world and thus not invariant with respect to the permutation of worlds. In this book, I tentatively assume a set of predetermined set of logical words including quantifiers, connectives, type-shifters and type \(\langle st, t, \vec{e}\rangle\) attitude predicates.

\(^6\)I would like to leave open the issue of whether the condition is encoded as a presupposition or as an at-issue content in the semantics of ask.
3.4 Proposition-oriented semantics for rogative predicates

Earlier, I have suggested that the interpretation of rogative predicates already poses a puzzle for the proposition-oriented semantics. The question, roughly, is how we can understand the meaning of a rogative predicate under the proposition-oriented semantics, if the predicate does not seem to embed a proposition to begin with. This puzzle, however, turns out to be a superficial one. Although the selectional restriction of rogative predicates makes it difficult, it *is* possible to posit a proposition-taking semantics for rogative predicates like wonder, which also accounts for the selectional restriction. In this section, I will outline such an analysis based on the semantics for wonder proposed in Uegaki (2015).

3.4.1 A proposition-oriented semantics for wonder

Uegaki’s (2015) analysis of wonder is based on the long-standing intuition that wonder can be paraphrased as ‘want to know’ (Karttunen, 1977, ? Guerzoni and Sharvit, 2007). Such a paraphrase is exemplified below:

(12) \([\text{Alice wonders who sang}] \simeq \text{‘Alice wants to know who sang’}\)

Uegaki (2015) incorporates this paraphrase directly into the semantics of wonder, decomposing the meaning of wonder into want and know:

(13) \([\text{wonder}]^w = \lambda p s t. \lambda x e. [\text{want}]^w (\lambda w'. [\text{know}]^w' (p))(x)(x)\)

To the extent that the paraphrase of wonder as ‘want to know’ is accurate (an issue we will come back to at the end of this section), the analysis straightforwardly captures the interpretation of wonder. For example, (12) is analyzed as in (15), given our baseline analysis of interrogative-embedding under the proposition-oriented semantics, repeated from Ch. 2 in (14).

(14) The baseline semantic analysis of interrogative-embedding sentences

\([x V s Q]^w \iff \exists w' [V_w (x, \text{AnsD}_{w'} (Q))]\)

(15) \([\text{Alice wonders whether Bob showed up}]^w \equiv [\text{want}_w (a, \lambda w'. \exists w'' [K_w (a, \text{AnsD}_{w''} ([\text{who sang}]^w''))]) \quad \text{(by (14))}\]

\([\text{want}_w (a, \lambda w'. K_w (a, \text{AnsD}_{w'} ([\text{who sang}]^w'))}) \quad \text{(by the veridicality of K)}\)

3.4.2 The selectional restriction of wonder

There is a further benefit to this analysis: the selectional restriction of wonder simply falls out from the lexical semantics, in light of the unacceptability of a want-to-know

---

7 This denotation is slightly different from the version in Uegaki (2015) since the original version is in fact question-oriented with the Ans-operator lexically encoded in the denotation. Here, I will use a proposition-oriented version without the lexically-encoded Ans-operator to illustrate the possibility of a proposition-oriented semantics for wonder.

8 The analysis does not commit to the morphological decomposition of wonder into want to know. The analysis simply states that the denotation of wonder corresponds to that of want to know.
3.4. PROPOSITION-ORIENTED SEMANTICS FOR ROGATIVE PREDICATES

sentence with a declarative complement, such as the following:

(16) ??Alice wants to know that Bob sang.

It turns out that the unacceptability of this example is expected, given the well-known facts about the presuppositions and the presupposition projection behaviors of want and know in (17), and the principle in (18) (Hereafter, I will abbreviate ‘\(\lambda w. O_w(\varphi)\)’ as ‘\(O(\varphi)\)’ for any propositional operator \(O\)):

(17) Presuppositions and presupposition projection properties of want

For any \(p \in D_{st}, \pi \in D_{st}, x \in D_e\) and \(w \in D_{s}\),

a. \(\llbracket \text{want} \rrbracket^w(p)(x)\) is defined only if \(\neg B_w(x, p)\)

b. \(\llbracket \text{want} \rrbracket^w(p)(x)\) is defined only if \(B_w(x, \pi)\)

(c) \(\llbracket \text{know} \rrbracket^w(p)(x)\) is defined only if \(p(w)\)

(18) Principle of Positive Certainty

For any \(x, p\) and \(w\), \(B_w(x, p)\) entails \(B_w(x, K(x, p))\).

The first fact about want in (17a) states that \(\llbracket x \text{ wants} \rrbracket p \neg\) presupposes that it is not the case that \(\llbracket x \text{ believes} \rrbracket p \neg\) (e.g., Heim, 1992). We call this the NONBELIEF PRESUPPOSITION of want. The second fact in (17b) states that want projects the presupposition of its complement to the attitude-holder’s belief state (e.g., Karttunen, 1974). The third is simply the factivity of know (e.g., Kiparsky and Kiparsky, 1970). Finally, the principle in (18) states that, if one believes \(p\), they believe that they know that \(p\). This principle is known as the Principle of Positive Certainty in epistemic logic involving both belief and knowledge operators (e.g., van der Hoek, 1993), and I take this to be a reasonable principle to assume in our semantics.

Given these assumptions, we predict \(\llbracket x \text{ wants to know} \rrbracket p \neg\) to have the presuppositions described in (19) and (20):

(19) \(\llbracket \text{want} \rrbracket^w(\lambda w'. \llbracket \text{know} \rrbracket^w(p)(x))(x)\) is defined only if \(\neg B_w(x, K(x, p))\) (by (17a))

(20) \(\llbracket \text{want} \rrbracket^w(\lambda w'. \llbracket \text{know} \rrbracket^w(p)(x))(x)\) is defined only if

a. \(B_w(x, p)\) (from (17b) and (17c))

b. \(B_w(x, K(x, p))\) (from (20a) and (18))

The two conditions in (19) and (20b) contradict each other, resulting in the logical triviality in the presupposition of \(x \text{ wants to know} p\). I submit that this logical triviality is underlying the unacceptability of (16) (e.g., Gajewski, 2002).

Now, importantly, a similar logical triviality is not predicted when the complement is interrogative. As I will explain immediately below, our baseline proposition-oriented semantics employing AnsD already captures the fact that want to know (and by extension wonder) does not involve logical triviality with an interrogative complement. It predicts that the presuppositions of a sentence like the following are consistent:

\(^9\)The sentence is acceptable under the reading ‘Alice wants to confirm that Bob sang’. Below, I will argue that this reading involves a local accommodation of the factivity of know, and that the semantics correctly predicts that the sentence is acceptable once the factivity is locally accommodated.
(21)  Alice wants to know whether Bob showed up.

The crucial difference between the declarative case and the interrogative case lies in the presupposition of the infinitive complement of *want*, e.g., *PRO knows that/whether Bob showed up*. In the declarative case, given the factivity of *know*, a *know*-that sentence presupposes that the complement is true, as shown in (22a). On the other hand, a *know*-wh sentence presupposes that the proposition returned by \( \text{Ans}_{w'} \) is true (where \( w' \) is the evaluation world of the infinitive clause embedded by *want*) as shown in (22b). (In the example here, we assume that \( p = \llbracket \text{Bob showed up} \rrbracket \) and \( Q = \llbracket \text{whether Bob showed up} \rrbracket \)).

(22)  a. \[
\llbracket \text{PRO to know [that Bob showed up]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} p(w') \quad (\simeq \text{’Bob showed’})
\]

b. \[
\llbracket \text{PRO to know [AnsD [whether Bob showed up]]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} \text{AnsD}_{w'}(Q)(w') \quad (\simeq \text{’the Dayal-answer of } Q \text{ in } w' \text{ is true in } w''')
\]

Note that the presupposition of (22b) is tautologous as it states that the true answer (in \( w' \)) to the embedded question is true (in \( w'' \)). In contrast, the presupposition of (22a) is, of course, non-tautologous, as it states that a specific answer is true. These presuppositions are projected as in (23) in the corresponding *want-to-know* sentences, based on the presupposition projection behavior of *want* in (17b), repeated below.

(23)  a. \[
\llbracket \text{Alice wants PRO to know [that Bob showed up]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} B_{w'}(a, p) \quad (\simeq \text{’Alice believes that Bob showed up’})
\]

b. \[
\llbracket \text{Alice wants PRO to know [AnsD [whether Bob showed up]]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} B_{w'}(a, \lambda w'. \text{AnsD}_{w'}(Q)(w')) \quad (\simeq \text{’Alice believes that the Dayal-answer of } Q \text{ is true’})
\]

(17b)  \[ \llbracket \text{want} \rrbracket (p, x)(w) \text{ is defined only if } B_{w'}(x, \pi) \]

The declarative-embedding version in (23a) presupposes that Alice believes that Bob showed up while the interrogative-embedding version in (23b) presupposes that Alice believes a tautologous proposition. The former, but not the latter, contradicts the non-belief presupposition of *want*, described below:

(24)  a. \[
\llbracket \text{Alice wants PRO to know [that Bob showed up]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} \neg B_{w'}(a, K(a, p)) \quad (\simeq \text{’It’s not the case that Alice believes she knows } p')
\]

b. \[
\llbracket \text{Alice wants PRO to know [AnsD [whether Bob showed up]]} \rrbracket _{w'} \overset{\text{presup}}{\Rightarrow} \neg B_{w'}(a, \lambda w'. K_{w'}(a, \text{AnsD}_{w'}(Q))) \quad (\simeq \text{’It’s not the case that Alice believes she knows the true answer to } Q’)
\]

Given the Principle of Positive Certainty, (18) repeated below, (23a) contradicts (24a).

(18)  For any \( x, p \) and \( w \), \( B_{w'}(x, p) \) entails \( B_{w'}(x, K(x, p)) \).

In contrast, (23b) does not contradict (24b), even if we take into account Positive Certainty. One the one hand, the presupposition in (23b) + Positive Certainty will lead to the following presupposition:

(25)  \[ B_{w'}(a, K(a, \lambda w'. \text{AnsD}_{w'}(Q)(w'))) \]
That is, Alice believes that she knows that a tautologous proposition is true. On the other hand, (24b) states that it is not the case that Alice believes that she knows the true answer. The two presuppositions are consistent. As long as Alice believes that she doesn't know the actual answer and she is rational enough to believe that a tautologous proposition is true, both presuppositions are met. Hence, logical triviality is predicted only for the declarative-embedding case, capturing the selectional restriction of want to know.10

3.4.3 Local accommodation

As suggested in footnote 9, (16) repeated below, is acceptable under the reading ‘Alice wants to be sure that Bob sang’.

(16) ??Alice wants to know that Bob sang.

This fact is expected under the current account, assuming the possibility that the factivity of know is locally accommodated. If the factivity of know is locally accommodated below want, we expect the interpretation of the sentence along the lines of ‘Alice wants to confirm that Bob sang’ without any logical triviality. To illustrate this, I employ the accommodation operator \( A \) from Beaver and Krahmer (2001), defined as follows:

\[
A(p) := \lambda w. \begin{cases} 
1 & \text{if } p(w) = 1 \land p(w) \text{ is defined} \\
0 & \text{if } p(w) = 0 \lor p(w) \text{ is undefined}
\end{cases}
\]

Given that know has the factivity presupposition (and assuming no other presupposition), applying \( A \) to \( x \) knows \( p \) gives us the following:

\[
A(\lambda w. [\text{know}^w(p)](x)) = \lambda w. \begin{cases} 
1 & \text{iff } [\text{know}^w(p)](x) \land p(w) \\
0 & \text{iff } [\text{know}^w(p)](x) \neq 1
\end{cases}
\]

That is, roughly, we have ‘\( x \) believes that \( p \) and \( p \) is true’ as the result of the application of \( A \) to \( \forall x \) knows that \( p \). Thus, applying \( A \) to the scope of want in \( \forall x \) wants to know \( p \), as in (28), we derive the interpretation ‘\( x \) wants \( p \) to be true and to believe \( p \)’.11

(28) \( [\text{want}^w(A(\lambda w'.[\text{know}^w'(p)](x)))](x) \)

I submit that this corresponds to the intuitive interpretation of the acceptable reading of (16).

10Note that taking into account the presupposition triggered by Ans does not significantly change the picture. Let’s consider the possibility that AnsDw(Q) has the existential+uniqueness presupposition, i.e., \( \exists! p \in Q[p(w)] \), we drive the following presupposition in place of (23b):

(i) \( B_w(a, \lambda w'. \text{AnsD}_w(Q)(w') \land \exists! p \in Q[p(w')]) \)

(\( \Leftrightarrow \) Alice believes that the true answer of \( Q \) is true and that \( Q \) has a unique true answer.)

It is easy to see that (i) is still compatible with the non-belief presupposition in (24b). It is possible that Alice believes that there is a unique true answer while not knowing the answer.

11For presentational purposes, the paraphrase here assumes that the meaning of know is ‘belief’ plus the factive presupposition. Needless to say, we know from the vast literature in epistemology that this assumption is too simplistic (see e.g., Ichikawa and Steup, 2018). Thus, a more precise paraphrase should be something like ‘\( x \) wants \( p \) to be true and to know \( p \) if \( p \) were true’.
In the analysis of "x wants to know p" without local accommodation presented above, the contradicting presuppositions of the sentence was deemed to be the culprit of its unacceptability. More specifically, the nonbelief presupposition of want and the factivity presupposition projected to the belief state of the subject of want contradict each other. However, if the factivity is locally accommodated, the contradiction disappears. We only predict the following non-belief presupposition for (28):

\[(29) \quad \neg B_w(x, K(x, p) \land p)\]

The presupposition projection behavior of want described in (17b) does not add any condition to the presupposition of x wants to know p since the complement of want does not contain any presupposition due to the local accommodation. As a result, unlike in the case where there was no accommodation, the presupposition of (28) is consistent, and thus it does not suffer from the unacceptability due to logical triviality.

So far, my discussion concerned the (un)acceptability of want-to-know sentences, such as (16). It is easy to see how the analysis carries over to want if we assume the decompositional analysis of wonder in (13), where \([\text{wonder}] = [\text{want to know}].\) A wonder-that sentence is unacceptable for the same reason why a want-to-know-that sentence without local accommodation is unacceptable. One question is why there is no option for locally accommodation in the case of wonder. Unlike in the case of want-to-know in (16), the following sentence is not acceptable under the ‘want to confirm’ reading.

\[(30) \quad *\text{Alice wonders that Bob sang.}\]

This fact naturally falls out if we assume that the A-operator has to be inserted somewhere in the LF structure. If we assume this, it is natural that A cannot be inserted between ‘want’ and ‘know’ in the semantic representation of (30) since ‘want’ and ‘know’ are not represented separately in the LF structure.\(^\text{12}\) Note that applying A to the matrix clause (i.e., accommodating the presupposition globally) does not change the prediction that (30) involves logical triviality. In such a case, we would simply have a contradiction in the asserted content rather than in the presupposition.

### 3.4.4 Wonder vs. want to know

The decompositional analysis of wonder presented so far in this section rests on the assumption that the interpretation of wonder is indeed accurately paraphrased by ‘want to know’. But, is this really the case? A 1971 Elvis Presley song I really don’t want to know provides a nice data point suggesting that the paraphrase is not perfectly accurate:

\[(31) \quad \text{Oh how many arms have held you} \]
\[\quad \text{And hated to let you go} \]
\[\quad \text{How many, oh how many, I wonder} \]
\[\quad \text{But I really don’t want, I don’t want to know} \]

\(^{12}\)This of course further assumes that we do not commit to the morphological decomposition of wonder into want to know. The claim is that we simply have the equivalence \([\text{wonder}] = [\text{want to know}].\)
3.4. PROPOSITION-ORIENTED SEMANTICS FOR ROGATIVE PREDICATES

Here, Elvis sings that the wonder-relationship holds between him and a certain question (i.e., how many arms have held his lover and hated to let them go) but the want-to-know-relationship does not hold between him and the same question. The consistency of this statement is surprising if wonder is paraphrased as want to know. Intuitively, one concrete situation that would make \((31)\) consistent and true is where any possible answer to the question is such that knowing it would break Elvis’s heart (which is why he does not want to know it), while knowing the answer would make him less inquisitive than when he doesn’t know it (which is why he wonders about it). The assumption here is that one’s heartbrokenness and inquisitiveness\(^{13}\) are independent emotions. Elvis will be heartbroken but will no longer be inquisitive if he knows how many relationships his lover has had. At the same time, he won’t be heartbroken but will be inquisitive if he has no idea about this question. Arguably, paraphrasing wonder as ‘want to know’ conflates these two in principle independent emotions.

Thus, \((31)\) seems to run counter to the semantic decomposition where \([\text{wonder}] = [\text{want to know}]\). However, importantly, it does not provide an argument against the proposition-oriented decompositional analysis of wonder par se. The datum is compatible with a refined version of the decompositional analysis, where a different predicate is used in place of want. Such an analysis may look like the following:

\[
\begin{align*}
\text{(32)} & \quad \langle \text{wonder} \rangle^w = \lambda p \forall x. \lambda \pi. \text{LessInq}_w (x, K(x, p)) \\
\text{(33)} & \quad \text{LessInq}_w (x, p) \iff p \text{ makes } x \text{ less inquisitive than } \neg p \text{ in } w
\end{align*}
\]

Roughly, the analysis states that \(\forall x \text{ wonders } Q^w\) is paraphrased as ‘\(x\) would be made less inquisitive by knowing (the answer to) \(Q\)’. The analysis is compatible with the Elvis song because, according to it, \(\forall x \text{ wonders } Q^w\) does not entail \(\forall x \text{ wants to know } Q^w\), as knowing the answer to \(Q\) may make \(x\) less inquisitive while being undesirable for \(x\). Although I will criticize this line of account later, the above semantics demonstrates that it is in principle possible to posit a proposition-oriented semantics of wonder compatible with the datum in \((31)\).

The account of the selectional restriction of wonder can also be preserved by assuming that LessInq has the same relevant presupposition (projection) behaviors as want discussed above. Specifically, once the following holds for LessInq, the above account of the selectional restriction of wonder carries over to the new decompositional analysis in \((32)\):

\[
\begin{align*}
\text{(34)} & \quad \text{LessInq}_w (x, p) \text{ is defined only if } \neg B_w (x, p) \\
& \quad \text{LessInq}_w (x, p\pi) \text{ is defined only if } B_w (x, \pi)
\end{align*}
\]

3.4.5 Conceptual problems with the decompositional proposition-oriented analysis

As discussed in the last section, it is in principle possible to maintain a decompositional proposition-oriented analysis for wonder in the face data suggesting that the ‘want to know’ paraphrase is not always applicable. The move involves changing the predicate

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\(^{13}\)This term has to be understood in a pretheoretical sense, independent of the semantic framework of Inquisitive Semantics.
‘want’ involved in the decomposition to the predicate LessInq. This move, however, comes with a number of conceptual problems, which I will discuss in Sect. 3.4.5. Furthermore, it turns out that the decompositional analysis in general is incompatible with the compositional implementation of the proposition-oriented theory I have introduced in Ch. 2.

**Problems with the LessInq-relation**

A decompositional analysis is explanatory only if the semantics of individual elements of the decomposed structure is well-motivated from their behavior when they appear in environments other than the decomposed structure. This is indeed the case with the decomposition of *wonder* into ‘want to know’, as the semantics of both *want* and *know* are well-understood, and the semantic treatments of these items can be tested independently by observing their behavior in other environments. However, it is doubtful whether we have independent motivation for the semantics of LessInq utilized in the previous section.

For one thing, it is not clear if there is an overt counterpart of LessInq in English, which allows us to independently test its semantic properties. Indeed, one may try to express the attitude as something like ‘be less inquisitive if...’. A problem with this paraphrase, however, is that the English predicate *be inquisitive* is by itself a rogative predicate when it is used as a clause-embedding predicate.

(35)  a. Alice is inquisitive about whether Bob showed up.
     b. ??Alice is inquisitive that Bob showed up.

Thus, the English predicate *be inquisitive* itself cannot be used as an element in a decomposed structure if our goal is to decompose a rogative predicate into proposition-taking predicates. A related problem is that LessInq, as defined in (33), arguably only embeds an epistemic or emotive statement. This is so because only *learning, unlearning* (e.g., loss of memory) or *change in emotion* (e.g., loss of interest) can make one less inquisitive. If LessInq always appears with an embedded epistemic/emotive statement, it casts doubt on the status of LessInq as an independent attitudinal predicate, whose semantics we can independently test.

The lack of independent motivation for the semantics of LessInq is especially problematic as we evaluate the validity of the explanation of the selectional restriction under the LessInq-based proposition-oriented analysis in the previous section. The issue is that the presuppositional properties of LessInq crucial for the explanation, repeated below, have to be essentially stipulated.

(34)  a. LessInq\(_w\)(\(x, p\)) is defined only if \(\neg B_w(x, p)\)
     b. LessInq\(_w\)(\(x, p_\pi\)) is defined only if \(B_w(x, \pi)\)

In the case of the *want-to-know* analysis, the presuppositional behaviors of *want* corresponding to (34) (i.e., (17a-17b) above) are empirically motivated by the observations about the natural language predicate *want* in the earlier literature (e.g., Karttunen, 1974, Heim, 1992). However, it is not obvious whether the parallel claims about LessInq in (34) can be empirically motivated in similar ways, as LessInq does not have an obvious natural language counterpart.
3.4. PROPOSITION-ORIENTED SEMANTICS FOR ROGATIVE PREDICATES

Another argument against a decompositional analysis of wonder in general (whether it is ‘want-to-know’ or ‘LessInq-to-know’) is given in the context of epistemology by Friedman’s (2013). Friedman argues that analyzing the attitude of wondering as a higher-order attitude—e.g., as ‘wanting/wishing to know’—is by itself problematic because wondering does not have to involve an introspective attitude toward one’s own attitude. For example, one may attribute the attitude of wondering to a very small child to whom one would not attribute a self-reflective attitude. If this argument is valid, it gives us another reason to be dubious about the decompositional analysis of wonder, which essentially analyzes a wonder-attitude ascription as involving a higher-order attitude ascription.

Incompatibility with the compositional implementation of the proposition-oriented theory

Another, more technical, problem with the decompositional analysis concerns its compatibility with the compositional implementation of the proposition-oriented theory, discussed in Ch. 2. The implementation involves the following lexical rule, which turns a proposition-taking denotation of a clause-embedding predicate to its question-taking counterpart:

\[ f_{Ans}^w = \lambda_{(st,et)} \lambda_{(st,t)} \lambda_{x_e} \exists w'[R(\text{AnsD}_{w'}(Q))(x)] \]

If we simply apply this rule to the decompositional denotations of wonder we considered above, repeated above, we would derive the question-taking denotations in (38):

\[ f_{Ans}^w((37a)) = \lambda_{Q,(st,t)} \lambda_{x_e} \exists w'[\text{want}^w(x, K(x, p))] \]

\[ f_{Ans}^w((37b)) = \lambda_{Q,(st,t)} \lambda_{x_e} \exists w'[\text{LessInq}^w(x, K(x, \text{AnsD}_{w'}(Q)))] \]

The resulting entries in (38) do not predict the intuitive paraphrases of ‘x wonders Q’ along the lines of ‘x wants to know the answer to Q’. Rather, they predict readings along the lines of ‘There is an answer p to Q such that x wants to know that p’:

\[ \exists w'[\text{want}^w(x, K(x, \text{AnsD}_{w'}(Q)))] \]

Not only is this an intuitively incorrect paraphrase, but it also predicts that ‘x wonders Q’ to be ungrammatical, for the same reason why ‘x wonders that p’ is predicted to be ungrammatical.

To avoid this incorrect prediction, the existential quantification over the world variable anchored to AnsD has to scope between want/LessInq and K. However, this is not possible under the natural assumption that the lexical rule \( f_{Ans} \) in (36) applies to a syntactic element in the LF, and the decomposed ‘parts’ of wonder do not have syntactic realizations (i.e., they are part of the lexical denotation of wonder). One could in principle abandon this assumption and assume that wonder is syntactically decomposed into elements corresponding to want/LessInq and know. However, such a move is not an innocent one, and has to be motivated by independent empirical evidence for the presence
of the decomposed parts in the LF. Another issue with the syntactic decomposition has to do with the possibility of accommodation, discussed in Section 3.4.3. If wonder is syntactically represented as want to know, then we would expect the accommodation operator A to be optionally inserted between the two predicates in the decomposed structure. But then, we won’t be able to capture the contrast between (overt) want to know and wonder as exemplified below:

(40) a. ??Alice wants to know that Bob sang = ‘Alice wants to be sure that Bob sang’
    b. *Alice wonders that Bob sang. ≠ ‘Alice wants to be sure that Bob sang’

3.5 Chapter summary

Prima facie, the interpretation and the selectional restrictions of rogative predicates, such as wonder and ask, seem to present a clear case of question-orientation, and thus provide an argument for preferring the question-oriented theory over the proposition-oriented theory. In this chapter, I have investigated the validity of this prima facie expectation, by comparing question-oriented and proposition-oriented analyses of rogative predicates. Specifically, I have examined two concrete analyses—one within the question-oriented semantics and the other within the proposition-oriented semantics—that are aimed at capturing the interpretation and the selectional restriction of the representative rogative predicate wonder: the question-oriented analysis based on the notion of inquisitive state by Ciardelli and Roelofsen (2015) and the proposition-oriented analysis where wonder is decomposed into want-to-know (Karttunen, 1977, Guerzoni and Sharvit, 2007, Uegaki, 2015). Interestingly, the proposition-oriented analysis, as well as the question-oriented analysis, can successfully capture the basic empirical facts concerning the predicate’s interpretation and selectional restriction. However, further examination reveals that the proposition-oriented analysis faces empirical and/or conceptual challenges surrounding the status of the decomposed parts.

Overall, the discussion in the current chapter suggests that the question-oriented theory is indeed well-suited to deal with rogative predicates like wonder. However, needless to say, the comparison between the two theories has to be carried out from a holistic point of view, taking into account the entire class of clause-embedding predicates not just based on the theories’ success (or lack thereof) with respect to a specific

Xiang (2020) provides a possible empirical argument for the syntactic decomposition. According to her categorial approach to the semantics of questions. It is predicted that Boolean coordination of interrogative complements always scope above the embedding predicate. This prediction seems to be correct for non-rogative predicates, as exemplified in (i) (cf. Szabolcsi, 1997). However, wonder seems to go against this generalization, as the examples in (ii) seemingly allow a reading where or takes scope above wonder:

(i) John knows who invited Andy or who invited Billy.
(ii) a. Peter wonders [whom John loves] or [whom Mary loves]. (Groenendijk and Stokhof, 1989)
    b. Mary wonders where she could rent a bike or who might have one that she could borrow. (Ciardelli et al., 2018)

Xiang (2020) suggests that the pattern is explained if the embedded coordination takes the intermediate scope in the decomposed structure of wonder, i.e. between want and know. It remains to be seen if the seeming narrow-scope interpretations of or in (ii) are in fact intermediate-scope interpretations and if the pattern is amenable to alternative explanations.
subclass of predicates. In the next few chapters, we will further examine the relative advantages of the two theories by delving into the semantic analysis of responsive predicates.
Bibliography


Chapter 4

Caring: question orientation in responsive predicates

4.1 Introduction

In the previous chapter, we have discussed the semantics of rogative predicates—predicates that are compatible only with interrogative complements (e.g., wonder, ask)—and how it bears on the comparison between the proposition-oriented theory and the question-oriented theory. In this section, I will shift our focus back to responsive predicates—predicates that are compatible with declarative and interrogative complements. In particular, within responsive predicates, I will identify three classes of predicates that possess a semantic property that is hard to capture under the proposition-oriented theory. I will then demonstrate that these predicates can be adequately analyzed under the question-oriented theory.

Recall from Chapters 1 and 2 that our baseline analysis of a know-wh sentence predicts exactly the same interpretation under the proposition-oriented theory and the question-oriented theory. For example, sentence (1) is analyzed as in (2a) and (2b) under the proposition-oriented theory and the question-oriented theory, respectively:

(1) Alice knows which girl won the prize.

(2) a. Proposition-oriented analysis

\[
\llbracket \text{Alice f}_{\text{Ans}} \llbracket \text{knows] which girl won the prize] }^w
\leftrightarrow \llbracket f_{\text{Ans}}\rrbracket^w(\llbracket \text{know] }^w(\llbracket \text{which girl won the prize] }^w)(a)
\leftrightarrow \exists w' \llbracket K_{w'}(a, \text{AnsD}_{w'}(\llbracket \text{which girl won the prize] }^w))\rrbracket
\]

b. Question-oriented analysis

\[
\llbracket \text{Alice knows which girl won the prize] }^w
\leftrightarrow \llbracket \text{know] }^w(\llbracket \text{which girl won the prize] }^w)(a)
\leftrightarrow \exists w' \llbracket K_{w'}(a, \text{AnsD}_{w'}(\llbracket \text{which girl won the prize] }^w))\rrbracket
\]

If this situation generalizes to all responsive predicates, that is, if the two theories predict empirically valid interpretations of interrogative-embedding sentences involving
responsive predicates in general, then responsive predicates will not provide us with a test case to compare the two theories under consideration.

My claim in this chapter is that the situation in fact does not generalize to all responsive predicates. Specifically, I will argue that English predicates of relevance (PoRs; e.g., care, matter), Estonian contemplative predicates (e.g., mõtlema, mõitsklema), and Japanese contemplative sentence-final particles (e.g., daroo, na) all constitute cases that are not amenable to a proposition-oriented analysis. The semantics of these predicates/particles, I will argue, crucially refers to the question denotation directly, without reducing it to a proposition via an answerhood operator.

The rest of this chapter is structured as follows. In Sect. 4.2, I introduce the property of Q-TO-P entailment, and show that the proposition-oriented theory predicts all responsive predicates to possess this property while the question-oriented theory in principle allows P-to-Q non-entailing responsive predicates. In Sect. 4.3, I describe the interpretations of the three classes of predicates briefly introduced above—English PoRs, Estonian contemplative predicates, and Japanese contemplative particles—and argue that they lack the property of Q-TO-P entailment. These predicates are thus problematic for the proposition-oriented theory, while they can be analyzed under the question-oriented theory, as will be presented in Sect. 4.4.

4.2 Q-to-P entailment

The discussion in the rest of the paper will center around a semantic property of responsive predicates which I call Q-to-P entailment, which is defined as follows.\footnote{Essentially the same property is discussed as the DISTRIBUTIVITY PRINCIPLE by Belnap (1982).}

(3) **Q-to-P entailment**

Let $V$ be a responsive predicate. Then, $V$ is Q-to-P entailing iff, for every entity-denoting term $x$ and every interrogative complement $Q$, $\forall x \forall V \forall Q \exists p \in Q$ such that $\forall x \forall V \forall p$.

For example, know is Q-to-P entailing since $\forall Alice \forall knows which girl won$ entails that there is an answer $p$ to the question ‘which girl won’ such that Alice knows that $p$. This inference holds regardless of the subject and the interrogative complement.

Crucially, the proposition-oriented theory as I have formulated in Chapters 1-2 predicts all responsive predicates to be Q-to-P entailing. This is so because the theory analyzes a sentence of the form $\forall x \forall V \forall Q$ (with any subject $x$ and interrogative complement $Q$) as in (4):

(4) $\forall x \forall V \forall Q [\exists w'(\forall V)(\forall AnsD_{w'}(Q))(x)]$ (proposition-oriented)

Since $\forall AnsD_{w'}(Q)$ is some answer of $Q$ for any $w'$, the predicted interpretation in (4) entails that there is an answer $p$ to $Q$ such that $\forall V(p)(x)$ holds, which is simply the interpretation of $\forall x \forall V \forall that p$ under the proposition-oriented analysis.

On the other hand, the same prediction is not made by the question-oriented theory. In other words, it is in principle compatible with the question-oriented theory that there exist responsive predicates that are not Q-to-P entailing. Recall that the theory analyzes $\forall x \forall V \forall Q$ and $\forall x \forall V \forall that p$ as follows:
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(5)  a. \( [x \text{Vs } Q]^{w} \leftrightarrow [V]^{w}(Q)(x) \) (question-oriented)
b. \( [x \text{Vs that } p]^{w} \leftrightarrow [V]^{w}(\{ p \})(x) \) (question-oriented)

Under this analysis, depending on the exact semantic content of \( V \), even if (5a) is true, it can be the case that there is no \( p \in Q \) such that \( "x \text{Vs that } p" \) is true. This is so, for instance, in the case of the hypothetical clause-embedding predicate \( \text{bel-uni} \), which has the following denotation:

(6) \( [\text{bel-uni}]^{w} = \lambda x_{x}. \lambda x_{e}. B_{w}(x, \cup Q) \)

To see why \( \text{bel-uni} \) doesn’t license Q-to-P entailment, consider the predicted interpretations for \( \text{bel-uni} \) with declarative and interrogative complements, as follows:

(7)  a. \( \text{Alice bel-unis which girl won}^{w} \leftrightarrow B_{w}(a, \cup [\text{which girl won}]^{w}) \)
b. \( \text{Alice bel-unis that Bonnie won}^{w} \leftrightarrow B_{w}(a, \cup [\{ \text{Bonnie won} \}]^{w}) \)

The statement in (7a) is quite weak, as it can be met as long as Alice believes that some girl won. On the other hand, as can be seen in (7b), \( \text{bel-uni} \) embedding a declarative complement turns out to be equivalent to \( \text{believe} \). As a consequence of this, (7a) can be true even if there is no girl \( x \) such that \( "\text{Alice bel-unis that } x \text{ won}" \) is true, meaning \( \text{bel-uni} \) is not Q-to-P entailing.

The crucial empirical question, then, is whether natural language contains clause-embedding predicates like \( \text{bel-uni} \), which is Q-to-P non-entailing. If there exist such predicates, they will provide an empirical argument for favoring the question-oriented theory over the proposition-oriented theory, as such predicates are only amenable to an analysis under the former theory, as I have just demonstrated. Below, I will argue that Q-to-P non-entailment predicates indeed exist, based on observations in existing works.

4.3 Q-to-P non-entailing predicates

In this section, I will identify three classes of predicates from cross-linguistic data that lack the property of Q-to-P entailment: English predicates of relevance (Elliott et al., 2017), Estonian contemplative predicates (Roberts, 2018) and Japanese sentence-final particles \( \text{daroo} \) and \( \text{na} \) (Uegaki and Roelofsen, 2018, Hara, 2018).

4.3.1 English predicates of relevance

Elliott, Klinedinst, Sudo, and Uegaki (2017) notice that English predicates of relevance (PoRs), such as \( \text{care, matter, be important, be significant, and be relevant}^{2} \) do not possess the property of Q-to-P entailment, and thus pose problems for the traditional proposition-oriented semantics for responsive predicates. PoRs are responsive predicates that they are compatible with both declarative and interrogative complements, as shown in (8-10):\(^3\)

\(^2\)The term verbs of relevance is from Karttunen (1977)

\(^3\)I assume that the preposition \( \text{about} \) can be inserted for purely syntactic reasons when \( \text{care} \) embeds an interrogative complement. Grimshaw (1990: Ch. 3) presents such a view, employing the notion of theta-
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(8) a. Alice cares (about) which student won the prize.
   b. Alice cares that Mary won the prize.

(9) a. It matters to Alice which student won the prize.
   b. It matters to Alice that Mary won the prize.

(10) a. It is important to Alice which student won the prize.
    b. It is important to Alice that Mary won the prize.

To see the relevance of these data to our discussion about Q-TO-P entailment, consider the presuppositions of these examples. The b-examples with declarative complements in (8-10) presuppose that Alice believes that Mary won the prize. In contrast, the a-examples with interrogative complements in (8-10) do not presuppose that there is a student such that Alice believes that they won the prize. Roughly speaking, the sentences can be true as long as Alice has interest in knowing which student won, even if she does not have any specific idea about who won. This means that PoRs are not Q-TO-P entailing. For example, the above observation about care in (8) suggests that \( \forall x \text{ cares about} Q \) does not entail that there is a proposition \( p \in Q \) such that \( \forall x \text{ cares that} p \). This is so since \( \forall x \text{ cares that} p \) presupposes that \( x \) believes that \( p \), but \( \forall x \text{ cares} Q \) can be true even if there is no proposition \( p' \in Q \) such that \( \forall x \text{ believes} p' \).

Another set of examples that illustrate the same property of PoRs (provided to me by Ciyang Qing (p.c.)) is the following. Suppose that Alice is invited to a party. She has heard that there is a dress code for the party, but she hasn’t heard what kind of clothes (formal, business casual, casual etc.) she is expected to wear. She has every kind of clothes at home, and she is happy to wear any of them. She just needs to find out the exact dress code because it matters to her that she goes to the party wearing the right type of clothes. In this context, the a-examples in (11-13) are true while the corresponding b-examples are not.

(11) a. Alice cares (about) which type of clothes she is expected to wear.
    b. Alice cares that she is expected to wear formal/business casual/casual clothes.

(12) a. It matters to Alice which type of clothes she is expected to wear.
    b. It matters to Alice that she is expected to wear formal/business casual/casual clothes.

(13) a. It is important to Alice which type of clothes she is expected to wear.
    b. It is important to Alice that she is expected to wear formal/business casual/casual clothes.

Again, this is due to the contrast in the presupposition between the a-examples and b-examples. The b-examples presuppose that Alice believes that she is expected to wear formal/business casual/casual clothes. In contrast, the a-examples don’t presuppose (or entail) that there is a particular type of clothes that she believes she is expected to wear.

marking. According to this view, all arguments—whether nominal or clausal—must be theta-marked. However, some heads with argument structures do not have the theta-marking ability. Arguments to such a head can be assigned a theta-role by a preposition while semantically participating in the argument structure of the head. See also Ch. 7 for more on the role of about in interrogative complementation.4
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Under the proposition-oriented analysis introduced in Chapter 2, it is not possible to derive this pattern. To see this, consider the interpretation predicted for \( ^r x \text{ cares (about) } Q \) in the proposition-oriented analysis following to the schema in (4):

\[(14) \quad \llbracket \text{Alice cares (about) which student won the prize} \rrbracket^w \leftrightarrow \exists w' \llbracket \text{care} \rrbracket^w (\text{AnsD}_w (\llbracket \text{which student won the prize} \rrbracket^w)) (a) \]

If we encode the belief presupposition (that the subject believes the declarative complement) to the proposition-oriented entry for care, we predict that the right-hand side of (14) presupposes that there is a student who Alice believes won the prize. This is precisely not what we observed above. \( ^r x \text{ cares (about) } Q \) can be true even if \( x \) does not believe any answer of \( Q \). On the other hand, if we do not encode the presupposition to the lexical entry of care, we simply cannot derive the belief presupposition in the declarative case compositionally. The belief presupposition is lexically triggered, as it is idiosyncratic to a certain class of predicates, which including PoRs but excludes communication predicates (e.g., tell) and preferential predicates (e.g., hope). The argument generalizes to other PoRs such as matter and be important. Given that the proposition-oriented theory predicts all responsive predicates to be Q-TO-P ENTAILING, the lack of Q-TO-P ENTAILMENT for PoRs presents a challenge for the proposition-oriented theory.

Similar challenges posed by PoRs for the theory of question-embedding had been noted prior to Elliott et al. (2017). Lahiri (1991, 2002) discusses PoRs in the context of his argument against Hintikka/Berman-style functional analysis, where the interpretation of \( ^r \text{Alice cares about which student won} \) would be analyzed as ‘for every student \( x \), if \( x \) won, Alice cares that \( x \) won’. Lahiri’s claim, however, is different from that of Elliott et al. (2017) in that he ultimately takes a proposition-oriented view. According to his analysis, \( ^r \text{Alice cares about which student won} \) is analyzed in terms of quantification over the propositional answers which Alice cares for (see e.g., Lahiri 2002: 41-43). Another important previous work that touches on PoRs is Nathan (2006). He discusses a challenge in terms of veridicality: whereas their interrogative-embedding variant is non-veridical, their declarative-embedding variant is veridical. That is, for example, the a-sentences in (8-10) do not entail that Alice cares that the student who actually won the prize won the prize; in contrast, the b-sentences entail that Mary won the prize.

Elliott et al. (2017) point out that this observation by Nathan (2006) presents another problem for a proposition-oriented analysis, with essentially the same structure as the problem about the belief presupposition pointed out above. That is, under the proposition-oriented analysis, the veridicality of the declarative-embedding variant would lead us to expect that the interrogative-embedding variant is also veridical. The empirical details, however, seem to be rather subtle. As a reviewer has pointed out, there are cases where the veridicality inference with respect to declarative complements is absent for matter and be important. For instance, the following sentences can be uttered even if the speaker is uncertain about whether Mary is on board with the project.

\[(15) \quad \begin{align*}
    a. & \quad \text{It matters to me that Mary is on board with the project.} \\
    b. & \quad \text{It is important to me that Mary is on board with the project.}
\end{align*} \]

In contrast, care and be relevant seem to be veridical with respect to declarative complements, according to the judgment of several native speakers. The following examples
imply (or presuppose) that Mary is in fact on board with the project.

(16) a. I care that Mary is on board with the project.
    b. It is relevant to me that Mary is on board with the project.

Although more empirical work is needed to establish the exact distribution of veridicality among PoRs, the data at least suggest that the issue for a proposition-oriented analysis arising from veridicality cannot be generalized to PoRs across the board. For this reason, I will set aside the discussion of veridicality in this chapter, and leave the treatment of veridicality in my formal analysis later in the chapter to a footnote.

4.3.2 Estonian contemplative predicates

Roberts (2018) presents a detailed investigation of the Estonian responsive clause-embedding predicate mõlema.5 With a declarative complement \( p \), \( \langle x \text{ mõlema } p \rangle \) has two possible interpretations: ‘\( x \) believes \( p \)’ and ‘\( x \) believes not-\( p \) but imagines what the world would be like if \( p \) were true’. These two interpretations are exemplified in (17) and (18), respectively:

(17) Liis mõtleb, et sajab vihma, aga ei saja.
    Liis MOTLEMA that falls rain but neg fall.NEG
    ‘Liis thinks that it’s raining, but it isn’t raining.’

(18) **Context:** I am discussing with my friend what life would be like if an asteroid had not collided with the earth at the end of the late Cretaceous period.

    Ma mõtlen, et dinosaurused on ikka elus, kuigi ma tean, et ei
    I MOTLEMA that dinosaurs are still alive although I know that neg
    be.NEG
    ‘I’m thinking about dinosaurs still being alive, even though I know that they aren’t.’

When an interrogative complement \( Q \), \( \langle x \text{ mõlema } Q \rangle \) also has two possible interpretations: ‘\( x \) wonders \( Q \)’ and ‘for some answer \( p \) to \( Q \), \( x \) does believes not-\( p \) but imagines what the world would be like if \( p \) were true’. The first interpretation is exemplified in (19), the second in (20).

(19) Ma mõtlen, kes ukse taga on.
    I MOTLEMA who door.gen behind is
    ‘I wonder who is at the door.’

(20) **Context:** Liis hears a knock at the door. She was expecting her friend Kirsi to come over, but she fantasizes for just a moment all the famous celebrities who could be showing up instead.

    Liis mõtleb, kes ukse taga on, kuigi ta teab, et on Kirsi.
    Liis MOTLEMA who door.gen behind is although she knows that is Kirsi
    ‘Liis is thinking about who is at the door, even though she knows, that it is Kirsi.’

5This section is taken from Roelofsen and Uegaki (2020).
To see that this predicate lacks the Q-TO-P entailment property, consider a context in which (i) Mary has no specific belief about whether it is raining and (ii) she wants to know whether it’s raining. Now consider the following statements:

(21) a. Mary mõtlema whether it is raining.
    b. Mary mõtlema that it is raining.
    c. Mary mõtlema that it isn’t raining.

In the given context, according to Roberts’ empirical description, (21a) is true (on the ‘wonder’ reading), (21b) is false (on either the ‘believe’ or the ‘imagine’ reading), and (21c) is false (on either the ‘believe’ or the ‘imagine’ reading). This mean that mõtlema is not Q-to-P entailing since the above examples demonstrate that (21a) does not entail, for either answer p of ‘whether it is raining’, that 

\[ \text{Mary mõtlema p}. \]

Roberts (2018) notes that mõtlema is not alone in this kind of behavior in Estonian: similar patterns can be observed with predicates in the class of contemplative verbs in general, including mõtisklema ‘consider’, vaatlema ‘observe’, and meelisklema ‘muse’. He also mentions that the Finnish verb miettiä, a presumed cognate of mõtlema, displays the same sort of behavior.

4.3.3 Japanese sentence-final particles daroo and na

The Japanese sentence-final particle daroo, as analyzed by Hara (2018) and Uegaki and Roelofsen (2018), as well as the particle na also constitute counterexamples to Q-to-P entailment. These particles can have either a declarative or an interrogative prejacent. With a declarative prejacent, its meaning is similar to think or suppose.

(22) a. Ken-wa utau daroo.
    Ken-top sing DAROO
    ‘I think/suppose that Ken will sing.’
    b. Ken-wa utau na.
    Ken-top sing NA
    ‘I think/suppose that Ken will sing.’

With an interrogative prejacent, their meanings are similar to wonder (a subtle difference will be discussed later but is not relevant here yet).\(^6\)

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\(^6\)I would like to thank Prof Yukinori Takubo for pointing out to me that the particle na behaves in a way similar to daroo in relevant respects, modulo the surface linearization with respect to the question particle ka.

\(^7\)The two particles differ in their surface linearization with respect to the question particle ka when they co-occur with an interrogative clause. As can be seen in (23), daroo precedes ka while na follows ka. Regardless of this surface linearization, I assume that the relevant particles embed an interrogative complement headed by the question particle at LF, as schematically represented below:

(i) \[ [ \text{Ken sings} ] Q ] na/daroo \]

In other words, the surface order of the question particle and na transparently represents the LF structure while there is a mismatch between the surface order and the LF in the case of daroo. I will follow Hara (2015, 2018) in assuming that a syntactic movement derives the surface ordering of daroo + ka. The analysis of na, on the other hand, will not rest on such a syntactic movement, given that the surface order transparently represents the structure in (i).
(23)  a. Ken-wa utau **daroo**-ka.
    Ken-top sing DAROO-Q
    ‘I wonder whether Ken will sing.’

   b. Ken-wa utau ka-**na**.
    Ken-top sing Q-NA
    ‘I wonder whether Ken will sing.’

(24)  a. Dare-ga katta **daroo**-ka.
    who-NOM won DAROO-Q
    ‘I wonder who won.’

   b. Dare-ga katta ka-**na**.
    who-NOM won Q-NA
    ‘I wonder who won.’

To see that **daroo** and **na** are not Q-TO-P ENTAILING, consider a context in which Mary would like to know whether Ken will sing (and doesn’t know yet). In such a context, Mary can truthfully (and felicitously) utter the sentences in (23) but not those in (22), nor variants of (22) in which the prejacent is negated. This shows that **daroo** and **na** are not Q-TO-P ENTAILING.

The reader might question the inclusion of the sentence-final particles in the current empirical scope. After all, sentence-final particles do not exhibit the same syntactic properties as other clause-embedding predicates that have been investigated so far in this book. Nevertheless, note that the theoretical issues that **daroo** and **na** raise for the compositional semantics of clausal-embedding is structurally the same as that of responsive predicates. Since both **daroo** and **na** are compatible with declarative and interrogative prejacents, when we consider their compositional semantic analysis, we have both the proposition-oriented analysis and the question-oriented analysis as analytical options, along the lines formulated in Ch. 2. Among these two options, the proposition-oriented analysis would predict that the particles will be Q-to-P entailing in the sense that, for any interrogative complement \(Q\), \(\langle Q**-daroo/na\rangle\) entails that there is a proposition \(p \in Q\) such that \(\langle p**-daroo\rangle\). The above description of the interpretations of the particles demonstrates that this prediction is not borne out.

### 4.4 Analysis under the question-oriented theory

The previous section established three classes of items that are Q-to-P non-entailing. Since the proposition-oriented theory predicts all clause-embedding predicates/particles to be Q-to-P ENTAILING, these items thus pose problems for the proposition-oriented theory. In this section, I demonstrate that their interpretations can be adequately analyzed under the question-oriented theory.

#### 4.4.1 Predicates of relevance

Under the question-oriented theory, PoRs, such as care, can be analyzed as follows (Elliott et al., 2017, Theiler et al., 2018):
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(25) \[ \text{[care]}^w = \lambda Q_{(s,t)} \lambda x e : B_w(x, \cup Q). \exists p \in Q [\text{BOU}_w^x \subseteq p \lor \text{BOU}_w^x \cap p = \emptyset] \]

where \( \text{BOU}_w^x \) is the bouletic state of \( x \) in \( w \), that is, the set of worlds compatible with \( x \)'s preferences in \( w \).

Roughly, this entry states that \( \textit{\text{care}} \) presupposes that \( x \) believes \( \cup Q \), and is true (given that the presupposition is met) iff there is some answer \( p \) to \( Q \) such that \( x \) prefers \( p \) or \( x \) prefers not-\( p \). \(^8\)

This analysis properly accounts for the fact that \( \text{care} \) is Q-to-P non-entailing. More specifically, (25) captures the fact that (26a) below has a very weak presupposition (Alice believes that some student won the prize), while (26b) has a much stronger presupposition (Alice believes that \( x \) won the prize).

(26) a. Alice cares (about) which student won the prize.
    b. Alice cares that \( x \) won the prize.

Because of this, (26a) can be true even if, for no \( x \), the presupposition of (26b) is satisfied, leading to the violation of Q-to-P entailment. In fact, note that the presuppositional component of (25) is exactly the same as the meaning of the fictitious predicate \( \text{bel-uni} \) defined in (6) discussed above. The reason why the meaning of \( \text{bel-uni} \) blocks Q-to-P entailment is exactly the same as the reason why the presupposition of \( \text{care} \) blocks the Q-to-P entailment.

4.4.2 Estonian contemplative predicates

As discussed above, Roberts (2018) gives the following empirical description of the behavior of \( \text{mõtlema} \).

(27) When \( \phi \) is declarative, \( \textit{\text{mõtlema}} \varphi \) is interpreted as either (a) \( x \) believes that \( \varphi \) is true; or (b) \( x \) does not believe \( \varphi \) but imagines what the world would be like if it were true.

(28) When \( \varphi \) is interrogative, \( \textit{\text{mõtlema}} \varphi \) is interpreted as either (a) \( x \) wonders what the answer to \( \varphi \) is; or (b) for some answer \( p \) to \( \varphi \), \( x \) does not believe \( p \) but imagines what the world would be like if it were true.

Staying close to this basic empirical description by Roberts (2018), I assume that \( \text{mõtlema} \) has two interpretations: On its ‘entertain’ interpretation, it says that the subject ‘entertains’ the issue expressed by the complement (this corresponds to the ‘think’ reading and the ‘wonder’ reading introduced in Sect. 4.3.2 above). On its ‘imagine’ interpretation, it says that there is an answer to the issue expressed by the complement such that the subject believes its negation and imagines what the world would be like if it were true. This is reflected in the disjunctive lexical entry below:

\(^8\)If we were to capture the veridicality of \( \text{care} \) with respect to declarative complements, the entry would look like the following (Elliott et al., 2017).

(i) \[ \text{[care]}^w = \lambda Q_{(s,t)} \lambda x e : B_w(x, \cup Q) \land w \in \cup Q. \exists p \in Q [\text{BOU}_w^x \subseteq p \lor \text{BOU}_w^x \cap p = \emptyset] \]

The second conjunct in the presupposition in (i) boils down to veridicality when \( Q \) is the denotation of a declarative complement and thus a singleton. On the other hand, the condition amounts to the existential presupposition with respect to interrogative complements.
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(29) \[ [\text{mõtlema}]^w = \lambda Q_{(st,t)} \lambda x. E_w(x, Q) \vee \exists p \in Q [B_w(x, p) \land \text{IMG}_x^w \subseteq p] \]

Here, \(E\) is the entertainment modality defined in terms of the inquisitive state \(\text{INQ}\), introduced in the question-oriented analysis of wonder in 3.\(^9\) \(\text{IMG}_x^w\) is the set of worlds that are compatible with what \(x\) imagines in \(w\).

This analysis accounts for the fact that \(\text{mõtlema}\) is Q-to-P non-entailing. To see this consider the following statements, repeated from Sect. 4.3.2 above.

(21) a. Alice mõtlema whether it is raining.
    b. Alice mõtlema that it is raining.
    c. Alice mõtlema that it is raining.

The situation to consider is where Alice would like to know whether it is raining and believes neither that it is raining nor that it is not raining. In such a situation, \(E_w(a, \{\text{raining}, \neg \text{raining}\})\) is true and neither \(B_w(a, \text{raining})\) nor \(B_w(a, \neg \text{raining})\) is true. Given the semantics for \(\text{mõtlema}\) in (29), such a situation makes (21a) true and both (21b) and (21c) false. Hence, this shows that (29) captures the Q-to-P non-entailing property of \(\text{mõtlema}\).\(^{11}\)

4.4.3 Japanese sentence-final particles

Recall that the Japanese particle \(\text{daroo}\) means ‘think’ when it takes a declarative complement and something similar to ‘wonder’ when it takes an interrogative complement. Hara (2018) and Uegaki and Roelofsen (2018) analyze the semantics of \(\text{daroo}\) as follows, simplifying irrelevant details:

(30) \[ [\text{daroo}]^w = \lambda Q_{(st,t)} . E_w(sp, Q) \]

According to this semantics, \(\lbrack \phi \text{-daroo}\rbrack\) means that the speaker would like to reach a doxastic state which resolves the issue expressed by \(\phi\). We first motivate this analysis of \(\text{daroo}\) empirically, and then move on to show that it correctly predicts the Q-to-P non-entailment.

\(^9\)The definitions for \(E\) and \(\text{INQ}\) are repeated below.

(i) **Definition: the entertainment modality, \(E\)**
    \[ E_w(x, Q) \iff \forall p \in \text{INQ}_x^w \exists p' \in Q [p \subseteq p'] \]

(ii) **Definition: inquisitive states, \(\text{INQ}\)**
    For each world \(w \in W\) and each agent \(a \in D\), \(\text{INQ}_a^w\) (i.e., the inquisitive state of \(a\) in \(w\))
    
    - is a downward-closed set\(^{10}\) of propositions that settle the questions that \(a\) has in \(w\), and
    - satisfies the constraint: \(\bigcup \text{INQ}_a^w = \text{DOX}_a^w\).

\(^{11}\)Roberts (2018) proposes an analysis of \(\text{mõtlema}\) that aims at unifying the ‘entertain’ interpretation and the ‘imagine’ interpretation by making reference to what he calls the \text{CONTEMPLATION STATE} of the subject. Although exploring the possibility of such a uniform account of \(\text{mõtlema}\) is by itself an interesting endeavor, I will not engage with this possibility. This is so because the theoretically more conservative analysis in (29), which stays close to Roberts’s (2018) empirical description, is sufficient for my purposes, i.e., to provide an analysis of \(\text{mõtlema}\) that accounts for its lack of Q-to-P entailment.
The entry in (30) captures the fact that \( ^\text{p-daroo} \), with a declarative complement \( p \), simply means ‘the speaker believes \( p \)’ due to the fact that entertaining \( \{p\} \) amounts to believing \( p \) since \( \bigcup \text{INQ}^w_x = \text{DOX}^w_x \) for any \( x \) and \( w \) (see (9)):

\[
(31) \quad \text{daroo}^w \iff E_w(\text{sp}, \{p\}) \iff B_w(\text{sp}, p)
\]

When (30) takes an interrogative complement \( Q \), \( ^\text{Q-daroo} \) is predicted to mean that the speaker entertains the issue represented by \( Q \):

\[
(32) \quad \text{daroo}^w \iff E_w(\text{sp}, Q)
\]

We have stated that \( \text{daroo} \) roughly means ‘wonder’ when it takes an interrogative complement. However, the analysis in (30) is crucially different from that of \( \text{wonder-Q} \) according to the semantics we have given above in Ch. 3, repeated here:

\[
(33) \quad \text{wonder}^w = \lambda Q(x,t) \lambda x,e. \neg \exists w'[B_w(x, \text{AnsD}_w'(Q))] \land E_w(x, Q)
\]

The crucial difference is that \( \text{daroo} \) lacks the ignorance component—\( \neg \exists w'[B_w(x, \text{AnsD}_w'(Q))] \)—which exists in \( \text{wonder} \). The lack of the ignorance component in the semantics of \( \text{daroo} \) is motivated in view of the following kind of examples:

\[
(34) \quad \text{Huji-santyoo-de-wa mizu-wa nando-de huttoo-suru daroo-ka.}
\quad \text{Mt.Fuji-top-loc-top water-top what.degree-in boil-do DAROO-Q}
\quad \text{Huji-santyoo-de-wa katsu-ga tijoo-no sanbunnoni kurai}
\quad \text{Mt.Fuji-top-loc-top air.pressure-nom ground.level-gen two-thirds about}
\quad \text{nanode, mizu-wa yaku 87.7 do de huttoo-suru.}
\quad \text{because water-top about 87.7 °C at boil-do}
\quad \text{‘At what temperature does water boil at the top of Mt. Fuji? Since the air}
\quad \text{pressure there is about 2/3 of the ground level, it boils at about 87.7°C.’}
\]

Here, the author/speaker uses \( ^\text{Q-daroo} \) to introduce the question \( Q \) as a topic, which she in fact knows the answer to. This suggests that \( ^\text{Q-daroo} \) does not semantically entail the speaker’s ignorance about \( Q \).\(^\text{12}\) This is in contrast to the behavior of \( \text{wonder} \), which is infelicitous in a similar context:

\[
(35) \quad \#I \text{ wonder at what temperature water boils at the top of Mt. Fuji. Since the air}
\quad \text{pressure there is about 2/3 of the ground level, it boils at about 87.7°C.}
\]

The absence of the ignorance component furthermore is also crucial in view of the responsiveness of \( \text{daroo} \), i.e., its compatibility with both declarative and interrogative complements. If \( \text{daroo} \) carried the ignorance component in its semantics, we would expect it to be rogative just like \( \text{wonder} \), i.e., be incompatible with declarative complements due to the predicted contradiction in meaning.

Finally, note that the entry in (30) accounts for the lack of the Q-to-P entailment property. If the speaker wonders which of the members of \( Q \) is true, but does not believe any specific answer of \( Q \), the condition in (32) are met, while there is no \( p \in Q \) such that the condition in (31) is met.

\(^{12}\)This said, \( ^\text{Q-daroo} \) may pragmatically implicate ignorance as a result of competition with \( ^\text{p-daroo} \), where \( p \) is a specific answer of \( Q \), as suggested by Uegaki and Roelofsen (2018).
4.5 Chapter summary

In this chapter, I have focused on a specific semantic property of responsive predicates, which I termed Q-to-P entailment:

(3) **Q-to-P entailment**

Let \( V \) be a responsive predicate. Then, \( V \) is Q-to-P entailment iff, for every entity-denoting term \( x \) and every interrogative complement \( Q \), \( \forall x \in \mathbb{Q} \) entails that there is a proposition \( p \in Q \) such that \( \forall x \in \mathbb{Q} \).

Examining the presence/absence of this property for responsive predicates in general is important for our purposes, as the proposition-oriented theory and the question-oriented theory make distinct predictions as to whether there can in principle be Q-to-P non-entailing. Specifically, the proposition-oriented theory predicts all responsive predicates to be Q-to-P entailing while the question-oriented theory allows for the possibility of Q-to-P non-entailing predicates.

Based on the existing literature, I have discussed three classes of Q-to-P non-entailing predicates: English predicates of relevance (Elliott et al., 2017) (e.g., care, matter), Estonian contemplative predicates (e.g., mõitlema), and Japanese sentence-final particles daroo and na. After describing the empirical behaviors of these items that show the lack of Q-to-P entailment, I have provided analyses that captures the behaviors under the question-oriented theory. Essentially, the analysis under the question-oriented theory is possible for a Q-to-P non-entailing item because the semantics of the item can be analyzed to directly refer to the question it takes, without referring to its answers.
Bibliography


Hara, Yurie. 2015. Darou ka: an interplay of bias, sentence types, and prosody. Ms., City University of Hong Kong, available online at http://semanticsarchive.net/Archive/TA0MmVkM/.


Chapter 5

Knowing, again:
non-reducibility of responsive predicates

5.1 Introduction

In the previous chapter, I have focused on three classes of responsive predicates/particles from cross-linguistic data—English predicates of relevance, Estonian contemplative predicates, and Japanese sentence-final particles—and argued that their interpretations call for a question-oriented analysis, given the observation that they lack the semantic property of Q-TO-P ENTAILMENT. In this chapter, I return to more familiar responsive predicates—know, surprise, and agree—and argue that they, too, require a question-oriented analysis, though, for reasons independent from Q-TO-P ENTAILMENT.

My argument that know, surprise, and agree require question-oriented semantic is based on an existing observation that their interpretations when taking an interrogative complement (at least under one of its readings) cannot be reduced to their interpretations when taking a declarative complement. This can be exemplified in the following example in (1), evaluated in Situation 1 and 2.\(^1\)

(1) **Situations:** Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Bonnie and Carol passed it, but Dana didn’t.

   **Situation 1:** Alice knows that Bonnie and Carol passed the exam, but has no idea about Dana.

   **Situation 2:** Alice knows that Bonnie and Carol passed the exam. She also believes incorrectly that Dana did too.

**Example:** Alice knows which girls among Bonnie, Carol and Dana passed the exam.

---

\(^1\)To illustrate the relevant observation, it is necessary to use non-exhaustivity-neutral complements. This is the reason why I will use which students passed the exam in the examples in this chapter, instead of exhaustivity-neutral ones used in the other chapters.
As discussed in Ch. 2, the strongly-exhaustive (SE) reading of (1) is false under both Situation 1 and 2, as Alice does not know the complete answer to the embedded question in either situation. The relevant observation I would like to highlight is that (1) has a reading that is true in Situation 1 and false in Situation 2. The relevant reading can be informally paraphrased as follows:

(2) \[ [(1)]^w \leftrightarrow \text{Alice knows that Bonnie and Carol passed the exam, and it's not the case that she believes that Dana did.} \]

The existence of this reading for know-wh has been noted by a number of authors (e.g., Groenendijk and Stokhof, 1984, Berman, 1991, Preuss, 2001, Spector, 2005, George, 2011) and experimentally confirmed by Cremers and Chemla (2016). Following the literature, I refer to the reading as false-answer sensitive reading of know-wh. Among the authors, George (2011, 2013) most prominently framed the data as a problem of for the proposition-oriented semantics of responsive predicates. To see why the reading poses a problem for the proposition-oriented theory, note that the paraphrase given in (2) is stated not only in terms of Alice’s knowledge, but also in terms of her lack of belief. Assuming that lack of belief is not analyzable in terms of knowledge, this means that the reading in (2) cannot be reduced to the form \[ \neg \text{Alice knows that } p \], where \( p \) is some proposition. This poses a problem for the proposition-oriented theory of responsive predicates, as it predicts the interpretations of \[ x V s Q \], for any responsive predicate \( V \), to be paraphrased as \[ x V s \text{ that } p \] for some proposition \( p \).

In this chapter, I will further develop the above line of argument against the proposition-oriented theory, based on the false-answer sensitive readings of responsive predicates. The argument will follow in the footsteps of George (2011, 2013) but will also include rebuttals of recent analyses of false-answer sensitive readings within the proposition-oriented theory, specifically, the analysis based on exhaustification by Cremers (2016) and Cremers and Chemla (2016) and the one based on trivalent presupposition projection by Fox (2020).

The rest of the chapter is structured as follows. In Sect. 5.2, I will introduce the semantic property of reducibility for responsive predicates due to George (2011), and compare the proposition-oriented theory and the question-oriented theory according to whether predicates are predicted to possess this property. False-answer sensitive readings of responsive predicates will then be discussed in detail in Sect. 5.3, focusing on three predicates: know, agree, and surprise. In this section, I will also argue that the false-answer sensitive readings of these predicates provide evidence that their semantics is non-reducible. In Sect. 5.4, I will review two proposition-oriented analyses of the false-answer readings—one by Cremers (2016) and Cremers and Chemla (2016) and the other by Fox (2020)—and point out problems with each. Section 5.5 provides question-oriented semantics for know, surprise and agree that captures their false-answer sensitive readings.

5.2 Reducibility

In addition to the property of Q-to-P entailment discussed in the previous chapter, the proposition-oriented theory for responsive predicates predicts that the interpretation of
5.2. REDUCIBILITY

A responsive predicate when it takes an interrogative complement is ‘reducible’ to its interpretation when it takes a declarative complement. The property of REDUCIBILITY can be defined as follows, based on George (2011):

(3) Reducibility

Let \( V \) be a responsive predicate. Then, \( V \) is reducible if, for any pair of individuals \( x \) and \( x' \), if \( \forall x \ V s \ that \ p \) \( \iff \forall x' \ V s \ that \ p \) for every declarative complement \( p \), then \( \forall x \ V s Q \) \( \iff \forall x' \ V s Q \) for every interrogative complement \( Q \).

The intuition behind this definition of reducibility is the following: we can say that the question-taking meaning of a predicate \( V \) can be reduced to its proposition-taking meaning iff whenever two people bear the \( V \)-relation to exactly the same set of propositions, they also bear the \( V \)-relation to exactly the same set of questions. For example, we can say that know is reducible if any two people with the same set of propositional knowledge have the same set of question knowledge.

It is easy to see that the proposition-oriented theory, according to which sentences of the form \( \forall x \ V s Q \) are analyzed as follows, predicts that all responsive predicates are reducible.

(4) \( [\forall x \ V s Q]^w \mapsto \exists w' ([\forall V] w (\text{AnsD}_w(Q))(x)] \) (proposition-oriented)

Here’s why: If \( x \) and \( x' \) are related to exactly the same set of propositions via the \( [\forall V] w \)-relation, then we have that \( \exists w' ([\forall V] w (\text{AnsD}_w(Q))(x)] \mapsto \exists w' ([\forall V] w (\text{AnsD}_w(Q))(x')] \). This, in turn, means that \( [\forall x \ V s Q]^w \mapsto [\forall x' \ V s Q]^w \), given the schema in (4). Thus, under the proposition-oriented theory, all responsive predicates are predicted to be reducible.

On the other hand, under the question-oriented theory, reducibility is not a necessary property of responsive predicates. To see this, consider the following entry for knowFAS, inspired by George (2011) (FAS stands for ‘false-answer sensitive’):

(5) \( [\text{knowFAS}]^w = \lambda Q_{st,t} \lambda x.e. \ K_w(x, \text{AnsD}_w(Q)) \land \forall p \in Q [B_w(x, p) \rightarrow p(w)] \)

We will go over empirical arguments that motivate this entry shortly below. For now, what is crucial is the fact that knowFAS is non-reducible, even though it is in principle allowed by the question-oriented theory. Under the question-oriented theory, the interrogative-embedding and the declarative-embedding sentences involving knowFAS are analyzed as follows:

(6) a. \( [\forall x \ \text{knowFAS} s Q]^w \) (question-oriented)
   \( \iff K_w(x, \text{AnsD}_w(Q)) \land \forall p \in Q [B_w(x, p) \rightarrow p(w)] \)

b. \( [\forall x \ \text{knowFAS} that p]^w \) (question-oriented)
   \( \iff [\text{knowFAS}]^w(\{p\})(x) \)
   \( \iff K_w(x, \text{AnsD}_w(\{p\})) \land [B_w(x, p) \rightarrow p(w)] \)
   \( \iff K_w(x, \text{AnsD}_w(\{p\})) \)

Note that the second conjunct in the penultimate step of (6b) is entailed by the first conjunct, resulting in the simplified statement in the last line.\(^2\) Now, suppose that in the

\(^2\)This is so because, in order for the first conjunct to be true, \( p(w) \) and \( K_w(x, p) \) have to hold. Assuming that knowledge entails belief, this entails the second conjunct.
evaluation world \( w \), Alice and Kim know (i.e., are related via the \( K \)-relation to) exactly the same set of propositions, but they believe (i.e., are related via the \( B \)-relation to) different sets of propositions. In particular, Alice believes a false answer to \( Q \), while Kim doesn’t believe any false answer. In such a world, \([\text{Alice know}\text{FAS that } p]^{w} \iff [\text{Kim know}\text{FAS that } p]^{w}\) for every declarative complement \( p \). However, we have that \([\text{Alice know}\text{FAS } Q]^{w} = 0\) while \([\text{Kim know}\text{FAS } Q]^{w} = 1\). This shows that know\text{FAS} as defined in (5) is non-REDUCIBLE. All in all, know\text{FAS} demonstrates that non-REDUCIBLE predicates are in principle allowed by the question-oriented theory while it is predicted to be impossible under the proposition-oriented theory.

In Sect. 5.3 below, I will give empirical arguments that motivate the false-answer sensitive analysis of know and other presuppositional predicates, along the lines of (5). As false-answer sensitive denotations for responsive predicates are non-REDUCIBLE, they motivate the question-oriented theory over the proposition-oriented theory, unless the data are amenable to an alternative analysis under the proposition-oriented theory. Such alternative analyses are considered in Sect. 5.4.

Before concluding the section, it is worth noting that REDUCIBILITY is independent from the property of \( Q\)-TO-P ENTAILMENT, repeated below from Ch. 4:

\[(7) \quad \text{Q-to-P entailment}
\]

Let \( V \) be a clause-embedding predicate. Then, \( V \) is \( Q\)-TO-P ENTAILING iff, for every entity-denoting term \( x \) and every interrogative complement \( Q \), \( \forall x \forall Q \exists p \in Q \) such that \( \forall x \forall Q \exists p \in Q \). A predicate can be \( Q\)-TO-P ENTAILING and non-REDUCIBLE. This is the case, for example, in know\text{FAS} in (5) above. Moreover, a predicate can in principle be REDUCIBLE but non-Q-TO-P ENTAILING. This is exemplified in the following hypothetical predicate:

\[(8) \quad [\text{bel-uni}]^w = \lambda Q_{(x,t)} \lambda x. B_w(x, \bigcup Q)\]

The predicate is REDUCIBLE. Suppose \( \forall x \forall Q \exists p \in Q \) for any declarative complement \( p \). This means that \( x \) and \( x' \) have exactly the same set of beliefs. In such a situation, we predict that \( \forall x \forall Q \exists p \in Q \) for any interrogative complement \( Q \). On the other hand, (8) is not \( Q\)-TO-P ENTAILING. To see this, consider a situation where Alice believes neither that it is raining nor that it is not raining. In this situation, \( \forall Alice \forall Q \exists p \in Q \) is true but neither \( \forall Alice \forall Q \exists p \in Q \) nor \( \forall Alice \forall Q \exists p \in Q \) is true. This shows that there is an interrogative complement \( Q \) such that \( \forall x \forall Q \exists p \in Q \) does not entail that there is a proposition \( p \in Q \) such that \( \forall x \forall Q \exists p \in Q \).

### 5.3 Non-reducible predicates

#### 5.3.1 Know

False-answer sensitivity in addition to weak exhaustivity

As briefly discussed in the introduction to this chapter, Spector (2005), Berman (1991), Preuss (2001), Spector (2005), George (2011) among others have pointed out that there
5.3. NON-REDUCIBLE PREDICATES

is a reading of know-wh sentences that is sensitive to false answers. The relevant example is repeated below:

(1) **Situations:** Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Bonnie and Carol passed it, but Dana didn’t.

   **Situation 1:** Alice knows that Bonnie and Carol passed the exam, but has no idea about Dana.
   
   **Situation 2:** Alice knows that Bonnie and Carol passed the exam. She also believes incorrectly that Dana did too.

**Example:** Alice knows which girls among Bonnie, Carol and Dana passed the exam.

The crucial reading of (1) is one where it is *true* in Situation 1 but *not true* in Situation 2. Note that this reading is not predicted under any level of exhaustivity for know-wh sentences discussed in Ch. 2, i.e., mention-some (MS), weak exhaustivity (WE) and strong exhaustivity (SE). The readings of (1) corresponding to these three levels of exhaustivity would correspond to the following paraphrases:

(9) **MS** ‘Alice knows that Bonnie passed the exam or she knows that Carol passed the exam.’

   **WE** ‘Alice knows that Bonnie and Carol passed the exam.’

   **SE** ‘Alice knows that Bonnie and Carol passed the exam and that Dana didn’t’

Given the descriptions of the situation above, the MS and the WE reading are true both in Situation 1 and in 2 while the SE reading is false in both.

The relevant reading—according to which the sentence is true in Situation 1 but untrue in Situation 2—is captured if there is an additional condition to the WE reading, requiring Alice *not* to believe a false answer. This is stated in the following paraphrase of (1) (again repeated from the introduction).

(2) \([[(1)]^w] \leftrightarrow Alice\ knows\ that\ Bonnie\ and\ Carol\ passed\ the\ exam,\ and\ it's\ not\ the\ case\ that\ she\ believes\ that\ Dana\ did.\)

More generally, it is claimed by Spector (2005) and George (2011) that know-wh sentences have a reading that requires that the subject not believe any false answer to the embedded question. The reading can be informally stated as follows:

(10) **WE + FALSE-ANSWER SENSITIVITY for know**

\([x\ knows\ Q]^w \leftrightarrow For\ every\ true\ answer\ p\ to\ Q,\ x\ knows\ that\ p\ and\ it\ is\ not\ the\ case\ that\ x\ believes\ any\ false\ answer\ of\ Q.\)

Following Theiler et al. (2018), I will call the underlined condition as exhibiting the **FALSE-ANSWER SENSITIVITY (FAS) of know.** The reading described in (10) is also referred to as having **INTERMEDIATE EXHAUSTIVITY (IE)**, as it is intermediate in strength between weak exhaustivity and strong exhaustivity (Klinedinst and Rothschild, 2011).

Cremers and Chemla (2016) experimentally confirmed the presence of the IE (i.e., WE+FAS) reading for know-wh sentences, as well as a corresponding reading for predict-wh sentences. In their experiment, participants were tasked to judge truth values of
sentences like the following, with respect to pictures showing ‘the actual situation’ and John’s beliefs/predictions.

(11)  a. John knew which squares were blue.
    b. John predicted which squares were blue.

Examples of the trials are given in Figure 5.1(a). Their results suggest that participants were significantly more likely to judge the sentences as true when they are coupled with a picture that validates both WE and IE readings than when they are coupled with a picture that only validates WE readings. This suggests that participants accessed IE readings. See Figure 5.1(b) for the overview of their experimental results.

Presuppositional status of FAS and the proportional reading

Two remarks are in order about the empirical status of FAS. First, the characterization of FAS in (2) and (10) assumes that it is a part of the assertive component of the truth conditions of know-wh sentences, as opposed to the presuppositional component. The data we have seen so far are rather ambiguous in this respect. That is, for instance, sentence (1) in Situation 2 is felt to be false at least for some speakers but oddness...
suggesting presupposition failure for some others.\(^3\) My analysis to be discussed below will assume that FAS is a condition on the assertive component of the truth conditions. In Sect. 5.4.2 below, I will discuss Fox’s (2020) analysis, in which FAS is treated as a presuppositional condition, and argue against this treatment on the basis of the fact that FAS does not seem to project out of presupposition holes.

Second, according to the intuitions of some native speakers I have consulted, the judgment for (1) depends on the proportion of the false propositions believed by Alice with respect to the set of all propositions in the question meaning. For example, even if (1) sounds untrue in the given situation to these speakers, they feel that the judgment is not so clear (or the sentence may sound true) in a situation where Alice knows of 99 students that they passed the exam and incorrectly believes for just one student that they did. For such speakers, (10) is too strong as a paraphrase of the relevant reading. Rather, we would have something like the following:

\[
\text{(12) \ WE + proportional false-answer sensitivity for know} \\
\left[ x \text{ knows } Q \right] ^{\text{we}} \iff x \text{ knows all true answers of } Q \text{ and it is not the case that } x \text{ believes ‘too many’ false answers to } Q
\]

I will not attempt to analyze what counts as ‘too many’ false answers in the paraphrase above. What is important is that, even for these speakers, the WE reading of (1) is too weak (as it would predict it to be true in Situation 2) to capture their judgment, and that an additional condition that quantifies over false answers is required. I will call the false-answer sensitive condition in (12) as proportional false-answer sensitivity, or proportional FAS. Henceforth, for the sake of simplicity, I will assume a non-proportional version of FAS in my analysis, but it can be replaced with proportional FAS, without affecting my overall argument. This is so essentially because the proportional FAS condition makes know non-reducible, just like the non-proportional FAS condition does.

### False-answer sensitivity in addition to mention-some

George (2011) has noted that FAS also occurs with mention-some (MS) readings. This is exemplified in the following:

\[
\text{(13) \ Situations: There are three newspaper stands in the neighborhood: Newstopia, Rotunda and PaperWorld. Newstopia and Rotunda sell Italian newspapers, but PaperWorld doesn’t.} \\
\text{Situation 1: Alice knows that Newstopia sells Italian newspapers, but has no idea about Rotunda or PaperWorld.} \\
\text{Situation 2: Alice knows that Newstopia sells Italian newspapers. She has no idea about Rotunda. She believes incorrectly that PaperWorld sells Italian newspapers.} \\
\text{Example: Alice knows where one can buy an Italian newspaper in the neighborhood.}
\]

\(^3\)Cremers and Chemla’s (2016) task forced participants to choose between ‘true’ and ‘false’, and thus their results do not address the question of whether FAS is an assertive condition or a presupposition condition.
George (2011) observes that (13) is true in Situation 1 and not in Situation 2. This suggests that (13) has the following reading, with the underlined F AS condition:

(14) \[ J(13) \land \text{Kw} \iff 'Alice knows that one can buy an Italian newspaper at Newstopia or Rotunda, and it is not the case that she believes that one can buy an Italian newspaper at PaperWorld.' \]

Thus, FAS (or the proportional version thereof) can appear as an additional condition to both WE and MS reading of know-wh (with the strengthened reading of WE being referred to as IE). As Theiler et al. (2018) note, we can consider FAS as a condition that can in principle be added to the interpretation of know-wh with any level of exhaustivity. We have just seen cases where FAS is added to MS and WE. In the case of SE, the addition of FAS is inconsequential because SE already entails FAS. The following summarizes the readings involving FAS as an additional condition to each level of exhaustivity:

(15) \[ x \text{ knows } Q \iff \begin{array}{l}
MS+FAS \quad \text{For some true answer } p \text{ to } Q, x \text{ knows that } p \text{ and it is not the case that } x \text{ believes any/most false answer(s) to } Q \\
WE+FAS \quad \text{For every true answer } p \text{ to } Q, x \text{ knows that } p \text{ and it is not the case that } x \text{ believes any/most false answer(s) to } Q \quad \text{(also known as IE)} \\
SE+FAS (=SE) \quad \text{For every true answer } p \text{ to } Q, x \text{ knows that } p; \text{ and for every false answer } p' \text{ to } Q, x \text{ knows that } p' \text{ is false.} 
\end{array} \]

Formally, given our baseline semantics for the MS/WE readings of interrogative-embedding under veridical predicates discussed in Ch. 2, the MS/WE+FAS reading can be represented as follows:

(16) \[ x \text{ knows } Q \iff \exists p \in \text{Ansf} w(Q)[\text{Kw}(x, p)] \land \forall p \in Q[\text{Bw}(x, p) \rightarrow p(w)] \]

Following Fox’s (2013) analysis, the first conjunct of (16) uniformly represents MS and WE readings (see Sect. 2.4.3 for discussion). The underlined second conjunct represents FAS.

False-answer sensitivity and non-reducibility

The FAS reading of know-wh—whether it is in addition to a WE or an MS reading—is non-reducible. This becomes clear when we consider the following minimal variants of (1):

(1’) Situation: Alice has three daughters: Bonnie, Carol and Dana. The three has taken a math exam. Bonnie and Carol passed the exam, but Dana didn’t.

\[ \text{a. Ansf} w := \lambda Q_{\text{st,t}}: \exists p \in \text{Max} w_{\text{weak}}(Q)(w), \{ p \mid p \in \text{Max} w_{\text{weak}}(Q)(w) \} \]

\[ \text{b. Max} w_{\text{weak}}(Q)(w) := \{ p \mid p \in Q \land p(w) \land \forall q[q \in Q \land q(w) \rightarrow q \not\subseteq p] \} \]
Alice knows that Bonnie and Carol passed the exam, but has no idea about Dana. Zoe, their aunt, knows that Bonnie and Carol passed the exam. She also believes incorrectly that Dana did, too. Alice and Zoe have exactly the same set of knowledge in other respects.

The situation can be summarized in the following table. (Names in the column headers represent the propositions that the person passed the exam. ‘#’ indicates that it is a presupposition failure, ‘?’ indicates that the subject is uncertain about the proposition.)

<table>
<thead>
<tr>
<th></th>
<th>Bonnie</th>
<th>Carol</th>
<th>Dana</th>
<th>¬Dana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts</td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>Does A know...?</td>
<td>Yes</td>
<td>Yes</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td>Does Z know...?</td>
<td>Yes</td>
<td>Yes</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td>In A’s beliefs</td>
<td>True</td>
<td>True</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>In Z’s beliefs</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>

a. Alice knows which girls among Bonnie, Carol and Dana passed the exam.

b. Zoe knows which girls among Bonnie, Carol and Dana passed the exam.

Given the WE+FAS reading, the situation makes (1’a) true while (1’b) untrue. This shows that the reading constitutes a counterexample to reducibility. This is so since for every declarative complement \( p \), "Alice knows that \( p \)" is equivalent to "Zoey knows that \( p \)" as one can see from the third and fourth columns of the table above. Yet, "Alice knows \( Q \)" is not equivalent to "Zoey knows \( Q \)" for some \( Q \), specifically when \( Q \) is the complement in (1’an,b).

The same result is obtained from a variant of (13), as follows:

(13’) Situation: There are three newspaper stands in the neighborhood: Newstopia, Rotunda, and PaperWorld. Newstopia and Rotunda sell Italian newspapers, but PaperWorld doesn’t. Alice knows that Newstopia sells Italian newspapers, but has no idea about Rotunda and PaperWorld. Zoe knows that Newstopia sells Italian newspapers, but has no idea about Rotunda. She also incorrectly believes that PaperWorld sells Italian newspapers. Alice and Zoe has exactly the same set of knowledge in other respects.

<table>
<thead>
<tr>
<th></th>
<th>Newstopia</th>
<th>Rotunda</th>
<th>PaperWorld</th>
<th>¬PaperWorld</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts</td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>Does A know...?</td>
<td>Yes</td>
<td>Yes</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td>Does Z know...?</td>
<td>Yes</td>
<td>No</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td>In A’s beliefs</td>
<td>True</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>In Z’s beliefs</td>
<td>True</td>
<td>?</td>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>

a. Alice knows where one can buy an Italian newspaper in the neighborhood.
b. Zoe knows where one can buy an Italian newspaper in the neighborhood. According to the MS+FAS reading, the situation makes (13’a) true and (13’b) untrue. The pair of examples constitute a counterexample to reducibility.

5.3.2 Agree

Uegaki (2019) notes that the predicate agree exhibits a behavior parallel to the FAS of know: "x agrees with y on Q" has a reading that is judged to be true only if x does not believe any proposition in Q that is not believed by y (or, under the proportional reading: only if x does not believe ‘too many’ propositions in Q that are not believed by y). Below, (17) exemplifies a case where this condition is added to a WE reading and (18) exemplifies a case where the condition is added to an MS reading.6

(17) Situations: Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Kim, their teacher, believes that Bonnie and Carol passed the exam, but that Dana didn’t.

Situation 1: Alice believes that Bonnie and Carol passed the exam, but has no idea about Dana.

Situation 2: Alice believes that all three of Bonnie, Carol and Dana passed the exam.

Example: Alice agrees with Kim on which girls among Bonnie, Carol and Dana passed the exam. (Situation 1: true; Situation 2: untrue)

(18) Situations: There are three newspaper stands in the neighborhood: Newstopia, Rotunda, and PaperWorld. Kim believes that Newstopia and Rotunda sell Italian newspapers, but she believes that PaperWorld doesn’t.

Situation 1: Alice believes that Newstopia sells Italian newspapers, but has no idea about Rotunda and PaperWorld.

Situation 2: Alice believes that both Newstopia and PaperWorld sell Italian newspapers. She has no idea about Rotunda.

Example: Alice agrees with Kim on where one can buy an Italian newspaper in the neighborhood. (Situation 1: true; Situation 2: untrue)

Just as in the case of know discussed in the previous section, the three levels of exhaustivity by themselves do not account for the judgments reported here: the SE reading of (17) is false in both Situation 1 and 2 while its WE and MS readings are true in both Situation 1 and 2; all of MS, WE and SE readings of (17) are true in both Situation 1 and 2. In order to capture the readings, we need an additional condition to WE and MS that require Alice to not believe anything that Kim does not believe. Specifically, the truth conditions of the relevant readings of (17,18) can be paraphrased as follows:

(19) \([(17)]^w \Leftrightarrow ‘Alice believes that Bonnie and Carol passed the exam, and it’s not the case that she believes that Dana did.’

6See Chemla and George (2016) for relevant experimental investigation into the interpretations of agree-wh sentences. Though, note that they use agree-wh sentences with plural subjects rather than the construction "x agrees with y on wh...", which is relevant here.
5.3. NON-REDUCIBLE PREDICATES

(20) $\lbrack (18) \rbrack_w \iff \text{‘Alice believes that Newstopia sells Italian newspapers, and it’s not the case that she believes that PaperWorld does.’} $

More generally, the readings under consideration can be formulated as follows, with the underlined condition added to the MS/WE condition: 7

(21) $\lbrack x \text{ agrees with } y \text{ on } Q \rbrack_w \iff \exists p \in \text{AnsF}_w^C \{ p \, | \, B_w(x, p) \} \{ p \, | \, B_w(y, p) \} \land \forall p \in Q \{ [ B_w(x, p) \rightarrow B_w(y, p) ] \}$

It is worth noting here that the relevant readings of agree-wh are similar to the F AS readings for know-wh in the sense that both require that the subject not believe any answer violating the presupposition of their declarative-embedding counterpart. That is, the FAS readings of know-wh require the subject not to believe any answer that fails to satisfy the presupposition of know-that, i.e., any false answer. Similarly, the relevant readings of (17,18) require the subject not to believe any answer that fails to satisfy the presupposition of agree-with-y-that, i.e., any answer not believed by $y$. The presuppositional behaviors of know-that and agree-with-y-that are exemplified below:

(22) Alice knows that Bonnie passed the exam. $\text{presup} \Rightarrow \text{‘Bonnie passed the exam.’}$

(23) Alice agrees with Kim that Bonnie passed the exam. $\text{presup} \Rightarrow \text{‘Kim believes that Bonnie passed the exam.’}$

Just as in the case of know, it is straightforward to show that the readings of agree-wh under consideration here constitute counterexamples to REDUCIBILITY. To see this, consider the following variant of (17):

(17′) **Situation:** Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Kim, their teacher, believes that Bonnie and Carol passed the exam but Dana didn’t. Alice believes that Bonnie and Carol passed the exam, but has no idea about Dana. Zoe, their aunt, believes that all three passed the exam. Alice and Zoe have exactly the same set of knowledge in other respects.

<table>
<thead>
<tr>
<th></th>
<th>Bonnie</th>
<th>Carol</th>
<th>Dana</th>
<th>¬Dana</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facts</strong></td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td><strong>Does A agree with Kim that...?</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td><strong>Does Z agree with Kim that...?</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>#</td>
<td>No</td>
</tr>
<tr>
<td><strong>In A’s beliefs</strong></td>
<td>True</td>
<td>True</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>In Z’s beliefs</strong></td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>

7Here, I use a generalized version of the AnsF operator anchored to a set $C$ of propositions, defined as follows (following similar formulations of the answerhood operator in Lahiri 2002, Cremers 2016):

(i) $\text{AnsF}_w^C := \lambda Q_{(s,t)} : \exists p \in \text{Max}_{\text{Max}_{\text{Max}}}(Q). \{ p \, | \, p \in \text{Max}_{\text{Max}_{\text{Max}}}(Q) \}$

(ii) $\text{Max}_{\text{Max}_{\text{Max}}}(Q) := \{ p \, | \, p \in Q \cap C \land \forall q \{ q \in Q \leftrightarrow q \not\subset p \} \}$

Roughly speaking, while AnsF$_w$ is anchored to the evaluation world $w$ and restricts the set of answers to those that are true in $w$, AnsF is anchored to $C$ and restricts the set of answers to those that are in $C$. In the case of agree-with-y-wh, AnsF$_w^C$ is used to restrict the set of answers to those that are believed by $y$. 
a. Alice agrees with Kim on which girls among Bonnie, Carol and Dana passed the exam.

b. Zoe agrees with Kim on which girls among Bonnie, Carol and Dana passed the exam.

In the reading described in (21), the situation makes (17’a) true and (17’b) untrue. This shows that agree-with-y... is not REDUCIBLE. In the exemplified situation, “Alice agrees with Kim that p” is equivalent to “Zoe agrees with Kim that p” for any complement p. Despite this, we have “Alice agrees with Kim on Q” not equivalent to “Zoe agrees with Kim on Q” where Q = “which girls among Bonnie, Carol and Dana passed the exam”. I leave the reader to construct a similar variant for (18).

5.3.3 Surprise

Fox (2020) observes that the emotive factive predicate surprise exhibits FAS, but within its presuppositional condition. More specifically, the presupposed knowledge for surprise requires the subject not to believe any false answer to the embedded question. This is exemplified in the following:

(24) SITUATIONS: Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Bonnie and Carol passed the exam, but Dana didn’t. Alice expected Bonnie to pass it but didn’t expect Carol to do so.

SITUATION 1: Alice knows that Bonnie and Carol passed the exam, but has no idea about Dana.

SITUATION 2: Alice knows that Bonnie and Carol passed the exam, and incorrectly believes that Dana did.

EXAMPLE: Alice is surprised at/by which girls among Bonnie, Carol and Dana passed the exam.

According to Fox, (24) is true in Situation 1, but is a presupposition failure in Situation 2. The relevant reading of (24) can be described as follows, with the underlined FAS condition:

(25) [(24)]

• presupposes: Alice knows that Bonnie and Carol passed the exam, and it is not the case that Alice believes that Dana did,

• if the presupposition is satisfied, is true iff Alice didn’t expect Carol or Dana to pass the exam.

More generally, the reading of surprise-wh in question can be described as follows:

(26) [x is surprised at/by Q]

• presupposes: for every true answer p to Q, x knows that p and it is not the case that x believes any false answer to Q

• if the presupposition is satisfied, is true iff there is a true answer p to Q such that x didn’t expect p.
5.4. PROPOSITION-ORIENTED ANALYSIS OF NON-REDUCIBLE PREDICATES

Crucially, the presupposition of the relevant reading of "x is surprised at/by Q" simply corresponds to the WE+FAS reading of "x knows Q".

It is straightforward to see that surprise under this reading is non-reducible. To see this, suppose that we have the following information about the additional character Zoe in Situation 1 of (24):

(27) ADDITION TO SITUATION 1: Zoe knows that Bonnie and Carol passed the exam, and incorrectly believes that Dana did too. Similarly to Alice, Zoe expected Bonnie to pass the exam but didn't expect Carol to do so. Also, Alice and Zoe have had exactly the same set of expectations.

Together with Situation 1 in (24), the situation can be summarized as follows:

<table>
<thead>
<tr>
<th></th>
<th>Bonnie</th>
<th>Carol</th>
<th>Dana</th>
<th>¬Dana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts</td>
<td>True</td>
<td>True</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>Is A surprised that...?</td>
<td>No</td>
<td>Yes</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>Is Z surprised that...?</td>
<td>No</td>
<td>Yes</td>
<td>#</td>
<td>#</td>
</tr>
<tr>
<td>In A's beliefs</td>
<td>True</td>
<td>True</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>In Z's beliefs</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>False</td>
</tr>
</tbody>
</table>

a. Alice is surprised at/by which girls among Bonnie, Carol and Dana passed the exam.

b. Zoe is surprised at/by which girls among Bonnie, Carol and Dana passed the exam.

According to the reading suggested in (26), (27a) is true while (27b) is a presupposition failure. This constitutes a counterexample to the reducibility of surprise. By assumption, for all declarative complement p, "Alice is surprised that p" ⇔ "Zoe is surprised that p". However, above we have a case where "Alice is surprised at/by Q" ̸⇔ "Zoe is surprised at/by Q".

5.4 Proposition-oriented analysis of non-reducible predicates

In the previous section, we have seen three predicates that exhibit non-reducibility: know, agree and surprise. As discussed in Sect. 5.2, as long as we adhere to the baseline proposition-oriented analysis for responsive predicates, repeated below, these predicates pose problems for the proposition-oriented theory.

(28) [x Vs Q]w ⇔ ∃w'[[V]w'(AnsDw'(Q))(x)] (proposition-oriented)

The presupposition failures in the 3rd/4th rows result from the factivity and knowledge presupposition of surprise. "Alice/Zoe is surprised that Dana passed the exam" is a presupposition failure because of the factivity (as Dana didn't pass the exam). "Alice/Zoe is surprised that Dana didn't pass the exam" is a presupposition failure because of the knowledge presupposition (as neither Alice nor Zoe believes that Dana didn't pass the exam).
Nevertheless, once we go beyond the baseline analysis and consider more sophisticated treatments of responsive predicates, it is in principle possible to account the prima facie non-reducible behaviors of responsive predicates within the largely proposition-oriented framework. In this section, I will consider two such analyses proposed in the literature: one based on exhaustification by Cremers (2016), Cremers and Chemla (2016) and one based on trivalent analysis of presupposition by Fox (2020).

5.4.1 Exhaustification

Cremers (2016) and Cremers and Chemla (2016) propose an analysis of the non-reducible reading of know-wh within the proposition-oriented theory, employing the mechanism of exhaustification (cf. Uegaki, 2015). The analysis is based on Klínedist and Rothschild’s (2011) (K&R’s) analysis of intermediate exhaustivity (IE) which treats F AS as arising from matrix application of the exhaustification operator. Below, I will review K&R’s exhaustification-based analysis of IE for the non-factive predicate predict, and discuss the extension of the analysis to know by Cremers (2016), Cremers and Chemla (2016).

Klinedist and Rothschild’s (2011) exhaustification-based analysis for the FAS of non-factive predicates

K&R propose that SE and IE readings of $\left\langle x \text{Vs} \quad \text{Q} \right\rangle$ arise from application of an exhaustification operator, which I call ExH$_{KR}$, to the LF at different clausal projections. Specifically, their analysis can be schematically represented as follows:

(29) a. Strong exhaustivity (SE)  
\[ x \quad \text{V} \quad \text{ExH}_{KR} \quad \text{Q} \]

b. Intermediate exhaustivity (IE)  
\[ \text{ExH}_{KR} \quad x \quad \text{V} \quad \text{Q} \]

We will focus on the IE structure in (29b). Before considering the formal definition of ExH$_{KR}$ and compositional derivation of the structure in (29b), let me illustrate the analysis with a concrete example having this structure, as follows:

(30) $[[\text{ExH}_{KR} \quad \text{Alice predicted [which girls would pass the exam]]}]^w$

$\Leftrightarrow$ Prejacent Alice predicted (in $w$) the Dayal-answer of ‘which girls would pass the exam’ in $w$; and

Negation of alternatives for every answer $p$ to ‘which girls would pass the exam’ stronger than its Dayal-answer in $w$, Alice didn’t predict $p$ (in $w$)

Following the standard definition of the exhaustification operator as a version of silent ‘only’ (e.g. Chierchia et al., 2012), the operator ExH$_{KR}$ takes a prejacent and returns...
5.4. **PROPOSITION-ORIENTED ANALYSIS OF NON-REDUCIBLE PREDICATES**

the conjunction of (the semantic value of) the prejacent and the negation of a suitable set of alternatives to the prejacent. K&R assume that the prejacent of Exh\(_{KR}\) in (30), i.e. "Alice predicted which girls would pass the exam", expresses ‘Alice predicted the Dayal-answer to which girls would pass the exam’ while the suitable set of its alternatives are of the form ‘Alice predicted \(p\)’, where \(p\) is an answer to the embedded question that is stronger than the Dayal-answer. As a result of this, we derive the interpretation for the sentence given in (30). Note that the negation of alternatives corresponds to the FAS condition. More concretely, in case only Bonnie and Carol have passed the exam in the evaluation world \(w\) (out of the three girls: Bonnie, Carol and Dana), the negation of alternatives amounts to ‘Alice didn’t predict that Bonnie and Carol would pass the exam’. In conjunction with the prejacent ‘Alice predicted that Bonnie and Carol would pass the exam’, we derive the FAS condition ‘Alice didn’t predict that Dana would pass the exam’.

Formally, K&R define the exhaustification operator as in (31), and assume that the alternative-semantic value ([\(\cdot\]\(_{alt}\)) of an interrogative complement is identical to its ordinary semantic value ([\(\cdot\)]), as given in (32).

(31) **K&R’s exhaustification operator**

\[
[\text{Exh}_{KR} \varphi] \iff [\varphi] \land \forall p'[p' \in [\varphi]_{alt} \land p' \in [\varphi] \rightarrow \lnot p']
\]

(32) **Alternative-value of interrogative complements**

For every interrogative complement \(Q\), \([Q]_{alt} = [Q]\).

(33) **Point-wise Functional application for alternative values:**

If \([\alpha]_{alt} \subseteq D_{(\sigma, \tau)}\) and \([\beta]_{alt} \subseteq D_{\sigma}\), then

\[
[\alpha \beta]_{alt} = \{ \beta \alpha \}_{alt} = \{ a(b) \mid a \in [\alpha]_{alt}, b \in [\beta]_{alt} \}
\]

Assuming the point-wise functional application for alternative values, as defined in (33), we can derive the IE reading of ‘\(\exists x\) predicted \(Q\)’, as follows:\(^{10}\)

(34) \([\text{Exh} [x \text{ predicted } Q]]^w\)

\[\iff\]

**Prejacent** \([x \text{ predicted } Q]^w\)

**Negation of alternatives** \(\forall p'[p' \in [x \text{ predicted } Q]_{alt} \land p' \in [x \text{ predicted } Q]^w \rightarrow \lnot p']\)

\[\iff\]

**Prejacent** \([\text{predicted}]^w(\text{AnsD}_w(Q))(x)\)

**Negation of alternatives** \(\forall p''[p'' \in \{ [\text{predicted}]^w(\text{AnsD}_w(Q))(x) \land p'' \in Q \} \land p' \subseteq [\text{predicted}]^w(\text{AnsD}_w(Q))(x) \rightarrow \lnot p']\)

The negation of alternatives in (34) corresponds to the FAS condition, as it states that the subject did not predict any proposition that is stronger than the true Dayal-answer of the question.

---

\(^{10}\)There is one technical problem with this derivation, as noted in Uegaki (2015: 87–92). To restrict the set of alternatives to negate, we need to compare the strength of the proposition of the form \(\lambda w. [\text{predicted}]^w(\text{AnsD}_w(Q))(x)\) (where \(w\) is the evaluation world) to the alternatives. However, this proposition cannot be easily retrieved as the semantic value of the prejacent, as the extension of the prejacent would look like \([\text{predicted}]^w(\text{AnsD}_w(Q))(x)\) while its intension would look like \(\lambda w. [\text{predicted}]^w(\text{AnsD}_w(Q))(x)\). Uegaki (2015: 87–92) offers a solution to this problem by reformulating Exh as an operator that binds into the world argument of AnsD.
K&R explicitly state that their analysis (at least in its basic form) does not capture the IE readings of factive predicates. This is so because the matrix application of EXh as in (29b) when V is a factive predicate would result either in a presupposition failure or vacuous negation of alternatives. To see this, consider the following example:

\[(35) \quad [\text{Exh}_{KR} [\text{Alice knows [which girls passed the exam]]}]^w \]

\[\Leftrightarrow \quad \text{Prejacent Alice knows (in } w\text{) the Dayal-answer of ‘which girls passed the exam’ in } w; \text{ and} \]

\[\text{Negation of alternatives} \quad \text{for every answer } p \text{ to ‘which girls passed the exam’ that is stronger than its Dayal-answer in } w, \text{ Alice doesn’t know } p \text{ (in } w\text{).} \]

Since every answer p to ‘which girls passed the exam’ that are stronger than the Dayal-answer is false, any statement of the form ‘Alice doesn’t know that p’ turns out to be either a presupposition failure (if the factivity of know projects through the negation) or vacuously true (if factivity is locally accommodated under negation). Either way, the presence of factivity in the embedding predicate in the set of alternatives seems to block the derivation of IE readings. What we would like to have instead is the negation of belief-statements, but this is not straightforwardly derived in (35). For this reason, K&R have restricted the scope of their analysis to IE readings of non-factive predicates, and left full investigation of IE readings of factive predicates to later studies.

The problem is not limited to factive predicates, however. The IE reading of agree-wh is also problematic under K&R’s analysis, for essentially the same reason why the IE reading of know-wh is problematic. This can be seen in the following predicted interpretation of the matrix application of Exh_{KR} to ‘x agrees with y on Q’ (here it is assumed that the strongest answer to the embedded question Kim believes is ‘Bianca and Carol passed the exam’ as in (17)):

\[(36) \quad [\text{Exh}_{KR} [\text{Alice agrees with Kim on [which girls passed the exam]]}]^w \]

\[\Leftrightarrow \quad \text{Prejacent Alice agrees with Kim (in } w\text{) that Bianca and Carol passed the exam; and} \]

\[\text{Negation of alternatives} \quad \text{for every answer } p \text{ to ‘which girls passed the exam’ that is stronger than ‘Bianca and Carol passed the exam’, Alice doesn’t agree with Kim that } p \text{ (in } w\text{).} \]

Just as in the case of matrix application of Exh_{KR} to know-wh, the negation of alternatives is either a presupposition failure or vacuous. Since, obviously, any p that is stronger than the strongest answer believed by Kim is not believed by Kim, ‘Alice doesn’t agree with Kim that p’ for such p is a presupposition failure (if the negation in Exh_{KR} projects the presupposition of ‘x agrees with Kim that p’) or is vacuous (if the presupposition is locally accommodated under Exh_{KR}).

**Extension of the exhaustification-based analysis to factive predicates**

Cremers (2016) and Cremers and Chemla (2016) point out that the set of alternatives for ‘x knows Q’ can also contain propositions that result from replacing the predicate, specifically know with believe. That is, they suggest the set of alternative values for ‘x knows Q’ along the following lines:
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(37) $\llbracket x \text{ knows } Q \rrbracket^w_{\text{alt}} = \{ R(p)(x) \mid R \in \{ K_w, B_w \}, p \in Q \}$

If the exhaustification operator negates belief (B) statements in the set of alternatives, the IE reading of ‘x knows Q’ can be derived straightforwardly, as follows (assuming that negation by the exhaustification of know-p statements is vacuously true with any false p):

(38) $\llbracket \text{Exh} [\text{Alice knows [which girls passed the exam]]} \rrbracket^w$

$\Leftrightarrow$ **Prejacent** Alice knows (in w) the Dayal-answer of ‘which girls passed the exam’ in w; and

**Negation of alternatives** for every answer p to ‘which girls passed the exam’ that is stronger than its Dayal-answer in w, Alice doesn’t know or believe p (in w)

One remaining technical problem concerns the definition of the exhaustification operator. Recall that ExhKR negates alternatives that are strictly stronger than the prejacent. This means that ExhKR would not negate the crucial believe-alternatives in (38), as the prejacent ‘x knows p’ is logically independent from ‘x believes $p$’ with a complement $p$ stronger than p. To remedy this problem, the exhaustification operator can be defined to negate independent alternatives. One way to do this without making exhaustification resulting in a contradiction is to adopt a version of the exhaustification operator from Fox (2007) employing the notion of innocent exclusion:

(39) **Fox-style exhaustification operator**

$\llbracket \text{Exh}_F \varphi \rrbracket \Leftrightarrow \llbracket \varphi \rrbracket \land \forall p' [p' \in \text{IE}(\llbracket \varphi \rrbracket, [\varphi]_{\text{alt}}) \rightarrow \neg p']$

(40) **Innocent exclusion**

$\text{IE}(p, A) := \bigcap \{ A' \subseteq A \mid A' \text{ is a maximal subset of } A \text{ s.t. } p \cap \bigcap \{ p' \mid p' \in A' \} \neq \emptyset \}$

The ExhF-operator conjoins the prejacent $\varphi$ with the negations of all innocently excludable (IE) alternatives to $\varphi$ given a set of alternatives for $\varphi$, i.e., $[\varphi]_{\text{alt}}$. What does it mean for an alternative to be innocently excludable? As defined in (40), the set of innocently excludable alternatives are maximal set of alternatives such that it is consistent to conjoin the prejacent with the negations of the members of that set. By replacing ExhKR with ExhF in the matrix exhaustification structure, and assuming that ‘believe’-statements are included in $[\text{x knows Q}]_{\text{alt}}^w$, we can correctly capture the FAS condition of know-wh. To see this, consider (38) again. All propositions of the form ‘Alice believes $p$', where $p$ is stronger than the correct Dayal-answer, is an Innocently Excludable alternative to the prejacent. Negating them all and conjoining them with the prejacent is consistent. In fact, it is precisely the WE+FAS reading.

Moreover, the solution can be extended to agree-wh, as long as we view ‘belief’-statements as an alternative to ‘agree’-statements, as follows:

(41) $\llbracket x \text{ agrees with Kim on } Q \rrbracket^w_{\text{alt}} \supseteq \{ B_w(p)(x) \mid p \in Q \}$

(42) $\llbracket \text{Exh}_F [\text{Alice agrees with Kim} \text{ on [which girls passed the exam]} \rrbracket^w$

$\Leftrightarrow$ **Prejacent** Alice agrees with Kim (in w) on the Dayal-answer of ‘which girls passed the exam’ in w; and
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Negation of alternatives for every answer \( p \) to ‘which girls passed the exam’ that is stronger than its Dayal-answer in \( w \), Alice doesn’t agree with Kim that \( p \) or believe \( p \) (in \( w \))

What is crucial here is that the analysis is set in the proposition-oriented semantics for the relevant predicates. Cremers (2016) and Cremers and Chemla (2016) have demonstrated that the seemingly non-reducible behavior exhibited by know-wh and agree-wh can be captured within the proposition-oriented theory, once we employ the analysis of IE based on matrix exhaustification (Klinedinst and Rothschild, 2011) and include ‘believe’-statements in the alternatives for ‘know’/‘agree’-prejacents.

Problem 1: surprise and presuppositional false-answer sensitivity

However, the exhaustification-based analysis faces a problem with the FAS condition with emotive factives, such as surprise. As discussed in Sect. 5.3.3, surprise-wh exhibits an FAS condition but solely in the presuppositional component: there is a reading of \( \square x \) is surprised at/by \( Q \) that presupposes an IE knowledge-wh.

To see why the exhaustification-based analysis has trouble accounting for the data, consider the following predicted interpretation based on matrix exhaustification plus inclusion of ‘believe’-statements in the alternatives.

(43) \[ \text{EXH} \quad \text{[Alice is surprised at/by [which girls passed the exam]]} \]

\( \Leftrightarrow \text{Prejacent} \quad \text{Alice is surprised (in \( w \)) at/by the Dayal-answer of ‘which girls passed the exam’ in \( w \);} \quad \text{and}

Negation of alternatives for every answer \( p \) to ‘which girls passed the exam’ that is stronger than its Dayal-answer in \( w \), it is not the case that Alice was surprised that \( p \) or believe \( p \) (in \( w \))

This analysis is problematic because it predicts the FAS condition of surprise-wh to be in the assertive component, rather than in the presuppositional component, to the extent that \( \text{EXH} \) asserts the negation of the relevant set of alternatives.

Now, it is in principle possible to replace the exhaustification operator in (43) with a variant that presupposes the negation of relevant alternatives. Indeed, such an operator is independently proposed by Bassi et al. (2019) to account for several problematic cases for the grammatical theory of scalar implicature (including the behavior of implicature under negation and the so-called ‘some-under-some’ puzzle; Chierchia 2004). There are two analytical options involving such a presuppositional exhaustivity operator. One option is to utilise it just in the case of surprise-wh and maintain \( \text{EXH} \) in the case of know-wh and agree-wh, while the other option is to utilise the presuppositional exhaustivity operator across the board. The first analysis faces a conceptual challenge in motivating the specific choice of the exhaustification operator depending on the embedding predicate. The second analysis is free from such a conceptual challenge, but faces an empirical problem in accounting for the projection behavior of FAS with know/agree-wh. If the FAS condition is taken to be a presupposition even in the case of know/agree-wh, then it is predicted that it projects through presupposition ‘holes’. This point will be discussed in detail in Sect. 5.4.2 below, in the context of the assessment
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of Fox (2020), who makes similar predictions regarding the presuppositional status of FAS.

Problem 2: Xiang’s challenge based on disjunctive false answers

The second problem with the exhaustification-based analysis concerns Xiang’s (2016) observation that disjunctive false answers also matter for FAS. Her observation can be illustrated with the following example:

(44) **Situation 1:** Alice knows that Bonnie and Carol passed the exam, but has no idea about Dana and Emma.

(45) **Situation 2:** Alice knows that Bonnie and Carol passed the exam. She also believes incorrectly that Dana or Emma did too.

**Example:** Alice knows which girls among Bonnie, Carol, Dana and Emma passed the exam.

Xiang observes that, although the example is true in Situation 1, it is perceived to be untrue in Situation 2, in a way similar to the original FAS example involving *know-wh*. What is crucial here is the fact that the false proposition incorrectly believed by Alice in Situation 2, i.e. ‘Dana or Emma passed the exam’ is a disjunctive answer of the question ‘which girls passed the test’, not included in its proposition-set denotation under Hamblin/Karttunen-style analysis outlined in Chap. 2.

This presents a challenge for the exhaustification-based analysis, as the relevant alternatives for \( \langle x \text{ knows } Q \rangle \) are constrained by the proposition-set denotation of \( Q \), which does not include disjunctive answers under normal assumptions. Romero (1998), Spector (2007), and more recently Xiang (in press), have argued that wh-questions allow higher-order readings, where a wh-clause ‘who passed the exam’ is interpreted as ‘which generalized quantifier \( G \) is such that \( G(\lambda x. x \text{ passed the exam}) \)’. One might think that including higher-order answers to the set of alternatives for exhaustification resolves the problem with the data in (44). For, the FAS condition shown in (44) can be treated as the negation of the following alternative:

(45) Alice believes \( [\lambda P_{et}. P(b) \land P(c) \land (P(d) \lor P(e))] (\lambda x_e. \text{passed}(x)) \)

However, an analysis based on higher-order answers succeeds only if it can be coupled with a suitable restriction on higher-order readings of wh-complements. To see this, suppose that there is no constraint on higher-order readings. If so, (45) cannot be in the set of innocently excludable alternatives given the prejacent ‘Alice believes that Bonnie and Carol passed the exam’, due to the presence of the following symmetric alternative:

(46) Alice believes \( [\lambda P_{et}. P(b) \land P(c) \land \neg(P(d) \lor P(e))] (\lambda x_e. \text{passed}(x)) \)

This means, without any constraint on higher-order readings, we in fact cannot derive the reading exemplified in (44) in terms of exhaustification. Spector (2007) argues that
the domain of the generalized quantifiers in a higher-order answer has to be restricted to increasing quantifiers, in order to avoid the problem with symmetric alternatives when deriving exhaustive interpretations of higher-order readings. However, it is still unclear why such a constraint exists in higher-order readings. Without a suitable theory on the nature and the source of constraints on higher-order readings, the data in (44) remains to be puzzling for an exhaustification-based analysis of FAS.

5.4.2 A trivalent analysis

Fox (2020)

Fox (2020) presents yet another proposition-oriented analysis of FAS, employing a trivalent analysis of presupposition projection. Fox’s proposal has two components: (a) a version of the answerhood operator having a presuppositional meaning modeled in a trivalent semantics; and (b) trivalent specifications about the ways in which embedding predicates project the presupposition of of their complement.

The analysis is motivated by the intuition that the interpretation of a sentence that embeds an interrogative clause is equivalent to a corresponding sentence that embeds a cleft. This correspondence is exemplified below:

(47) a. Alice knows who passed the exam.
    b. Alice knows that it is Bonnie and Carol who passed the exam.

In case Bonnie and Carol passed the exam and no one else did among the relevant set of exam-takers, (47a) and (47b) are intuitively equivalent. Fox (2020) further argues that the cleft sentence in (47b) has a reading corresponding to the SE reading—‘Alice knows that Bonnie and Carol passed the exam and no one else did’—and a reading corresponding to IE—‘Alice knows that Bonnie and Carol passed the exam, and it is not the case that she believes anyone else did.’ Fox argues that these facts receive a unified analysis in terms of the presupposition projection behaviors of the embedding predicate, once we posit an answerhood operator for (47a) that has a presuppositional meaning that parallels that of the cleft construction.

More specifically, Fox adopts Büring and Kriz’s (2013) analysis of the cleft construction, which treats it as having a trivalent presuppositional semantics (with # marking the third value), as follows:

(48) \[
\text{[It is Bonnie and Carol who passed the exam] }^w = \begin{cases} 
1 & \text{if Bonnie and Carol passed the exam} \\
0 & \text{if Bonnie didn’t pass the exam or Carol didn’t pass the exam} \\
# & \text{otherwise}
\end{cases} 
\]

Mirroring this treatment of cleft, Fox defines the answerhood operator as follows:\footnote{SEP’ in AnsSEP stands for ‘Strong Exhaustivity—Presuppositional’}

(49) \[
\text{Fox’s trivalent answerhood operator} \quad \text{(Fox, 2020: 19-20, (34′))}
\]

\[\text{AnsSEP}_{w'}(Q) = \lambda w'. \begin{cases} 
1 & \text{if the SE answer of } Q \text{ in } w \text{ is 1 in } w' \\
0 & \text{if the WE answer of } Q \text{ in } w \text{ is 0 in } w' \\
# & \text{otherwise}
\end{cases} \]
5.4. PROPOSITION-ORIENTED ANALYSIS OF NON-REDUCIBLE PREDICATES

The other component of Fox’s analysis concerns the presupposition projection properties of embedding attitude predicates. He models them by considering two versions of lexical entries for the predicates: one for capturing universal projection of presuppositions and the other for capturing existential projection. Here, the universal projection captures the commonly accepted generalization after Karttunen (1973, 1974) that presuppositions of clausal complements of attitudinal predicates (universally) project to the belief state of the subject. On the other hand, the existential projection is motivated by the data like the following, due to Heim (1992: 209).\footnote{Heim (1992) cites Fauconnier (1984) and Zeevat (1991) as earlier sources discussing similar examples to (50).}

(50) [John and Mary are speaking on the phone]
John: I am already in bed.
Mary: My parents think I also are in bed. \(\text{Heim, 1992: 209, (71)}\)

(51) [Imagine John and Mary competed for one job, and everybody, including the parents, knew this.]
John: I got the job.
Mary: #My parents think that I also got it. \(\text{Heim, 1992: 219, fn. 51}\)

In these example, it is not the case that the presupposition triggered by also is projected to Mary’s parents beliefs. Rather, it is only presupposed that the presupposition is compatible with their beliefs. Formally, the two entries for know with universal and existential projection properties are defined as follows (here, \(B_w^x := \bigcap \{ p \mid B_w(x, p) \}\)):

(52) Universal and existential presupposition projection by know
a. \([\text{know}_{\forall \text{proj}}]^w(p)(x)\) (\(\forall\)-projection; Fox 2020: 17, (36))
   \[
   = \begin{cases} 
   1 & \text{if } p(w) = 1 \land \forall w' \in B_w^x[p(w') = 1] \\
   0 & \text{if } p(w) = 1 \land \forall w' \in B_w^x[p(w') \neq \#] \land \exists w' \in B_w^x[p(w') = 0] \\
   \# & \text{otherwise}
   \end{cases}
   \]

b. \([\text{know}_{\exists \text{proj}}]^w(p)(x)\) (\(\exists\)-projection; Fox 2020: 24, (50))
   \[
   = \begin{cases} 
   1 & \text{if } p(w) = 1 \land \exists w' \in B_w^x[p(w') \neq \#] \land \forall w' \in B_w^x[p(w') \neq 0] \\
   0 & \text{if } p(w) = 1 \land \exists w' \in B_w^x[p(w') = 0] \\
   \# & \text{otherwise}
   \end{cases}
   \]

The universal projection of the presupposition of the AnsSEP-operator results in an SE reading while the existential projection results in an IE reading. To see this, let’s consider a simplified model, as follows.

(53) Let \(Q = \text{[which girls among Bonnie, Carol and Dana passed the exam]}^w\), and the actual world \(w_\bullet\) be the world in which Bonnie and Carol but not Dana passed the exam. In addition to the actual world, we consider the following two worlds:
   a. \(w_{\text{WE}} := \text{the world in which only the WE answer of } Q \text{ is true, i.e., the world in which all three of Bonnie, Carol and Dana passed the exam.}\)
   b. \(w_{\#} := \text{a world in which the WE answer of } Q \text{ is false, i.e., the world in which either Bonnie or Carol didn’t pass the exam.}\)
Given this model, we have the values for \( \text{AnsSEP} \) in (54) and the predicted interpretations for \( \text{⌜Alice know}_{\text{proj}}/\text{know}_{\exists\text{proj}} \text{ which girls among Bonnie, Carol and Dana passed the exam}⌝ \):

\[
\begin{align*}
(54) & \quad \text{a. } \text{AnsSEP}_{w@}(Q)(w@) = 1 \\
& \quad \text{b. } \text{AnsSEP}_{w@}(Q)(w_{\text{WE}}) = \# \\
& \quad \text{c. } \text{AnsSEP}_{w@}(Q)(w_{@}) = 0 \\
(55) & \quad \text{a. } [\text{know}_{\text{proj}}]^{w}(\text{AnsSEP}_{w@}(Q))(a) \\
& \quad \begin{cases} 1 & \text{if } w = w@ \land B^a_w \subseteq \{w@\} \\
0 & \text{if } w = w@ \land \{w_{@}\} \subseteq B^a_w \subseteq \{w_{@}, w_{@}\} \\
\# & \text{otherwise} \end{cases} \\
& \quad \text{b. } [\text{know}_{\exists\text{proj}}]^{w}(\text{AnsSEP}_{w@}(Q))(a) \\
& \quad \begin{cases} 1 & \text{if } w = w@ \land \{w_{@}\} \subseteq B^a_w \subseteq \{w_{@}, w_{\text{WE}}\} \\
0 & \text{if } w = w@ \land w_{@} \in B^a_w \\
\# & \text{otherwise} \end{cases}
\end{align*}
\]

It can be seen that (55a) represents the SE reading, as it is true only if \( w_{@} \) is the only world (out of \( w_{@}, w_{\text{WE}} \) and \( w_{@} \)) compatible with Alice’s beliefs. On the other hand, (55b) represents the IE reading. It can be true if \( w_{\text{WE}} \) is compatible with Alice’s beliefs as long as \( w_{@} \) is also compatible with her beliefs.

Thus, Fox (2020) provides an elegant treatment of FAS within the proposition-oriented framework. Since the analysis does not employ exhaustification, it does not face problems with the presuppositional FAS of surprise-\textit{wh} and sensitivity to disjunctive false answers, which are problematic for the exhaustification-based account as pointed out in Sect. 5.4.1. In general, the analysis predicts that cases involving subject beliefs that are incompatible with the SE answer result in an ‘untrue’ judgment with existential presupposition projection, if the predicate encodes knowledge either in the presuppositional or in the assertive dimension.

**Problem: non-presuppositional status of FAS**

Despite the advantages, the analysis by Fox (2020) makes a problematic prediction that the FAS condition is essentially a presuppositional condition. To see this, consider a situation in which Alice’s beliefs entirely consist of \( w_{\text{WE}} \), described in (53). That is, \( B^a_w = \{w_{\text{WE}}\} \). In this situation, both the SE and IE readings of \( \text{⌜Alice knows which girls passed the exam}⌝ \) represented in (55) are predicted to have the value \#, representing a presupposition failure.

However, there are reasons to believe that the FAS condition of know-\textit{wh} is not a presupposition. First, it does not seem to project through the usual presupposition holes, such as polar questions. For example, the polar question in the following example can be felicitously uttered even if the speaker does not know anything about Alice’s beliefs with respect to the relevant question.

\[
(56) \quad [\text{We all know that Alice and Bonnie passed the exam and Carol didn’t.}] \\
\text{Does Alice know which girls (among these three) passed the exam?}
\]
This is surprising given Fox’s analysis since, under both SE and IE readings, the polar question is predicted to presuppose that it is not the case that Alice believes all three girls to have passed the exam (because such a belief entirely consists of worlds in which the WE answer is true but the SE answer is false).

Similarly, the interpretation of the following sentence seems to be incompatible with the view that the FAS condition is a presupposition.

(57) Kim doubts that Alice knows which girls (among Bonnie, Carol, and Dana) passed the exam.

The sentence can be felicitously uttered if (a) it is commonly known that Bonnie and Carol but not Dana passed the exam, and (b) the speaker believes that Kim thinks Alice incorrectly believes all three girls to have passed the exam. This is again surprising under the presuppositional analysis. If the complement of doubt in (57) presupposes that it is not the case that Alice believes that all three passed the exam, this presupposition will either existentially or universally project through doubt, resulting in the sentential presupposition that it is at least compatible with Kim’s beliefs that it is not the case that Alice believes that all three passed the exam.

It is in principle possible for a presuppositional analysis to account for the above facts by resorting to local accommodation. However, under standard assumptions, local accommodation results in a non-default, marked, reading although the judgments reported above do not seem to reflect non-default readings. Although more detailed empirical work is needed to assess the proper phenomenology of FAS, I take the above facts to be empirical problems for Fox (2020), whose central claim consists in taking Fox to be presuppositional.

5.4.3 Section summary

Although the non-reducibility of certain responsive predicates pose problems for the baseline analysis within the proposition-oriented theory, there are two proposals in the literature that aim to capture non-reducibility by enriching the proposition-oriented baseline analysis. One such enrichment is based on exhaustification by Cremers (2016), Cremers and Chemla (2016) (cf. Klinedinst and Rothschild, 2011) and the other is based on trivalent semantics for presupposition projection (Fox, 2020). In this section, I have reviewed these proposals and pointed out empirical problems for both. Specifically, the FAS of surprise-wh and sensitivity to disjunctive false answers (Xiang, 2016) prove to be challenging for the exhaustification-based analysis while the non-presuppositional status of the FAS of know-wh is problematic for the trivalent analysis.

5.5 Question-oriented analysis of non-reducible predicates

As discussed in Sect. 5.2, enocoding FAS conditions in the denotation of a responsive predicate is straightforward under the question-oriented theory. Below are possible implementations of the FAS condition within the question-oriented denotations of know,
agree, and surprise:\textsuperscript{13,14}

(58) **Question-oriented FAS denotations for responsive predicates**

a. \( [\text{know}_{\text{FAS}}]^w = \lambda Q_{(s,t,t)} x e. \quad \exists p \in \text{AnsF}_w(Q)[K_w(x, p)] \land \neg B_w(x, \text{AnsSE}_w(Q)) \)

b. \( [\text{agree}_{\text{FAS}}]^w = \lambda Q_{(s,t,t)} y e. \quad \exists p \in \text{AnsF}_{(p|B_w(y,p))}(Q)[K_w(x, p)] \land \neg B_w(x, \text{AnsSE}_{(p|B_w(y,p))}(Q)) \)

c. \( [\text{surprise}_{\text{FAS}}]^w = \lambda Q_{(s,t,t)} x e. \quad \exists p \in Q[\text{surprise}_w(x, p)] \)

(59) **Definitions**

a. \( \overline{p} := \{ w | w \not\in p \} \)

b. \( \text{AnsSE}_w := \lambda Q_{(s,t,t)} x e. \quad \bigcap \{ p | p \in Q \land w \in p \} \cap \bigcap \{ \overline{p} | p \in Q \land w \not\in p \} \)

c. \( \text{AnsSE}'_w := \lambda Q_{(s,t,t)} x e. \quad \bigcap \{ p | p \in Q \land p \in C \} \cap \bigcap \{ \overline{p} | p \in Q \land p \not\in C \} \)

Following Fox’s (2020) and Theiler et al.’s (2018) insight, the FAS conditions are stated in terms of compatibility between the subject’s beliefs and the SE answer of the question, appropriately defined. This allows us to capture Xiang’s (2016) observation. The condition rules out a situation in which the subject believes a false disjunctive answer.

Note that the underlined conditions do not affect the interpretation of these predicates with declarative complements. This is so since, under the question-oriented theory, a declarative complement is treated as a singleton proposition-set \( \{ p \} \), and, in such a case, the underlined conjunct in (58a-58b) are entailed by the other conjunct, given that the presupposition of the sentence is met. For example, given that the existential presupposition of \( \text{AnsF}_w(\{ p \}) \) is met (i.e., that \( p \) is true), the left conjunct of (58a) amounts to \( K_w(x, p) \) and the right conjunct of (58a) amounts to \( \neg B_w(x, \overline{p}) \), where the former entails the latter.

### 5.6 Chapter summary

In this chapter, I made yet another comparison between the proposition-oriented theory and the question-oriented theory by focusing on the semantic property of reducibility for responsive predicates, i.e., the possibility for the interrogative-embedding use of a responsive predicate to be completely paraphrased in terms of its declarative-embedding use. The proposition-oriented theory, at least under its baseline formulation, predicts all responsive predicates to be reducible while the question-oriented theory allows a predicate to be non-reducible. Building on the existing literature, I argued that the so-called false-answer sensitivity (FAS) of know, agree, and surprise embody their non-reducibility. I have also considered two existing proposals to deal with FAS within the largely proposition-oriented framework, i.e., the exhaustification-based analysis by Cremers (2016), Cremers and Chemla (2016) and the trivalent analysis by Fox (2020), and pointed out empirical problems for them. All in all, the non-reducibility of know,

\textsuperscript{13}In the case of agree, it would be more accurate to refer to the relevant condition as ‘sensitivity to the answers not believed by the \( y \)-argument’. However, I will refer to the condition as false-answer sensitivity (FAS), for the sake of brevity.

\textsuperscript{14}See fn. 7 for the definition of \( \text{AnsF}' \).
agree and surprise manifested by FAS constitutes another empirical argument for the question-oriented theory of clause-embedding predicates.

At this point, the reader may wonder if the question-oriented theory is too powerful. It is rather trivial to define non-reducible predicate entries in the question-oriented theory as demonstrated in Sect. 5.5. In contrast, the proposition-oriented theory is constrained, making it impossible to define empirically adequate non-reducible denotations. Although this turned out to be an empirical advantage for the question-oriented theory in the context of the current chapter, one might find the extensive expressive power of the question-oriented theory to be conceptually problematic. In fact, one can define all sorts of unattested non-reducible meanings within the question-oriented theory. This issue will be taken up in Ch. 8.
Bibliography


Fox, Danny. 2013. Mention-some readings. Ms. MIT and HUJI.

Fox, Danny. 2020. Pointwise exhaustification and the semantics of question embedding. Manuscript, MIT.


Xiang, Yimei. in press. Higher-order readings of wh-questions. *Natural Language Semantics*.

Chapter 6

*Hoping*: predicates that hate questions

### 6.1 Introduction

In Ch. 1, I discussed the challenges ‘picky’ predicates—those predicates that are compatible only with a certain clause type—pose for the semantics of clause-embedding predicates. It is important to recall that there are in fact two classes of picky predicates—ROGATIVE PREDICATES and ANTI-ROGATIVE PREDICATES—and that each of these two classes poses distinct challenges for the proposition-oriented theory and the question-oriented theory of clause-embedding predicates.

I already discussed, in Ch. 3, the challenges posed by ROGATIVE PREDICATES, i.e. the class of picky predicates that are only compatible with interrogative complements. There, I argued that interpretation and the selectional restriction of rogative predicates are more readily accounted for by the question-oriented theory than by the proposition-oriented theory. This is perhaps not so surprising, since the selectional restriction of rogative predicates, such as *wonder*, *ask*, and *investigate*, already suggests that the predicates describe relationships between an agent and a *question*. Thus, at an intuitive level, the question-oriented semantics makes sense for these predicates. Ch. 3 details the argument that this analytical hunch is in fact on the right track. Rogative predicates can be given empirically accurate question-oriented semantics, which also explains their incompatibility with declarative complements from semantic grounds.

On the other hand, ANTI-ROGATIVE PREDICATES—the class of predicates that are only compatible with declarative complements (e.g., *believe*, *think*, *hope*)—prima facie appear to be problematic for the question-oriented theory. If clause-embedding predicates always describe relationships between an agent and a question, why do certain predicates hate to be combined with interrogative complements? In fact, to the extent that anti-rogative predicates are mirror images of rogative predicates, they might seem to be more amenable to a proposition-oriented analysis than to a question-oriented analysis. This is the overarching issue to be explored in this chapter.

In this chapter, based on my joint work with Yasutada Sudo (*Uegaki and Sudo,*
I will focus on a particular subclass of anti-rogative predicates, i.e. the class of predicates that are both non-veridical and preferential (e.g., hope, prefer), and argue that their interpretation and selectional restrictions can be adequately analyzed under the question-oriented theory. The analysis of non-veridical preferential predicates complements an existing question-oriented analysis of another subclass of anti-rogative predicates, i.e. neg-raising predicates (e.g., think, believe), due to Theiler et al. (2019). Although the two subclasses—the non-veridical preferentials and the neg-raisers—do not cover the entire class of anti-rogative predicates, I take the two analyses to provide a promising proof of concept for the question-oriented semantics for anti-rogative predicates. This is significant because proposition-oriented semantics, too, faces a challenge of explaining the selectional restriction of anti-rogative predicates, as argued in Ch. 1 and will be expanded shortly below. Thus, despite the initial appearances, the behaviors of anti-rogative predicates do not pose challenges specifically to the question-oriented theory. Rather, the theory lends itself to an otherwise unavailable semantic explanations for their selectional restrictions.

The rest of the chapter is structured as follows. In Sect. 6.2, I will introduce the class of anti-rogative predicates in English and recapitulate the challenges it poses to both the proposition-oriented and the question-oriented theory. In Sect. 6.3, I review existing literature that aims to account for the selectional restriction of anti-rogative predicates, as argued in Ch. 1 and will be expanded shortly below. Thus, despite the initial appearances, the behaviors of anti-rogative predicates do not pose challenges specifically to the question-oriented theory. Rather, the theory lends itself to an otherwise unavailable semantic explanations for their selectional restrictions.

### 6.2 The challenges posed by anti-rogative predicates

Anti-rogative predicates are those predicates that are compatible with declarative complements but incompatible with interrogative complements. This class of predicates include believe, think, hope and deny in English, as exemplified below:

1. a. Alice believes/thinks/hopes that she will win the race.
   b. Alice denied that she was lying.
2. a. *Alice believes/thinks/hopes which girl will win the race.
   b. *Alice denied which girl was lying.

As discussed briefly in Ch. 1, the presence of anti-rogative predicates poses challenges both for the proposition-oriented and for the question-oriented theory of clause-embedding predicates. The problem is obvious in the case of the question-oriented theory. If all clause-embedding predicates semantically select for questions, it is prima facie surprising that there are predicates that are only compatible with declarative complements.
For, it is not straightforward what a question-oriented lexical entry would look like if the predicate never takes an interrogative complement. Furthermore, even if a question-oriented entry for an anti-rogative predicate can be devised, it will be another issue why a predicate having such an entry is incompatible with an interrogative complement.

At first glance, the presence of anti-rogative predicates seems to be less problematic for the proposition-oriented theory, as it is straightforward how the proposition-oriented entries for anti-rogatives can be defined. In fact, most of the progress in the semantics of attitudinal predicates since Hintikka (1962) is based on a proposition-oriented analysis. However, capturing the selectional restriction of anti-rogative predicates turns out to be challenging also within the proposition-oriented theory. This is so because the proposition-oriented theory as a framework for the analysis of clause-embedding predicates in general is necessarily coupled with a compositional mechanism, such as the answerhood operator, that allows responsive predicates to embed interrogative complements. Applying such a mechanism to anti-rogative predicates makes an incorrect prediction that they can embed interrogative complements. Thus, the application of the mechanism has to be somehow blocked in the case of anti-rogative predicates, but it remains to be a problem how this can be done. One could, of course, resort to syntactic selectional properties (c-selection). However, such a theory would face the same problem as the problem for the ‘eclectic’ theories discussed in Ch. 1. That is, for such a theory to be truly explanatory, it needs to be able to predict which predicates have what syntactic restrictions from independent grounds, but this turns out to be not at all trivial.

6.3 Question-oriented analyses of anti-rogative predicates

6.3.1 Neg-raising predicates and anti-rogativity

Recently, Theiler et al. (2019) have proposed an account of a subset of anti-rogative predicates within the question-oriented theory (cf. also Mayr, 2019). Their account is based on the following generalization about the relationship between the NEG-RAISING property and anti-rogativity of clause-embedding predicates (Zuber, 1982).

\begin{align}
(3) \text{ All neg-raising clause-embedding predicates are anti-rogative.} \\
(4) \text{ A predicate } V \text{ is neg-raising iff } \neg x \text{ doesn’t } V \text{ that } p \Rightarrow \neg x \text{ } V \text{ that not}(p) \end{align}

We will revisit the empirical validity of this generalization shortly below, but let us simply observe for now that the generalization applies to the neg-raising predicates in English such as believe, think, expect, assume, presume, reckon, advisable, desirable, and likely. The central claim of Theiler et al. (2019) is that, once we encode the neg-raising property of a predicate in its lexical semantics, a question-oriented analysis of its semantics predicts logical triviality when the predicate embeds an interrogative complement. Here, we will sketch a simplified version of their analysis, without going into its formal details.
Theiler et al. (2019) follow the analysis of neg-raising by Bartsch (1973) and Gajewski (2005), according to which, the neg-raising inference arises due to the EXCLUDED-MIDDLE presupposition of the form ‘x V s that p or x V s that not(p)’. Implementing this in the question-oriented theory gives us the semantics of a neg-raising predicate, as follows:

(5)  For any set Q of propositions and any individual x, \([\text{believe}] (Q)(x)\)

   (i) presupposes that \(\exists p \in Q[\text{DOX}_x^w \subseteq p] \lor \forall p \in Q[\text{DOX}_x^w \cap p = \emptyset]\)

   (ii) if the presupposition is true, \([\text{believe}] (Q)(x)\) asserts that \(\exists p \in Q[\text{DOX}_x^w \subseteq p]\)

This captures the neg-raising inference in case Q is a denotation of a declarative complement. On the other hand, when Q is a denotation of an interrogative complement, the presupposition in (i) turns out to be equivalent to the assertion in (ii). Here is why. When Q is a question, the question has the existential presupposition that at least one answer is true, which is projected to the attitude holder’s belief state (see Ch. 2 for how this is implemented). This means that the second disjunct of (5i) cannot hold (as x cannot believe that none of Q’s answer is true), and thus the presuppositional condition in (5i) amounts to just the first disjunct, which is equivalent to the assertion (5ii).

Thus, it is predicted that a neg-raising predicate combined with an interrogative complement has a logically trivial semantic content. Specifically, when its presupposition is satisfied, its assertion is always true. Such a systematic logical triviality is known to lead to unacceptability (e.g., Barwise and Cooper, 1981, Gajewski, 2002, 2009, Chierchia, 2013, Schwarz and Simonenko, 2018, Del Pinal, 2019, Chierchia, 2019). Thus, the analysis captures that neg-raising predicates are incompatible with interrogative complements, i.e., Zuber’s generalization in (3).

White (2021) questions the validity of the empirical generalizations in (3) noting that believe and think can in fact combine with a whether-interrogative clause in the following attested examples from corpora:

(6)  (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.
   c. I am torn between believing whether or not Jagex can detect the RSBot client.

(7)  (White, 2021: 11, (13-15))
   a. The image of having the members of one branch of government standing up [...] cheering and hollering while the court [...] has to sit there, expressionless [...] is very troubling. And it does cause you to think whether or not it makes sense for us to be there.
   b. [...] the righteousness is unbelievable and people [...] will have to think whether they want four more years of that.
   c. When Jan Brown completed her safety briefing for the passengers, she tried to think whether she had covered everything.
d. I’m trying to think whether I’d have been a star today or not.

e. Often, when listening to some other players (especially beginners) I start to think whether there’s an unwritten law for guitarists to never play an interval bigger than the major third.

f. [...] he wanted a domain that was memorable, brandable, keyword-rich, and relatively short. That’s tough and he started to think whether it was worthwhile to look into other TLDs.

There are two recent studies—Özyıldız (2021) and Qing (2021)—that provide possible explanations of these exceptional cases while preserving Theiler et al.’s (2019) core proposal about the link between neg-raising and anti-rogativity. Özyıldız (2021) offers an in-depth analysis of think by taking into account its aspectual properties. Özyıldız observes that think-wh describes a dynamic event, which he characterizes as ‘a deliberative process whose agent seeks to answer’ the question denoted by the interrogative complement. The dynamic nature of the event description in think-wh can be supported by its compatibility with pseudo clefts with clear indication of agency and dynamic action, as exemplified below:

(8) (Özyıldız, 2021: 28, (22a))

a. What Anna’s doing over there is she’s thinking who she should invite to the party.

b. What Anna did over there is she thought who she should invite to the party.

(9) (Özyıldız, 2021: 28, (22b))

a. What’s happening over there is Anna’s thinking who she should invite to the party.

b. What happened over there was Anna thought who she should invite to the party.

In addition, Özyıldız shows that think-wh is compatible with agent-oriented adverbs like carefully or intentionally, and that it can occur as the infinitive complement of force or persuade. These behaviors are characteristic of dynamic event descriptions, not exhibited by stative event descriptions, such as know or love. Özyıldız utilizes further diagnostics involving the interpretation of narrative progression to show that a dynamic interpretation is not merely compatible with think-wh but rather obligatory. In contrast, similar diagnostics show that think-that is compatible with both stative and dynamic interpretations.

These considerations about the aspectual properties of think-that and think-wh are important, Özyıldız says, in view of a generalization due to Bervoets (2014, 2020): if there is a dynamic counterpart of a stative neg-raiser, that dynamic counterpart does not license a neg-raising inference (cf. also Xiang 2013 for a related observation in Mandarin). In particular, it can be shown that the dynamic think does not license neg-raising. This is shown by the following examples:

(10) (Bervoets 2014: (186))

1Qing (2021) offers a similar intuition, noting that think is interchangeable with consider in the examples in (7).
a. *The farmer wasn’t **thinking** the tree fell until late last night when the barking dog startled him out of his reverie this morning.

b. As they turned the corner, the farmer wasn’t **thinking** rain would help the situation. ⇐ As they turned the corner, the farmer was thinking that rain wouldn’t help the situation.

In the examples in (10), the dynamic interpretation of **think** is forced by the progressive and the *when/*as temporal adjunction. In (10a), the strong NPI *until*-PP is not licensed, suggesting the lack of neg-raising. In (10b), the neg-raising inference is not observed. These facts are compatible with the possibility that **think** is ambiguous between the neg-raising stative interpretation and the non-neg-raising dynamic interpretation, where only the stative variant comes with the excluded-middle presupposition and thus is incompatible with interrogative complements, along with Theiler et al.’s (2019) proposal. Though, Özyıldız (2021) proposes a more explanatory analysis, according to which the dynamic interpretation as well as the lack of neg-raising for **think-wh** falls out from the interplay between the unified semantics of **think** and that of interrogative complements according to inquisitive semantics.

As for **believe**, Qing (2021) points out that the examples in (6) all involve an embedding operator that seems to involve a meaning of choice between multiple alternatives or difficulty in the choice thereof: choose, be torn, and struggle. Qing suggests that these examples involve percolation of alternatives generated by the interrogative complement through the anti-rogative **believe**, which are ultimately ‘used up’ by the higher choice-related operators. The examples in (6) have the following paraphrases according to this analysis:

(11) a. I struggled between the following alternatives: {believing that I could trust the Scriptures, believing that I could not trust the Scriptures}

b. We can choose between the following alternatives: {believing that the word of God is true, believing that the word of God is not true}

c. I am torn between the following alternatives: {believing that Jagex can detect the SRBot client, believing that Jagex cannot detect the SRBot client}

Since the main focus of the current chapter is the non-veridical preferential predicates like **hope**, I will not examine these proposals to account for White’s (2021) examples of **believe/think-wh** further. This said, I believe that the analyses by Özyıldız (2021) and Qing (2021) offer interesting and reasonable ways to reconcile White’s (2021) prima facie counterexamples with the proposed link between anti-rogativity and neg-raising due to Theiler et al. (2019).

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2Qing (2021) argues that this mechanism of alternative percolation is marked. For example, it requires an additional type-shifting that allows **believe** to combine point-wise with each alternative in the complement, rather than the set of alternatives as a whole. Qing suggests that this is the reason why the examples are rather marked.
6.4. PREFERENTIAL PREDICATES AND THEIR SELECTIONAL PROPERTIES

6.3.2 Prospects for the question-oriented analysis of non-neg-raising anti-rogatives

One limitation of the above account based on neg-raising, however, is that they only explain a proper subset of anti-rogative predicates. That is, while neg-raising predicates seem to be all anti-rogative, not all anti-rogative predicates are neg-raising. Concretely, predicates like *hope, wish, fear, deny*, and *regret* are not neg-raising but are still anti-rogative.

Thus, while there is a conceptual advantage in explaining anti-rogativity in semantic terms, such explanations are not applicable to all anti-rogative predicates. This of course does not mean that these accounts should be dismissed altogether. Rather, it is plausible that different anti-rogative predicates are anti-rogative for different semantic reasons. In this chapter, I will develop a semantic analysis of the anti-rogativity of non-veridical preferential predicates like *hope*. If successful, it will complement the aforementioned analyses of the anti-rogativity of neg-raising predicates.

The idea pursued in the rest of the chapter is similar in nature to the aforementioned accounts of neg-raising predicates: preferential predicates like *hope* are prohibited from combining with interrogative clauses because such combinations are bound to result in trivial meanings. I will furthermore show that this analysis also accounts for the fact that their veridical counterparts, like *be happy*, are responsive. More generally, the analysis is intended to derive the following empirical generalization regarding the relationship between the lexical semantics of clause-embedding predicates and their selectional restrictions:

(12) **Generalization:** All non-veridical preferential predicates are incompatible with constituent *wh*-complements.

If the analysis is successful, it will complement Theiler et al.’s (2019) analysis of neg-raising predicates and offers a promising prospect for explanatory accounts of the selectional restriction of anti-rogative predicates within the question-oriented theory. At this point, it is important to note that the above generalization is stated to allow non-veridical preferential predicates to allow *whether*-complements, unlike the formulation of the corresponding generalization in Uegaki and Sudo (2019). This is due to White’s (2021) observation that *hope* can co-occur with *whether*-complements in certain contexts, to be discussed in the next section.

6.4 Preferential predicates and their selectional properties

Following previous studies on the typology of attitude predicates (Anand and Hacquard 2013, Bolinger 1968, Heim 1992, Villalta 2008, Rubinstein 2012, Harner 2016, among others), I recognize a class of attitude predicates that are focus sensitive and express comparative meanings about focus alternatives, which will be simply referred to as preferential predicates in this chapter. They include desideratives (e.g. *hope, wish, want, deny*).
be surprised, be happy) and directives (e.g. demand, advise, encourage). The main observations at this point are based on the following predicates:

(13) a. **Non-veridical preferential predicates:**
- hope, wish, fancy, want, be eager, aspire, desire, prefer
b. **Veridical preferential predicates:**
- be surprised, be annoyed, be glad, be happy, like, love, hate

All of these predicates are compatible with declarative complements, as in (14).

(14) a. Ben hopes/wishes that Becky is invited to the party.
   b. Chris desires/prefers that Cathy will be invited to the party.
   c. Dorothy is surprised/annoyed/glad/happy that Daniel will give a presentation.

Among these, the ones that are veridical/factive with declarative complements are responsive and are compatible with interrogative complements, as in (15).

(15) a. Andy is surprised (at/by) which students are invited to the party.
   b. Ben is happy/glad (about) which students are invited to the party.
   c. Chris liked/hated which students were invited to the party.

The non-veridical ones, on the other hand, are incompatible with constituent interrogative complements.

(16) a. *Alice prefers which students will be invited to the party.
   b. *Ben hopes/wishes which students will be invited to the party.
   c. *Chris desires how many students will be invited to the party.

Note here that the which-NP clauses in the above examples cannot have a free-relative interpretation (Huddleston and Pullum, 2002: 398). That these predicates can embed genuine interrogative complements (as opposed to free relatives) can be further confirmed by checking the compatibility with wh-else (Ross, 1967: 38), which also cannot be interpreted as a free relative.

(17) a. Andy is surprised (at/by) who else is invited to the party.
   b. Ben is glad/happy (about) who else is invited to the party.
   c. Chris liked/hated who else was invited to the party.

The contrast between veridical and non-veridical preferential predicates with respect to constituent interrogative complements, as illustrated in the above examples, is the empirical focus of the current chapter. However, it should be noted that not all types of interrogative complements are compatible with veridical preferential predicates, as previously observed (Karttunen, 1977). That is, they are incompatible with whether-complements:

---

4 Some of these cases sound better with a preposition like about, but we should be careful as about itself might make an interrogative complement available. This issue will be taken up in Ch. 7.

5 By 'constituent interrogative complements', we refer to the interrogative complements except for whether/if-complements.
6.4. PREFERENTIAL PREDICATES AND THEIR SELECTIONAL PROPERTIES

(18)  a. *Andy is surprised (at/by) whether Alice is invited to the party.
    b. *Ben is glad/happy (about) whether Becky is invited to the party.
    c. *Chris liked/hated whether Cathy was invited to the party.

I assume that the pattern exemplified in (18) receives an explanation independent from the analysis of the anti-rogativity of non-veridical preferentials. In particular, my final analysis of preferential predicates presented in Sect. 6.5.4 below is compatible with Romero’s (2015) account of the incompatibility between preferential predicates and whether-complements. For other existing accounts of the same puzzle, see e.g. d’Avis (2002), Abels (2004), Guerzoni (2007), Sæbø (2007), Nicolae (2013), Roelofs et al. (2019) and Roelofsen (2019).

All in all, the data presented above corroborate the generalization in (12) that non-veridical preferential predicates are incompatible with constituent interrogative complements. Before moving on to the analysis, several further remarks are in order.

6.4.1 White’s (2021) data

White (2021) shows that whether-complements are compatible with non-veridical preferential predicates, at least in some cases. This is exemplified in the following corpus data involving hope and fear.

(19)  a. This Trump/Carson boom really has people like Bush, Walker, Rubio, and others wondering and hoping whether history will repeat itself and whether Republicans will return back to focusing on the establishment choices but it’s all about outsider candidates right now.
    b. I was hoping whether you are able to guide me [...] 
    c. I have done a quite a bit of research on using a Limited Co but was hoping whether someone with more experience could confirm my understanding of a few points [...] 

(20)  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.
    c. [...] I fear whether I’ll have use of my arms/hands by age 55 or 60.
    d. I know parents who seriously fear whether their children will ever hold a meaningful job.

These data are presented by White (2021) in response to the claim in Uegaki and Sudo (2019)—the predecessor of this chapter—that all non-veridical preferential predicates are anti-rogative and incompatible even with whether-complements. I will present the analysis of Uegaki and Sudo (2019) in Sect. 6.5, and propose a slight modification to the analysis in Sect. 6.6 to account for the data in (19). Previewing the content of Sect. 6.6, I will propose that hope, as well as other non-veridical preferentials in (13a), will be analyzed as being sensitive to HIGHLIGHTED propositions (notion borrowed from Roelofsen and Farkas 2015) on top of the semantics proposed by Uegaki and Sudo (2019). On the
other hand, the data involving fear in (20) will turn out to be not amenable to such an
analysis, falling outside the scope of the extension of Uegaki and Sudo (2019), although
I will speculate a possible reason for this exceptional behavior of fear.

6.4.2 Focus Sensitivity

My empirical generalization based on Uegaki and Sudo (2019) is limited to what I call
preferential predicates, which have preference-based semantics and are focus sensitive
in the semantic sense. Admittedly, whether a given predicate has preference-based
meaning is not always pre-theoretically clear (cf. Portner and Rubinstein 2020). On
the other hand, focus sensitivity is a very useful criterion for my purposes. That is,
as many authors have noted (Villalta, 2008, Rubinstein, 2012, Romero, 2015, Harner,
2016), the attitude predicates in question change truth conditions based on the focus
structure of the embedded sentence. Here’s an example illustrating this (modeled after
Romero 2015: (13)):

(21) CONTEXT: Natasha does not like to teach logic and prefers to teach syntax. She
is not allowed to teach both. This year, it is likely that she needs to teach logic,
and if so, she prefers to do so in the morning, as she prefers to do all her teaching
in the morning.
   a. Natasha hopes that she’ll teach logic in the MORning. (true)
   b. Natasha hopes that she’ll teach LOGic in the morning. (false)

Similarly, Romero (2015) provides the following example for surprise:

(22) CONTEXT: Lisa knew that syntax was going to be taught. She expected syntax to
be taught by John, since he is the best syntactician around. Also, she expected
syntax to be taught on Mondays, since that is the rule.
   a. It surprised Lisa that John taught syntax on TUESdays. (true)
   b. It surprised Lisa that JOHN taught syntax on Tuesdays. (false)

In addition to these truth-value judgments, we can test focus-sensitivity of the embed-
ding predicates by considering responses to the utterance of (b)-examples, as follows:

(23) No, she doesn’t hope that she’ll teach LOGic in the morning; she hopes that
she’ll teach logic in the MORning.
(24) No, it didn’t surprise her that JOHN taught syntax on Tuesdays; it surprised her
that he taught syntax on TUESdays.

The felicity of these responses to the (b)-examples in (21-22) points to the same con-
clusion: the predicates are semantically focus-sensitive. If it were not for the focus-
sensitivity of the embedding predicates, these conjunctions would sound contradictory.
These and similar observations led the authors cited above to postulate semantics for
preferential predicates that compare the focus alternatives determined by the focus struc-
ture of the embedded sentence. I will discuss a particular version of this idea due to
Romero (2015) in the next section.

It is important to note that these predicates exhibit truth-conditional effects of focus,
not just pragmatic effects of focus, which presumably all predicates exhibit one way
or another (see Harner 2016 for more discussion on this). For instance, a preference-based analysis for *decide* that compares different alternatives might appear promising. If *decide* is a preferential predicate, it will be a counter-example to our generalization, because it is not veridical but is responsive.

(25)  

a. Natasha decided that she’ll go to LONdon this summer.  

b. Natasha decided where she’ll go this summer.

The idea is that *decide* in (25a) compares different places Natasha could go to this summer.

However, according to the aforementioned definition of preferential predicates, *decide* doesn’t count as one, because it does not seem to trigger truth-conditional effects of focus. Concretely, consider the following example.

(26)  

Context: Natasha is required to teach logic, but she’s free to choose when to teach it. However, if she teaches anything in the morning, it needs to be logic. In the end, she decides to teach logic in the morning and syntax in the afternoon.

a. Natasha decided that she’d teach logic in the MORning. TRUE  
b. Natasha decided that she’d teach LOGic in the morning. ?TRUE

Crucially, in this context it is not up to Natasha to decide what to teach if she teaches in the morning. If *decide* were truth-conditionally focus sensitive, (26b) should be false, but it does not seem to be. Rather, it’s true yet infelicitous (which is presumably the pragmatic effect of focus here). Our account below will crucially rely on truth-conditional focus sensitivity. Therefore, predicates like *decide* simply fall outside of our analysis here.

### 6.4.3 Infinitival Complements

My last remark in this section concerns infinitival complements. Many preferential predicates take infinitival complements, in addition to finite ones (some, such as *want*, *be eager*, and *aspire*, are in fact more natural with infinitival complements than with finite ones). As expected from the hypothesis, non-veridical preferential predicates that are compatible with infinitival complements are only compatible with declarative (non-*wh*) ones and not with interrogative (*wh*) ones, as shown in the following examples.

(27)  

a. Alice prefers to invite Andrew to the party.  
b. Ben hopes/wishes to invite Becky to the party.  
c. Chris wants/is eager to invite Cathy to the party.

(28)  

a. *Alice prefers (about) who to invite to the party.  
b. *Ben hopes/wishes (about) who to invite to the party.  
c. *Chris wants/is eager (about) who to invite to the party.

What is unexpected, however, is that veridical preferential predicates that are compatible with infinitival complements are also only compatible with declarative ones, as illustrated in (29).
a. *Alice is surprised (at/by/about) who to invite to the party.
b. *Ben is glad/happy (about) who to invite to the party.
c. *Chris liked/hated (about) who to invite to the party.

The analysis to be presented below will focus on finite complements, and will not have much to say about infinitival complements. However, it will only entail that non-veridical preferential predicates cannot take constituent interrogative complements; it remains compatible with the possibility that the partial anti-rogativity of veridical preferential predicates with infinitival complements observed here is due to some other, yet unknown reason, which is in line with the general idea that anti-rogativity may arise from several different factors.

6.5 Why veridicality matters for preferential predicates

In this section, I will spell out Uegaki and Sudo’s (2019) explanation as to why non-veridical preferential predicates are anti-rogative while veridical ones may be responsive. The core idea is that non-veridical preferential predicates with interrogative clauses give rise to trivial meaning while veridical preferential predicates do not, regardless of the complement clause type. This will be formalized in terms of a question-oriented analysis of non-preferential predicates (Sect. 6.5.1) and its extension to degree-based semantics for preferentials (Romero, 2015) (Sect. 6.5.2).

The analysis will crucially rely on the lexical denotations of clause-embedding predicates. It is important therefore to make explicit a certain methodological principle which I follow in determining lexical denotations of specific clause-embedding predicates. The principle goes as follows:

(30) **Posit only observable lexical-semantic variation:**

For any pair of predicates $V$ and $V'$, lexical-semantic variation between $V$ and $V'$ should be posited only if this lexical-semantic variation can be motivated by the truth conditions of acceptable sentences $\langle x \, V \, s \, \varphi \rangle$ and $\langle x \, V's \, \varphi \rangle$, where $x$ is a DP and $\varphi$ is a clausal complement.

In other words, once we conclude that $V$ and $V'$ have certain lexical denotations based on observations about the truth conditions of (acceptable) sentences with a certain clause type (e.g., a declarative complement), the denotations will not be revised based on a further observation that $V$ and $V'$ differ in their compatibility with another clause type (e.g., an interrogative complement). The rationale behind this principle is to ensure that our account of selectional restrictions with respect to a certain clause type is explanatory in the sense that it is based on independently motivated lexical semantics. Below, when making theoretical decisions about lexical denotations, I will refer back to this principle.

6.5.1 A question-oriented analysis of non-preferential predicates

Uegaki and Sudo (2019) follow the question-oriented theory of clause-embedding predicates as outlined in Chapters 1-2. This means that (a) all clause-embedding predicates
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take sets of propositions as arguments, and (b) declarative clauses denote singleton sets of propositions, while interrogative clauses denote non-singleton sets of propositions.

Following the baseline semantics presented in Ch. 2, non-preferential predicates like be certain and know are analyzed with existential quantification into the world that anchors the answerhood operator, as in (31).

\[\begin{align*}
\text{a.} & \quad \llbracket \text{be certain}\rrbracket^w = \lambda Q_{(s,t)} \lambda x. \exists w' [\text{certain}_w(x, \text{AnsD}_{w'}(Q))] \\
\text{b.} & \quad \llbracket \text{know}\rrbracket^w = \lambda Q_{(s,t)} \lambda x. \exists w' [\text{K}_w(x, \text{AnsD}_{w'}(Q))]
\end{align*}\]

Two notes about the lexical entries above. First, following Ch. 2, I limit my discussion to cases where an interrogative complement is exhaustivity-neutral since exhaustivity is orthogonal to my discussion in this chapter. This allows us to have the simplified entries above, without reference to AnsF or Exh, which are necessary to derive different layers of exhaustivity. Secondly, for the sake of simplicity, I will ignore the additional FALSE-ANSWER SENSITIVITY (FAS) condition for know, discussed in Ch. 5. Adding the FAS condition to know above and also to veridical preferential predicates do not affect the analysis I will present below.

Following the basic tenets of the question-oriented theory, all clause-embedding predicates take a set of propositions, so they are all type-compatible with both interrogative and declarative complements. For instance, the denotation of believe is of the same type as that of know. I posit the following lexical entry for believe.

\[\begin{align*}
\llbracket \text{believe}\rrbracket^w = \lambda Q_{(s,t)} \lambda x. \exists w' [\text{B}_w(x, \text{AnsD}_{w'}(Q))]
\end{align*}\]

Following the methodological principle in (30), I do not posit any lexical semantic variation between be certain and believe beyond what is observable from their behaviors with declarative complements. In particular, both be certain and believe involve existential quantification over propositions because (a) we have analyzed be certain as having an existential semantics, given the truth conditions with interrogative complements, and (b) the truth conditions of be certain and believe with declarative complements do not motivate variation in the quantificational force between the two predicates. The anti-rogativity of believe, therefore, needs to be explained by other means than type incompatibility. As mentioned before, see Theiler et al. (2019) and Mayr (2019) for proposals to reduce it to its neg-raising property. Formally, this will involve assuming the excluded-middle presupposition for the metalanguage predicate B.

6.5.2 Degree-based semantics for preferential predicates

To analyze preferential predicates, Uegaki and Sudo (2019) follow Romero’s (2015) degree-based semantics, which in turn is based on Villalta’s (2008) analysis. As will be discussed later, this degree-based semantics offers an attractive account of the anti-rogativity of non-veridical preferential predicates, involving a reasonable assumption about the semantics of degree constructions in general.

As noted above in Sect. 6.4.2, preferential predicates show truth-conditional focus sensitivity, which led previous authors to propose that these predicates compare focus alternatives determined by the focus structure of the embedded clause. The degree-based semantics for preferential predicates by Romero (2015) builds on this insight, and
treats the focus structure of the complement as providing the comparison class against which the subject’s preferences are compared. Concretely, assuming the Roothian alternative semantics for focus (Rooth, 1985, 1992), the context is assumed to provide a set of alternatives \( C \), which preferential predicates refer to.\(^6\) For example, the semantics for *be happy* looks like (33), where \( \text{Pref} \) is a degree function defined in (34) and \( \theta(C) \) is the threshold degree given the comparison set \( C \).\(^7\) We will have more to say on the threshold function \( \theta \) below.

\[
\text{[be happy}_C\text{]}^w = \lambda p(x,t)\lambda x:\ p(w) \land B_w(x,p) \land p \in C. \text{Pref}_w(x,p) > \theta(C)
\]

\[
\begin{align*}
\text{(33)} & \quad \text{[be happy}_C\text{]}^w = \lambda p(x,t)\lambda x:\ p(w) \land B_w(x,p) \land p \in C. \text{Pref}_w(x,p) > \theta(C) \\
\text{(34)} & \quad \text{a. } \text{Pref}_w(x,p) := \text{the maximum degree to which } x \text{ prefers } p \text{ at } w \\
& \quad \text{b. } \theta(C) := \text{the standard threshold given the comparison class } C
\end{align*}
\]

In prose: *x is happy that p* presupposes that p is true, that x believes that p, and that p is a member of the focus alternatives \( C \), and asserts that the degree to which \( x \) prefers \( p \) at \( w \) is greater than the threshold given \( C \). As Romero (2015) argues, the last presupposition—that \( p \in C \)—is an instance of a presupposition existing in degree constructions in general, namely that the comparison class includes the comparison term.

Note that (33) assumes that *be happy* semantically selects for a proposition. To reformulate the analysis to fit the question-oriented approach, I (following Uegaki and Sudo 2019) make the predicate select for a set of propositions and relate the subject and the set using (34) via existential quantification of the world that anchors the AnsD operator:\(^8^9\)

\[
\text{[be happy}_C\text{]}^w = \lambda Q_{(st,t)}\lambda x:\ \exists w' \left[ \text{AnsD}_{w'}(Q)(w) \land B_w(x, \text{AnsD}_{w'}(Q)) \land \text{AnsD}_{w'}(Q) \in C \land p(w) \land \text{Pref}_w(x, \text{AnsD}_{w'}(Q)) > \theta(C) \right]
\]

---

\(^6\)For the sake of exposition, it is assumed that focus association with preferential predicates is conventional (in the sense of Beaver and Clark 2008), but nothing crucial hinges on this. See Romero (2015) for discussion.

\(^7\)The formulation in (33) uses a *measure function* \( \text{Pref} \) that maps individual-proposition pairs to degrees rather than to relations between degrees and individuals/propositions as done in Romero (2015). This is only for presentational reasons (the former formulation results in shorter formulae); nothing crucial hinges on this choice.

\(^8\)In (35), to avoid the ‘binding problem’ concerning the existential quantifications in the presupposition and the assertion, the content of the presupposition is repeated in the scope of the existential quantification in the assertion. See Spector and Egré (2015) for a similar solution to the binding problem in the domain of question embedding.

\(^9\)In Uegaki and Sudo (2019), this entry is simplified as follows, with existential quantification over propositions in the question denotation.

\[
\begin{align*}
\text{(i)} & \quad \text{[be happy}_C\text{]}^w = \lambda Q_{(st,t)}\lambda x:\ \exists p \in Q \left[ p(w) \land B_w(x,p) \land \exists p'' \in Q \left[ p''(w) \land B_w(x,p'') \land p'' \in C \land \text{Pref}_w(x,p'') > \theta(C) \right] \right]
\end{align*}
\]

Note that the entry in (35) simply replaces the occurrences of \( p \) and \( p'' \) in (i) with \( \text{AnsD}_{w'}(Q) \) and \( \text{AnsD}_{w'}(Q) \) with appropriate existential binding of the world variables. I choose the formulation in (35) to make it compatible with my overall analysis of question embedding presented in this book, including the background assumptions regarding exhaustivity and existential/uniqueness presupposition given in Ch. 2.
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Let us see how (35) works with concrete interrogative and declarative complements. First, following Beck (2006), I take wh-items to be necessarily focused. Given this, in our semantics the focus semantic value of a wh-complement turns out to be equivalent to its ordinary-semantic value, as in (36).\footnote{As pointed out by Henriëtte de Swart (p.c.), this equivalence might not hold when number morphology is involved. Concretely, while [which student] ranges over singular individuals, its focus value [which student] might include plural individuals, in which case the ordinary semantic value will be a subset of the focus semantic value. As far as we can see, however, there is no empirical reason to assume that [which student] contains plural individuals. In Uegaki and Sudo (2019), this problem is addressed by reformulating the analysis in terms of selective focus binding in Beck (2006).} Letting $Q$ be the focus/ordinary semantic value of the interrogative complement, be happy with an interrogative complement can be analyzed as in (37):

\[(36) \quad Q := [\text{who won the race}] = [\text{who} \ F \text{ won the race}]\]

\[(37) \quad [\text{Kim is happy} \ F \ (about) \ [\text{who} \ F \text{ won the race}]] = \lambda w : \exists w' [\text{AnsD}_{w'}(Q)(w) \land B_w(k, \text{AnsD}_{w'}(Q)) \land \text{AnsD}_{w'}(Q) \in C] \land \text{Pref}_w(k, \text{AnsD}_{w'}(Q)) > \theta(C)\]

Given the definition of the $\sim$-operator in (38) (Romero 2015, cf. Rooth 1985, 1992), $C$ in (37) is constrained as in (39).

\[(38) \quad [\alpha \sim C]^o \text{ is defined only if } C \subseteq [\alpha]^o ; \text{ if defined, } [\alpha \sim C]^o = [\alpha]^o\]

\[(39) \quad C \subseteq [\text{who won the race}] = Q\]

All in all, (37) presupposes that there is a true Dayal-answer of $Q$ which Kim believes, and asserts that a true Dayal-answer of $Q$ which Kim believes is such that she prefers it to a greater extent than the standard threshold given the alternatives in $C$, which in turn is a subset of $Q$, given (39).

Next, a declarative-embedding sentence would be analyzed as in (40), with the variable $C$ constrained by the focus structure as in (41). Here, we let $A := \lambda w. \text{wonTheRace}_w(a)$.

\[(40) \quad [\text{Kim is happy} \ F \ (about) \ [\text{who} \ F \text{ won the race}]] = \lambda w : \exists w' [\text{AnsD}_{w'}(\{A\})(w) \land B_w(k, \text{AnsD}_{w'}(\{A\})) \land \text{AnsD}_{w'}(\{A\}) \in C] \land \text{Pref}_w(k, \text{AnsD}_{w'}(\{A\})) > \theta(C)\]

\[(41) \quad C \subseteq [\text{that } \text{Alice} \ F \text{ won the race}] = Q\]

That is, (40) presupposes that Alice won the race and that John believes that Alice won the race, and asserts that John prefers Alice’s winning to a greater extent than the threshold given the alternatives in $C$, which again is constrained by $Q$.

Thus, the degree-based analysis provides a straightforward account of both declarative and interrogative complementation under veridical preferential predicates. Romero (2015) shows that the degree-based analysis enables an attractive account of two puzzles...
concerning veridical preferential predicates: (i) incompatibility with whether-complements\footnote{More precisely, Romero’s (2015) analysis enables an account of the incompatibility of preferentials with alternative-question whether-complements. To account for their incompatibility with polar-question whether-complements, Romero has to make additional assumptions, e.g. that polar questions involve an elliptical or not and thus are structurally equivalent to alternative questions.} and (ii) (typical) incompatibility with strongly-exhaustive embedded questions. Another virtue of the degree-based analysis is that (with suitable assumptions) it can account for the behavior of preferential predicates as gradable predicates, as in their occurrence in comparatives, e.g. (42).

\begin{enumerate}
  \item Chris is happier that Alice won than Bill is.
  \item Chris liked/hated that Alice won more than Bill did.
\end{enumerate}

6.5.3 The semantics of non-veridical preferential predicates

Building on the semantics for veridical preferentials in the previous section, I propose the following semantics for a non-veridical preferential, such as hope, again following Uegaki and Sudo (2019):

\begin{equation}
\text{\[hope_C\]}_o = \lambda Q_{(st, t)} \lambda x : \exists w'[\text{AnsD}_{w'}(Q) \in C], \exists w'' 
\begin{array}{l}
\text{AnsD}_{w''}(Q) \in C \wedge \\
\text{Pref}_w(x, \text{AnsD}_{w''}(Q)) > \theta(C)
\end{array}
\end{equation}

In contrast to the veridical preferential be happy in (35), which requires that the preferred answer is true and is believed by the subject, the non-veridical preferential hope in (43) lacks such requirements. The body of the function simply states that there is a Dayal-answer (which is also a member of $C$) that the subject prefers to a greater extent than the threshold given $C$. Again, following the methodological principle in (30), no lexical semantic variation is posited between veridical and non-veridical preferential predicates beyond what is observable in their behavior with declarative complements. With a declarative complement, (43) derives the meaning that the subject prefers the proposition denoted by the complement to a greater degree than the threshold given focus alternatives. Here is a concrete example. Again, let $A := \lambda w. \text{wonTheRace}_w(a)$.

\begin{equation}
\text{\[Kim \text{hopes}_C \text{ that } [Alice_F \text{ won the race}] \sim C\]}_o = \lambda w : \exists w'[:\text{AnsD}_{w'}(\{A\}) \in C], \exists w'' 
\begin{array}{l}
\text{AnsD}_{w''}(\{A\}) \in C \wedge \\
\text{Pref}_w(k, \text{AnsD}_{w''}(\{A\})) > \theta(C)
\end{array}
\end{equation}

On the other hand, the meaning predicted for (43) with an interrogative complement, exemplified in (45), turns out to be systematically trivial, assuming an additional presupposition triggered by the preferential predicate, which is the boxed portion of the presupposition—what we call \text{THRESHOLD SIGNIFICANCE}. (The proposal is thus to include this presupposition in the lexical entry for hope in (43). As \text{THRESHOLD SIGNIFICANCE} is a presupposition triggered by preferential predicates in general, the lexical entry for be happy in (35) must also be revised to include this presupposition.)
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(45) \[
\lambda w: \exists w' [\text{AnsD}_{w'}(Q) \in C] \land \exists d \in \{ \text{Pref}_w(k, p) | p \in C \} [d > \theta(C)] \land \exists w'' [\text{AnsD}_{w''}(Q) \in C \land \text{Pref}_w(k, \text{AnsD}_{w''}(Q)) > \theta(C)]
\]

Threshold significance requires that there be an element in the comparison class whose degree along the relevant scale is higher than the threshold returned by $\theta$. I take this to be a general property of gradable expressions whose interpretations depend on a threshold, including the positive form of gradable adjectives like tall and preferential predicates like hope. I will give an empirical and conceptual motivation for (45) in Sect. 6.5.5, but let me first illustrate how (44) together with (45) derives a logically trivial meaning, which in turn leads to unacceptability, following Gajewski (2002, 2009), among others.

6.5.4 Deriving the anti-rogativity of non-veridical preferentials

The gist of the analysis of the anti-rogativity of non-veridical preferentials goes as follows. Given threshold significance, (45) turns out to be necessarily true whenever it is defined. This is so since whenever threshold significance holds, there is always a proposition in $C \subseteq Q$ which Kim prefers more than the threshold given $C$. I follow Barwise and Cooper (1981), Gajewski (2002, 2009), Chierchia (2013, 2019), Schwarz and Simonenko (2018), Del Pinal (2019) in assuming that systematic logical triviality leads to unacceptability. Hence, the logical triviality of (45) accounts for its unacceptability. On the other hand, hope with a declarative complement, as in (44), is not logically trivial, regardless of threshold significance. This is so because whether the assertion of (44) is true depends on whether or not Kim prefers the particular proposition mentioned in the declarative complement (i.e., that Alice won the race), and threshold significance does not guarantee that he does. This explains the anti-rogativity of non-veridical preferential predicates like hope.

Moving on to veridical preferentials, we note that they do not induce logical triviality regardless of the complement clause type, due to the veridical restriction on existential quantification. The assertion of be happy with an interrogative complement in (37) above is non-trivial (regardless of threshold significance) since its truth is contingent on whether Kim prefers a true answer. That is, even when threshold significance is met, the assertion of (37) can be false if Kim prefers a false answer rather than a true answer. Also, similarly to the non-veridical case, be happy with a declarative complement as in (40) is non-trivial because the quantification over answers has a singleton domain. Whether (40) is true depends on whether Kim prefers the particular proposition that is in the ordinary semantic value of the declarative complement.

Regarding the precise relationship between logical triviality and unacceptability, I assume the following principles from Gajewski (2002, 2009).

(46) a. An LF constituent $a$ of type $t$ is L-analytic iff $a$’s logical skeleton receives the same truth-value under every variable assignment where the denotation is defined.

b. A sentence is unacceptable if its Logical Form contains an L-analytic constituent.
Here, we also need the definition of logical skeletons, in which all non-logical vocabularies are represented as variables. Defining logical vocabularies in general is beyond the scope of this book (see Abrusán 2019, Del Pinal 2019 and Chierchia 2019 for recent discussion); I will simply assume that the logical skeletons of sentences with a matrix predicate embedding a clausal complement look as follows:

(47) a. \[ \alpha [ VP \ \text{pred} \ [ CP \ C [ \sim \Gamma ] ] (\text{declarative complementation}) \]

b. \[ \alpha [ VP \ \text{pred} \ [ CP \ C [ + \text{wh} \ ... \beta F ... ] \sim \Gamma ] ] (\text{interrogative complementation}) \]

Here, all Greek letters—\( \alpha \) (the subject), \( \Gamma \) (the comparison class), and \( \beta \) (the focused item; a \text{wh}-item in the case of (47b))—are variables, while all other items—\text{pred}, \text{C} [\pm \text{wh}], and the operator \( \sim \) are logical vocabularies. Also, it is assumed here that a logical skeleton represents a focus structure, and \([ ... \beta F ... ]\) indicates that the constituent contains an occurrence of \( \beta \) as a focus (It is furthermore assumed that \( C[\pm \text{wh}] \| w = \text{Ident} \).

According to the definition in (46a), the declarative version of the logical skeleton, i.e. (47a), is not L-analytic, regardless of whether the embedding preferential predicate \text{pred} is veridical or non-veridical. This is so since the truth of the LF depends on whether \( \alpha \) ‘s referent prefers the specific proposition mentioned in the complement. On the other hand, the interrogative version of the logical skeleton, (47b), is L-analytic if \text{pred} is a non-veridical preferential predicate (e.g. \text{hope}) with \text{THRESHOLD SIGNIFICANCE}.

If the truth value of (47b) is defined, i.e., if its presupposition—in particular \text{THRESHOLD SIGNIFICANCE}—is met, (47b) is always true regardless of the assignments for the free variables. This is so since the semantics of a non-veridical preferential \text{pred} is such that it returns true whenever there is a proposition in the comparison class that exceeds the threshold.

Before concluding this section, I would like to comment on Anand and Hacquard’s (2013) proposal that the lexical semantics of emotive doxastics (a subtype of non-veridical preferentials) such as \text{hope} and \text{fear} not only involves the preferential component but also the \text{DOXASTIC CONDITION} that the subject considers the prejacent possible. Prima facie, this proposal might appear incompatible with the current analysis since the doxastic condition can be seen as providing a restriction on the existential quantification, just as the veridical restriction does in veridical predicates. However, this is not the case, as the doxastic condition provides a restriction on the \text{comparison class as a whole}. That is, we propose the following rendition of our entry for \text{hope} to incorporate Anand and Hacquard’s (2013) doxastic condition (the boxed part corresponds to the doxastic condition):

(48) \[ \text{[hope}_{C}] = \lambda Q_{(st,t)} \lambda x : \exists w' [ \text{AnsD}_{w'}(Q) \in C \land \exists d \in \{ \text{Pref}_{w}(x, p) | p \in C \} [ d > \theta(C)] \land \exists w'' [ \text{AnsD}_{w''}(Q) \in C \land \text{Pref}_{w''}(x, \text{AnsD}_{w''}(Q)) > \theta(C)] \]

In this entry, the comparison class \( C \) is restricted to those alternatives that are compatible with the subject’s beliefs. \text{THRESHOLD SIGNIFICANCE} then states that there is an element in this restricted domain \( C \) that exceeds the subject’s standard threshold for
6.5. WHY VERIDICALITY MATTERS FOR PREFERENTIAL PREDICATES

preference. Given these presuppositions, the assertion of hope with an interrogative complement remains to be trivial.

Interpretations of declarative-embedding sentences provide evidence for different ways in which the veridicality of veridical preferential predicates and the doxastic condition of emotive doxastics are encoded. In (49a), Kim’s preference for Alice’s winning is compared to alternative propositions that are false at the evaluation world. In contrast, in (49b), Kim’s preference for Alice’s winning is compared only to those alternatives that she considers possible at the evaluation world.

(49)  
   a. Kim is happy that ALICE won the race.  
   b. Kim hopes that ALICE won the race.

This suggests that the veridicality of be happy does not place a restriction on the comparison class itself whereas the doxastic condition of hope does, as in the lexical entry in (48). Thus, the doxastic condition of emotive doxastics proposed by Anand and Hacquard (2013) is compatible with our analysis of their anti-rogativity since the condition restricts the comparison class as a whole. In the rest of this chapter and next, I omit the doxastic condition in the analysis of hope for the sake of simplicity, but it can be added back in without any unwelcome consequences.

6.5.5 Motivations for threshold significance

The current explanation of the anti-rogativity of non-veridical preferential predicates makes crucial use of threshold significance. In this section, I give empirical and conceptual motivation for threshold significance in preferential predicates such as be happy and hope.

Empirical support for threshold significance comes from the following kind of example.

(50)  
   CONTEXT: Kim’s students have competed against each other in a 100m sprint, and she saw that Alice won it. There is no particular student Kim wanted to win the race; she didn’t have any preferences as to which student wins the race.

   EXAMPLE: #Kim {isn’t happy about/doesn’t like} which of her students won the race.

If it were not for threshold significance, the sentence in (50) would be true given the context. That is, in the given context, it’s not true that Kim’s preference singles out one student, so if it were not for threshold significance, the sentence should be judged true. But instead it appears to presuppose the existence of a student that Kim preferred to win the race.\(^{12}\)

\(^{12}\)It is not straightforward to give a parallel empirical argument for threshold significance with interrogative predicates like hope. Indeed, the following sentence sounds infelicitous given the context.

(i)  
   (CONTEXT: there is no student Kim wants to win the race.)  
   #Kim doesn’t hope that ALICE will win.

However, this might be due to focus. That is, focus induces the presupposition that some alternative is true, which projects through negation (e.g., Tonhauser et al., 2013).
Conceptually, threshold significance can be motivated based on how pragmatic considerations affect the choice of the threshold. In particular, Qing and Franke (2014) and Lassiter and Goodman (2017) present a game-theoretic analysis of the semantics of gradable adjectives, where the choice of the threshold is determined by how much it contributes to the communicative utility of using the adjective. From this pragmatic perspective, threshold significance is quite natural. Here is why. Suppose we choose a threshold such that threshold significance is not satisfied. That is, every degree in the comparison class is below the threshold. Choosing such a threshold will be useless for communicative purposes since it does not allow us to draw any distinction in the comparison class. Using a more concrete example, if the threshold for tallness is known to exceed the height of any individual in the comparison class, uttering $x$ is tall is useless since it will always be false. Thus, threshold significance can be thought of as a natural consequence of the pragmatic reasoning about thresholds. Qing and Franke (2014) further argue that the consideration about the optimal communicative success drives the semantic conventionalization of a certain threshold within a linguistic community in the long run. According to this view, it is plausible that a general principle like threshold significance enters into the semantic convention.

One might think that a predicate like be indifferent (about), exemplified in (51), is a problem for my claim, as it is compatible with a situation as described in (50).

(51) Kim is indifferent about which student has won the race.

However, there is an important difference between predicates like hope and be happy on the one hand and predicates like be indifferent on the other. The former involve comparison of propositions while the latter involves comparison of questions. The fact that be indifferent concerns comparison of questions can be supported by the fact that it is marginal at best with declarative complements:

(52) a. ??Kim is indifferent that Alice will sing.
    b. Kim is indifferent about whether Alice will sing.
    c. Kim is indifferent about who will sing.

Given that be indifferent involves comparison of questions, the focus value relevant for sentences like (51) is a set of questions, rather than a set of propositions. Thus, threshold significance in the case of (51) would require that there is a question that Kim is indifferent about to an extent higher than the threshold. This is compatible with the situation described in (50). For example, (50) is compatible with a possibility where Kim has preference about (i.e., not indifferent about) other questions about her students, e.g., which student won the speech context, which student passed the math test etc. In this case, threshold significance regarding Kim’s indifference with respect to questions is satisfied as there is a question about which Kim’s indifference is above the threshold (namely the question about the race).

Relatedly, note that our analysis is consistent with the fact that (i) is felicitous with a different focus structure, for example, a broad focus on the entire complement clause. This is so because a different focus structure would induce a different set of alternatives, and thus it is possible for threshold significance to be met with respect to that set of alternatives while the situation in (i) holds. For example, threshold significance with respect to the broad focus is satisfied if Kim prefers Alice not to win, which is compatible with the situation given.
6.6 hope-whether and fear-wh

In this section, I discuss apparent counterexamples to the above analysis of non-veridical preferential predicates based on Uegaki and Sudo (2019). The data involve whether-complements and are due to White (2021). The relevant examples are repeated below from Sect. 6.4:

(19) a. This Trump/Carson boom really has people like Bush, Walker, Rubio, and others wondering and hoping whether history will repeat itself and whether Republicans will return back to focusing on the establishment choices but it’s all about outsider candidates right now.
b. I was hoping whether you are able to guide me [...]  
c. I have done a quite a bit of research on using a Limited Co but was hoping whether someone with more experience could confirm my understanding of a few points [...] 

(20) 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.
c. [...] I fear whether I’ll have use of my arms/hands by age 55 or 60.
d. I know parents who seriously fear whether their children will ever hold a meaningful job.

These examples are problematic for my analysis if whether complements are treated as denoting a bipolar non-singleton proposition-set of the form \{p, \neg p\}. Take (19b) as an example, if we take the semantics for hope proposed in the previous section together with threshold significance, the sentence is predicted to presuppose that the speaker either prefers the addressee to guide her or prefers the addressee not to guide her, and assert exactly the same disjunctive preference. This would be an instance of the systematic logical triviality, which is assumed to give rise to unacceptability. In the following two subsections, I will discuss the issues pertaining to hope and fear separately.

6.6.1 hope and highlighting

What seems crucial in analyzing the cases in (19) is that their actual interpretations are distinct from what would be predicted given bipolar denotations for the whether-complements even if we disregard the presupposition of hope. Rather than expressing a disjunctive preference, they express preference for the proposition that is overtly expressed under whether. Specifically, (19a) conveys the subject’s preference for history repeating itself and Republicans returning back to focusing on the establishment choices, (19b) the speaker’s preference for the addressee guiding them, and (19c) the speaker’s preference for someone with experience confirming their understanding. In other words, the relevant hope-whether sentences seem to be close in interpretation to the following hope-that variants:
a. This Trump/Carson boom really has people like Bush, Walker, Rubio, and others **hoping that** history will repeat itself and whether Republicans will return back to focusing on the establishment choices.

b. I was **hoping that** you are able to guide me.

c. I was **hoping that** someone with more experience could confirm my understanding of a few points.

A similar phenomenon occurs with dubitative predicates like **doubt**:

(54)  
\[\text{a. They are\, } \text{doubting whether}\, \text{history will repeat itself.}\]
\[\text{b. I\, } \text{doubt whether}\, \text{you are able to guide me.}\]
\[\text{c. I\, } \text{doubted whether}\, \text{he had more experience than me.}\]

(55)  
\[\text{a. They are\, } \text{doubting that}\, \text{history will repeat itself.}\]
\[\text{b. I\, } \text{doubt that}\, \text{you are able to guide me.}\]
\[\text{c. I\, } \text{doubted that}\, \text{he had more experience than me.}\]

In the literature, this phenomenon is treated by acknowledging that the overtly-realized proposition in a polar interrogative clause (e.g., ‘history will repeat itself’ in (54a)) has a privileged status at some level of semantic representation. For example, Biezma and Rawlins (2012) treat polar interrogatives (without or not) as having a singleton denotation consisting of the overtly realized proposition. Pruitt and Roelofsen (2011), on the other hand, argue that polar interrogatives have a two-membered bipolar denotation, yet assumes a separate level of representation where they express a single highlighted proposition. Under both analyses, the synonymy of (54) and (55) is captured by positing a lexical entry for **doubt** that is sensitive to the singleton representation of the complement. Roughly, ‘\(x\) doubts \(\varphi\)’ is true in this line of analysis iff \(x\) doubts the unique proposition in the singleton representation of \(\varphi\), whether it is \(\varphi\)’s ordinary semantic value (Biezma and Rawlins, 2012) or its highlighted value (Pruitt and Roelofsen, 2011).

I suggest that something similar is going on with **hope-whether** examples in (19). That is, **hope** is sensitive to the overtly-realized proposition in a polar interrogative complement, exhibiting an interpretation similar to the corresponding **hope-that** examples in (53). As a formal analysis, I adopt an analysis based on highlighting by Pruitt and Roelofsen (2011), as treating polar **whether**-complements as denoting a singleton set along the lines of Biezma and Rawlins (2012) would have an absurd consequence that ‘**that** \(p\)’ and ‘**whether** \(p\)’ are equivalent under the question-oriented theory. Writing the set of propositions highlighted by clause \(\varphi\) (or its highlighted value) as \(\text{[\varphi]}^w\_h\), the analysis assumes the following range of highlighted propositions for different types of clauses:

(56)  
\[\begin{align*}
\text{Highlighted propositions} \\
\text{a. } \text{[whether/if Alice won the race]}^w_h = \{A\} & \quad \text{(polar interrog.)} \\
\text{b. } \text{[that Alice won the race]}^w_h = \{A\} & \quad \text{(declarative)}
\end{align*}\]
That is, both polar interrogatives and declarative clauses have the singleton set consisting of the overtly realized proposition as its highlighted value while constituent interrogative clauses highlight all the alternative propositions expressed by the ordinary semantic value of the clause. See Roelofsen and Farkas (2015) and Theiler (2020) for independent motivations for the notion of highlighting based on the interpretation of answer particles and the German particle *denn*, respectively.

Given this notion of highlighting, we can hypothesize a highlighting-sensitive version of the denotation of *hope*, which captures its compatibility with polar interrogatives complements while preserving Uegaki and Sudo’s (2019) analysis for its incompatibility with constituent interrogative complements:

\[(57)\] 

\[
\langle \text{hope}\;\text{C}\;\varphi \rangle^w = \lambda x : \\
\exists w' [\text{AnsD}_w'([\varphi]) \in C] \wedge \\
\exists d \in \{ \text{Pref}_w(x, p) \mid p \in C \} \; | \; d > \theta(C) .
\]

The only difference between (57) and the previous denotation based on Uegaki and Sudo (2019) in (43) is that the relevant Dayal-answer preferred by the subject according to the semantics in (57) is restricted to be a highlighted proposition of the complement \(\varphi\) instead of a member of the ordinary semantic value of \(\varphi\). With a declarative complement and a constituent interrogative complement, this revision does not make any difference as the highlighted content for such complements is equivalent to their ordinary semantic value (see (56b,c)). However, the situation is different when the complement is a polar interrogative. Since a polar interrogative complement only contains one highlighted proposition (see (56a)), \(\langle \text{hope}\;\text{whether}\;p \rangle\) does not end up having an L-trivial content. This is so because the presupposition is satisfied as long as the subject prefers \(p\) or not-\(p\) while the asserted content is satisfied iff the subject prefers \(p\). By the same token, the analysis also captures the equivalence of *hope-whether* sentences in (19) and their *hope-that* counterparts in (53).

White (2021) dismisses an analysis that assimilates *hope-whether* with *hope-that*, by pointing out that (19a) involves a conjunction of the form \(\langle \text{wondering and hoping whether}\rangle\) and that \(\langle *\text{wondering and hoping that}\rangle\) is ungrammatical. However, note that this is not an issue for the analysis sketched above. According to the analysis, in \(\langle \text{wondering and hoping whether}\rangle\), *wonder* is simply combined with a *whether*-clause, which has a distinct ordinary semantic value from a *that*-clause. Thus, as long as the unacceptability of *wonder-that* is accounted for with reference to the ordinary-semantic value of the complement, we can account for the acceptability of \(\langle \text{wondering and hoping whether}\rangle\).

### 6.6.2 Fear and negative preferences

Let us now move on to the *fear-whether* cases in (20) repeated below. First of all, note that a solution in terms of highlighting as sketched above for *hope* doesn’t work here. For, the examples in (20) are not always equivalent to the *fear-that* counterparts in (58). Specifically, all *fear-whether/that* pairs except for (20a, 58a) seem to have distinct interpretations.
(20) 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.

c. [...] I **fear whether** I’ll have use of my arms/hands by age 55 or 60.

d. I know parents who seriously **fear whether** their children will ever hold a meaningful job.

(58) a. Interstellar space is so vast that there is no need to **fear that** stars in the Andromeda galaxy will accidentally slam into the Sun.

b. I **fear that** this test would run safely on the oxygen sensor as it has a lot of drawback when compared with the others.

c. [...] I **fear that** I’ll have use of my arms/hands by age 55 or 60.

d. I know parents who seriously **fear that** their children will ever hold a meaningful job.

In fact, there is evidence to believe that the exceptional behavior of **fear** goes beyond **whether**-complements. That is, there are attested examples where **fear** is combined with non-**whether** interrogative complements. These are exemplified below:

(59) a. I **fear who** I have become.

(https://alexparkinson34.wordpress.com/2012/08/19/7-years-journey-to-life-day-95-friends-of-the-past/)

b. Both women initially worried about taking the bus, **fearing who else** might be riding the bus. Both have been pleasantly surprised. Express bus seats recline, and have individual reading lights and air-conditioning vents.


c. But if my party doesn’t enter this city, I **fear who else** will.

(Martha Wells, 2016, *The Edge of Worlds*; Start Publishing)

Although the **wh**-clause in (59a) may be a free relative, the other examples seem to involve genuine **wh**-complements, as **wh-else** cannot be construed as a free relative (Ross, 1967).

The interpretations of these examples seem to be compatible with the assertive content predicted by the current analysis of non-veridical preferential predicates. That is, roughly, “x **fears Q**” is interpreted as ‘there is a Dayal-answer p to Q such that x’s dis-preference for p is higher than a threshold’. The question then is why L-triviality due to **threshold significance** does not arise here. I suggest the following answer: negative preferentials like **fear** involves the same **threshold significance** presupposition as its positive counterpart with an opposite preference. That is, we have the following denotation for **fear**:

\[
[fear]\leftarrow^w_C = \lambda Q: \lambda x : \exists w' [\text{AnsD}_{w'}(Q) \in C] \land \\
\exists d \in \{ \text{Pref}_{w}(x, p) \mid p \in C \} [d > \theta(C)] . \exists w'' \left[ \text{AnsD}_{w''}(Q) \in C \land \\
\text{Pref}_{w''}(x, \text{AnsD}_{w''}(Q)) < \theta(C) \right]
\]
This hypothetical denotation for fear accounts for the predicate’s compatibility with interrogative complements, as we do not predict L-triviality. On the one hand, the presupposition states that there is a proposition in \( C \) that the subject prefers more than the threshold. On the other hand, the assertion states that there is a proposition which the subject prefers less than the threshold. Conceptually, this analysis can be motivated if fear is decomposed into the negation and hope, following a decompositional analysis for antonyms along the lines of Büring (2007) and Heim (2006, 2008).

Although I have to leave an in-depth investigation of this hypothesis for future studies, it is worth mentioning the results by Özyıldız et al. (2022) in this context. Özyıldız et al. (2022) present preliminary cross-linguistic evidence from a survey of 14 languages that there is indeed a contrast between positive and negative preferential predicates with respect to their ability to take interrogative complements. Cross-linguistically, positive preferential predicates seem to take interrogative complements only via the highlighting strategy whereas negative preferential predicates seem to allow non-highlighting strategies, as evidenced by the possibility of the predicate to target the negative answer of a polar interrogative complement. Exactly why there is this contrast, however, remains to be seen.

### 6.7 Chapter summary

In this chapter, I have considered the issues presented by anti-rogative predicates, i.e., predicates that can embed declarative complements but not interrogative complements. Prima facie, the presence of anti-rogative predicates seems to pose problems for the question-oriented theory. However, the interpretations and selectional restrictions of a majority of English anti-rogative predicates can in fact be given an adequate analysis under the question-oriented theory. In particular, following Theiler et al. (2019), the anti-rogativity of neg-raising predicates (e.g., believe, think) is explained by their lexical semantics, under the assumption that neg-raising predicates come with the excluded-middle presupposition (Bartsch, 1973, Gajewski, 2005). Also, following Uegaki and Sudo (2019), the anti-rogativity of non-veridical preferential predicates (e.g., hope, prefer) is explained by an interplay between a degree-based analysis of preferentiality and the treatment of veridicality under the question-oriented semantics. In both cases, the predicates are typewise compatible with interrogative complements, but the specific semantic properties of the predicates give rise to logical triviality when they are combined with interrogative complements, leading to unacceptability.

I have also discussed empirical challenges to this view pointed out by White (2021) and suggested possible replies to them. Taking a step back, I would like to emphasize that the existence of the exceptional cases where predicates that have been traditionally thought of as anti-rogative (e.g., believe, hope) take interrogative complements, as in White’s (2021) examples, is not a problem for the question-oriented theory par se. The existence of these exceptional cases would be problematic for a theory in which anti-rogative predicates are stipulated to take only propositions. In contrast, the view of selectional restrictions I have advocated in this chapter is not stated in terms of such lexical stipulations. Anti-rogative predicates are type-wise compatible with both declarative and interrogative complements, but combining them with interrogative complements
results in unacceptability due to semantic triviality. This view is compatible with a possibility that linguistic contexts surrounding the predicate+complement combination (such as aspectual properties of the matrix clause, presence vs. absence of matrix negation etc.) affect crucial aspects of semantic interpretations, thus giving rise to patterns that go beyond the default restrictions. The current challenge lies in precisely stating which linguistic contexts give rise to exceptional behaviors and why, but I hope to have shown in this chapter that there are promising avenues for this line of investigation as well.
Bibliography


Chapter 7

Thinking about: clausal complements as predicates?

7.1 Introduction

There is a growing body of literature in the syntax and semantics of clausal complementation which advocates for the PREDICATIVE VIEW of clausal complementation, according to which clausal complements semantically act as a predicate modifying the object of an attitude (Kratzer, 2006, Moulton, 2009, Elliott, 2017). Under this view, for example, think denotes a relationship between a thinker and a content-bearing object (either of an individual type or an eventuality type), and the complement clause of think semantically functions as a modifier that specifies the content of the content-bearing object. Thus, this theory maintains that the attitude denoted by think and the proposition traditionally associated with the complement clause does not have a direct predicate-argument relationship. Rather, the relationship is mediated by the object that fills the internal argument slot of the predicate. The view is commonly attributed to Kratzer (2006) and has been further developed by Moulton (2009), Bogal-Allbritten (2016), Elliott (2017), Bassi and Bondarenko (2020), and Moltmann (2020). Prima facie, the view seems to be at odds with the theories of clausal complementation entertained in this book, whether the theory is proposition-oriented or question-oriented. After all, both theories I have introduced in Ch. 1-2 and have so far considered in this book treat the meaning of a clausal complement (whether it is a proposition or a question) as filling the internal argument slot of a clause-embedding predicate. Let us call this the ARGUMENT-BASED VIEW of clausal complementation, as opposed to the predicative view.

In this chapter, I will discuss the distinction between the predicative view and the argument-based view, and its relevance to the main focus of this book, i.e., the distinction between the proposition-oriented theory and the question-oriented theory. As I will detail in Sect. 7.2, the distinction between the proposition-oriented theory and the question-oriented theory can be replicated within the predicative view. That is, we can conceive of both the predicative version of the proposition-oriented theory (henceforth
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the predicative proposition-oriented theory) and the predicative version of the question-oriented theory (henceforth the predicative question-oriented theory). As I will discuss shortly, at least some of the arguments for the question-oriented theory I have put forth in the previous chapters can be reformulated as an argument for the predicative question-oriented theory over the predicative proposition-oriented theory. A question, then, is whether there are specific arguments that favor the predicative version of the question-theory over the argument-based version.

Comparing the argument-based view and the predicative view of clausal complementation is by itself a book-length endeavor, and thus I must leave open the full comparison to another occasion. Instead, in Sect. 7.3, I will focus on a specific set of data that pertain to the distinction between the two views, i.e., interrogative clauses introduced by about. As I will argue below, close examination of the phenomenon reveals that we need a predicative analysis of about-clauses at least in cases where they are traditional adjuncts, but also that we have to treat certain cases of about-clauses as true complements, assuming that some predicates take clausal meanings as internal arguments.

7.2 Proposition-orientation and question-orientation in the predicative view

7.2.1 An event-based implementation of the predicative view

As introduced above, according to the predicative view of clausal complementation, clauses embedded by an embedding verb like believe semantically functions as a predicate that specifies the content of the internal argument of the embedding verb. I will henceforth call the internal argument of an embedding verb in this view the content-bearing argument. There is some variation within the literature on predicative view regarding the model-theoretic status of the content-bearing argument. In particular, Kratzer (2006) and Moulton (2009) distinguish the content argument from the eventuality argument of an embedding verb, while Rawlins (2013) and Elliott (2017) identify these two, letting the eventuality argument carry the content to be specified by the complement clause. Hacquard (2006) utilizes a similar setup in her analysis of modals (see also Moltmann 2020 for other aspects of the model-theoretic status of the content argument, which she calls the attitudinal object). In this chapter, I will assume the latter implementation, as it is in line with Rawlins’s (2013) analysis of about-clauses, based on which I will develop my own analysis.

According to the latter implementation, a clause-embedding predicate has a neo-Davidsonian denotation as in (1).

(1) \[[\text{believe}]^w = \lambda e_v : e \in \text{Dom}(\text{Con}) \cdot \text{believe}_w(e)\]

The predicate takes an eventuality argument with a ‘content’ that can be represented as a proposition. The content of an eventuality is retrieved by the content-retrieving function, Con, simply defined as follows:

(2) Con(e) := the content of e \hspace{1cm} (\text{Con}: \langle v, st \rangle; v: \text{the type for eventualities})
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The fact that the denotation of *believe* is a predicate over content-bearing eventualities (as opposed to eventualities in general) is guaranteed by the domain specification in (1).

Making use of the Con-function, then, the meaning of a declarative complement is analyzed as a predicate that is true of eventualities with a specific propositional content. For example, *that it is raining* is analyzed as follows:

\[ \text{that it is raining} = \lambda e. \text{Con}(e) \wedge \text{believe}_w(e) \]

A VP denotation is then derived via Predicate Modification by combining the two event predicates denoted by the embedding predicate and the complement. For example, the VP *believe that it is raining* would have the following denotation:

\[ \text{believe that it is raining} = \lambda e. \text{Con}(e) \wedge \text{believe}_w(e) \wedge \text{Con}(e) = \lambda w'. \text{rain}_{w'} \]

Following the neo-Davidsonian composition, the agent/experiencer argument is introduced by a designated head and the eventuality variable is existentially closed. As a result, the semantic representation of a sentence involving *believe* and a declarative complement would look like the following:

\[ \text{Alice believes that it is raining} \iff \exists e \left( \text{Exprncr}(e) = a \wedge \text{believe}_w(e) \wedge \text{Con}(e) = \lambda w'. \text{rain}_{w'} \right) \]

### 7.2.2 Interrogative complements in the predicative view

The predicative proposition-oriented theory

How can we extend the predicative analysis of declarative complements along these lines to interrogative complements? One option is to treat an interrogative complement as the predicate that is true of eventualities whose propositional content is equivalent to an *answer* of the question (denoted by the interrogative complement under the traditional analysis). That is, we can transpose the proposition-oriented analysis to the predicative view, by reducing the semantics of an interrogative complement to that of a declarative complement. Under such a view, the interrogative complement *who won the race* would be analyzed as follows, where \( Q \) is the Hamblin proposition-set denotation of *who won the race*, assumed in Chapter 2:

\[ \text{who won the race} = \lambda e. \exists w' \left( \text{Con}(e) = \text{AnsD}_w(Q) \right) \]

With such an analysis for an interrogative complement and the neo-Davidsonian analysis for *know* as in (7), we can reconstruct the proposition-oriented analysis of *know-why* from Ch. 2, as follows:

\[ \text{know} = \lambda e. \text{Con}(e)(w) \]

\[ \text{know who won the race} = \lambda e. \left[ \text{know}_w(e) \wedge \text{Con}(e) = \text{AnsD}_w(Q) \right] \]

The factivity of *know* is analyzed as the presupposition that the content of the eventuality argument is true. This results in the veridicality of the interpretation in (8), i.e., the content is equated with the Dayal-answer in the evaluation world. This treatment of veridicality mirrors the treatment of veridicality in Spector and Egré (2015) employed in Ch. 2 as part of the baseline proposition-oriented theory.\(^1\)

---

\(^1\)Note that I am assuming that the Hamblin denotation of the complement is exhaustivity-neutral. See Ch. 2.
**The predicative question-oriented theory**

Yet, what is sketched above is not the only way to extend the predicative view to interrogative complements. Rawlins (2013) extends the predicative analysis to interrogative complements by enriching the notion of ‘content’ to something that encompasses both statements and questions. Specifically, he models a content as a set of propositions (type \( \langle st, t \rangle \)), where a statement corresponds to a singleton set and a question corresponds to a non-singleton set. This will involve redefining Con as a function from content-bearing objects to type \( \langle st, t \rangle \) objects, and analyzing declarative and interrogative complementation as follows:

\[
(9) \quad a. \quad [\text{that Bonnie won the race}]^w = \lambda e_v. [\text{Con}(e) = \{ \lambda w'. \text{wonTheRace}_w(b) \}]
\[
b. \quad [\text{who won the race}]^w = \lambda e_v. [\text{Con}(e) = Q]
\]

\[
(10) \quad a. \quad [\text{know that Bonnie won the race}]^w = \lambda e_v. [\text{know}_w(e) \land \text{Con}(e) = \{ \lambda w'. \text{wonTheRace}_w(b) \}]
\[
b. \quad [\text{know who won the race}]^w = \lambda e_v. [\text{know}_w(e) \land \text{Con}(e) = Q]
\]

This analysis is the predicative version of the question-oriented theory. Contents of eventualities described by clause-embedding predicates are analyzed as having the semantic type of a question, i.e. type \( \langle st, t \rangle \), and contents corresponding to statements are analyzed as a special case of type \( \langle st, t \rangle \) objects.

**7.2.3 Comparing proposition-orientation and question-orientation within the predicative view**

In the previous chapters, I have made several empirical arguments for the question-oriented theory and against the proposition-oriented theory of clausal complementation. At least three of these arguments can be extended to the predicative version of the theories sketched above.

First, rogative predicates like wonder discussed in Ch. 3 are problematic for the predicative version of the proposition-oriented theory. Decomposing wonder into e.g., want/wish-to-know would be an option, but the empirical and conceptual issues with such decomposition, discussed in Ch. 3, still applies to the predicative version of the analysis. Furthermore, just like the non-predicative version of the theory, the predicative proposition-oriented theory predicts that all responsive predicates have the following two properties:

\footnote{Here are rough proofs. The predicative proposition-oriented theory predicts that all responsive predicates are Q-to-P entailing. This is so because, for any responsive predicate \( V \) and any interrogative complement \( \varphi \), we have:

\[
(i) \quad [[V \varphi]]^w = \lambda e_v. [[V]^w(e) \land \exists w'[\text{Con}(e) = \text{AnsD}_{\varphi}(Q)]] \quad \text{(where Q is the Hamblin denotation of Q)}
\]

\[
\text{AnsD}_{\varphi}(Q) \quad \text{for any w' is a possible answer to Q. Thus, if x is an agent/experiencer of an event that makes (i) true, then there is some answer p to Q such that x is an agent/experiencer of an event that makes the following true:

(ii) \quad [[V \text{that p}]]^w = \lambda e_v. [[V]^w(e) \land \text{Con}(e) = p]]
\]}

This is so because, for any responsive predicate \( V \) and any interrogative complement \( \varphi \), we have:

\[
(i) \quad [[V \varphi]]^w = \lambda e_v. [[V]^w(e) \land \exists w'[\text{Con}(e) = \text{AnsD}_{\varphi}(Q)]] \quad \text{(where Q is the Hamblin denotation of Q)}
\]

\[
\text{AnsD}_{\varphi}(Q) \quad \text{for any w' is a possible answer to Q. Thus, if x is an agent/experiencer of an event that makes (i) true, then there is some answer p to Q such that x is an agent/experiencer of an event that makes the following true:

(ii) \quad [[V \text{that p}]]^w = \lambda e_v. [[V]^w(e) \land \text{Con}(e) = p]]
\]
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(11) **Q-to-P entailment**
Let \( V \) be a responsive predicate. Then, \( V \) is Q-TO-P ENTAILING iff, for every entity-denoting term \( x \) and every interrogative complement \( Q \), \( \forall x \) Vs \( \neg Q \) entails that there is an answer \( p \) to \( Q \) such that \( \forall x \) Vs \( p \).

(12) **Reducibility**
Let \( V \) be a responsive predicate. Then, \( V \) is REDUCIBLE iff, for any pair of individuals \( x \) and \( x' \), if \( \forall x \) Vs that \( p \) \( \Leftrightarrow \forall x' \) Vs that \( p \) for every declarative complement \( p \), then \( \forall x \) Vs \( Q \) \( \Leftrightarrow \forall x' \) Vs \( Q \) for every interrogative complement \( Q \).

As I have argued in Chapters 4 and 5, these predictions are empirically problematic. English predicates of relevance (e.g., *care*), Estonian contemplative predicates (e.g., *mõtlema*), and the Japanese contemplative particles *na* and *daroo* count as counterexamples to Q-TO-P ENTAILMENT while the false-answer sensitivity of *know* and other presuppositional predicates makes REDUCIBILITY problematic.

On the other hand, the solutions to these phenomena under the question-oriented theory I have proposed in the previous chapters can be straightforwardly extended to the predicative question-oriented theory. Such an extension is achieved by analyzing the event predicates denoted by the relevant embedding verbs as being sensitive to the (type \( \langle st, t \rangle \)) content of events. Concretely, this can be done by relating the denotations of the embedding verbs under the predicative view and those under the argument-based view in the following way, via meaning postulates (\( \llbracket \cdot \rrbracket_{pred} \) is a semantic value under the predicative view and \( \llbracket \cdot \rrbracket_{arg} \) is a semantic value under the argument-based view):

(13) For every \( e \) and \( w \),

a. \( \llbracket \text{wonder} \rrbracket_{pred}(e) \text{ iff } \llbracket \text{wonder} \rrbracket_{arg}(\text{Con}(e))(\text{Agent}(e)) \)

b. \( \llbracket \text{care} \rrbracket_{pred}(e) \text{ iff } \llbracket \text{care} \rrbracket_{arg}(\text{Con}(e))(\text{Agent}(e)) \)

c. \( \llbracket \text{know} \rrbracket_{pred}(e) \text{ iff } \llbracket \text{know} \rrbracket_{arg}(\text{Con}(e))(\text{Agent}(e)) \)

This will guarantee that the question-oriented analysis of these predicates under the argument-based version of the theory is inherited in the predicative version of the theory, making it possible to account for, e.g., the selectional restriction of *wonder*, the lack of Q-TO-P ENTAILMENT for *care*, and the non-REDUCIBILITY of *know*. Hence, the arguments made in the previous chapters can be taken to favor the predicative question-oriented theory over the predicative proposition-oriented theory.

---

The predicative proposition-oriented theory also predicts that all responsive predicates are REDUCIBLE because, if \( \forall x Vs that p \Leftrightarrow \forall x' Vs that p \) for every \( p \), we have

(iii) For every proposition \( p \), \( \exists e [\text{Agent}(e) = x \land [V]_{w}(e) \land \text{Con}(e) = p] \Leftrightarrow \exists e [\text{Agent}(e) = x' \land [V]_{w}(e) \land \text{Con}(e) = p] \)

Since \( \forall x Vs Q \Leftrightarrow \forall x' Vs Q \) for any interrogative complement \( Q \) is analyzed in terms of eventualities having propositional contents, (iii) entails that \( \forall x Vs Q \Leftrightarrow \forall x' Vs Q \) for any \( Q \).
7.3 About and the need for an argument-based analysis

Now that we have seen that the predicative question-oriented theory is at least as empirically adequate as its argument-based counterpart, an obvious question is whether there are arguments that favor one over the other. In the literature, several empirical arguments have been made to motivate the predicative view of clausal complementation based on e.g., behavior of content nouns as well as CP proforms (Moulton, 2009, 2015), interpretation of the English explain (Elliott, 2017), multiple flavors of the attitude predicate nízín in Navajo (Bogal-Allbritten, 2016) and the interpretation of CP disjunction and conjunction (Bassi and Bondarenko, 2020). On the other hand, Roberts (2020) argues for a hybrid view, where clausal complements can enter semantic composition either as a predicate or as an argument of an embedding verb, primarily based on evidence from the behavior of the so-called V-DP-CP construction such as Alice believes Kim that it is raining (see also Djärv 2019 for related discussion of the construction).

As I have demonstrated in the previous section, this issue is tangential to the main goal of this book—to compare the proposition-oriented theory and the question-oriented theory. Thus, I would like to leave a full investigation of the relative empirical advantage of the predicative question-oriented theory as opposed to its argument-based variant to another occasion. This being said, fine-grained empirical patterns concerning the selectional restriction of anti-rogative predicates (discussed in the previous chapter) turn out to bear on the issue of predicative vs. argument-based view. More specifically, cases where the preposition about introduces an interrogative complement pose a problem for the analysis of non-veridical preferential predicates proposed in the previous chapter. As I will argue below, we need a theory that incorporates both the predicative view and the argument-based view (partially in line with Roberts 2020) to analyze these cases.

The empirical problems posed by about will be introduced in Sect. 7.3.1. I will review an existing account of about-clauses by Rawlins (2013) in Sect. 7.3.2, which treats about-clauses as a modifier based on the predicative analysis. In Sect. 7.3.3, I will point out an issue with Rawlins’ (2013) treatment, and proposes a hybrid picture where about-clauses can either be a true complement or a modifier. In Sect. 7.3.4, I show that the data presented in Sect. 7.3.1 can be accounted for once we take into account the (obligatory) transitivity of the embedding predicates.

7.3.1 The issue of about

One of the issues I left open in the empirical discussion in the previous chapter is the potential complication posed by the preposition about. As shown in (14), interrogative complements under some veridical preferential predicates are optionally introduced with a preposition like about. In fact, a preposition seems to be preferred in many cases where there is such an option (Égré, 2008, Mayr, 2019).

(14) a. Max likes which students are invited to the party.
   b. Max is happy ?(about) which students are invited to the party.
   c. Max is surprised (about/at) which students are invited to the party.

On the other hand, the presence or absence of about does not affect the ungrammaticality of non-veridical preferentials with interrogative complements, as shown below:
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(15)  
   a. *Max prefers (about) which students are invited to the party.  
   b. *Max hopes/wishes (about) which students are invited to the party.  
   c. *Max expects (about) which students are invited to the party.  
   d. *Max believes (about) which students are invited to the party.  

The data so far are compatible with the view that *about in (14) is semantically vacuous and that its distribution is purely a matter of syntax.3 Under such a view, as long as a predicate is semantically incompatible with an interrogative complement, it cannot embed an interrogative complement regardless of the presence of *about. However, such a view turns out to be too simplistic, once we start considering data involving other anti-rogative predicates that allow interrogative complements with the help of *about, as in (16), and cases involving nominalizations of non-veridical preferential predicates, as in (17).

(16)  
   a. Pat spoke *about who will be invited to the party.  
   b. Pat thought *about who will be invited to the party.  

(17)  
   a. Pat has a preference about who will be invited to the party.  
   b. Pat has a hope/wish about who will be invited to the party.  
   c. Pat has an expectation about who will be invited to the party.  
   d. Max has a belief about who will be invited to the party.  

Below, I will argue that the above data can be accounted for by employing Rawlins’ (2013) ‘non-orthogonality’ semantics for *about, but restricting its application to traditional adjuncts. To sketch the analysis more concretely, I will assume that there are two lexical entries for *about: *about∅ and *aboutR, where *about∅ is semantically vacuous while *aboutR is the ‘Rawlins-style’ *about denoting the non-orthogonality relation between two issues (to be elaborated below). An interrogative CP introduced by *about∅ is allowed as long as the predicate is semantically compatible with an interrogative complement, given the considerations discussed in the previous chapter. On the other hand, an interrogative CP introduced by *aboutR is allowed only in an adjunction structure. Crucially, contra Rawlins, I argue that not all clauses embedded by *about have an adjunction structure (and hence a non-orthogonality semantics). A further requirement is imposed by obligatory transitivity as a lexical specification of the predicate (Chomsky, 1965). If a clause-embedding predicate is obligatorily transitive, it must merge with a complement clause, which may involve *about∅ but may not involve *aboutR.

7.3.2 Rawlins (2013)-style analysis of *about

To elaborate on the analysis, I begin with our rendition of Rawlins’ (2013) semantics for *about. According to Rawlins, *about denotes a relation between a question and an eventuality that holds if the question is non-orthogonal to the content of the eventuality.

---

3See fn. 3 in Ch. 4 for discussion of an instance of such a view by Grimshaw (1990: Ch. 3).
This is formally defined as follows, after Lewis’s (1988) definition of relevance:\(^4\)

\[ [\text{about}_R]^w = \lambda e_{v^w_\text{e}} : e \in \text{Dom}(\text{Con}). \neg \text{Orthogonal}(Q, \text{Con}(e)) \]

\[ \text{Orthogonal}(Q_1, Q_2) \iff \forall p \in Q_1 \cup \{W - \bigcup Q_1\} \forall p' \in Q_2 \cup \{W - \bigcup Q_2\} [p \cap p' \neq \emptyset] \]

As touched on in Sect. 7.2, Rawlins (2013) assumes an event-semantic variant of the predicative analysis of complementation, according to which attitudinal and speech-report predicates are one-place predicates of content-bearing eventualities. For example, think is analyzed as follows:

\[ [\text{think}]^w = \lambda e_{v^w_\text{e}} : e \in \text{Dom}(\text{Con}_{w^w_\text{e}}). \text{think}_{w^w_\text{e}}(e) \]

Given the entry for about in (19) and the event-predicate analysis of think in (20), we can analyze think-about plus an interrogative clause as involving an event-predicate modification. (21) describes the type-driven composition, and (22) the resulting VP interpretation of think about who sang.

(21) **Modification with about\(_R\)-PP**

```
  VP = \langle v, t \rangle
     \__________________
        \              think \langle v, t \rangle
     \__________________
        \                PP = \langle v, t \rangle
     \__________________
        \         \__________________
           \       about\(_R\) \__________
             \                 \__________
                \                  who sang
             \__________________ \__________________
                 \              \langle \langle st, t \rangle, vt \rangle \__________
                   \_______________ \langle st, t \rangle
```

\[ [\text{think about}_R \text{ who sang}]^w = \lambda e_{v^w_\text{e}} : e \in \text{Dom}(\text{Con}_{w^w_\text{e}}). \text{think}_{w^w_\text{e}}(e) \land \neg \text{Orthogonal}([\text{who sang}]^w, \text{Con}(e)) \]

The resulting VP interpretation in (22) is a predicate that is true of thinking events whose content is non-orthogonal to who sang.

\(^4\)Rawlins (2013) represents a content as an equivalence relation on a set of worlds, following an earlier formulation of propositions in inquisitive semantics (Groenendijk and Roelofsen, 2009). Here, we will simply assume that a content is represented as a set of propositions, which may be denoted by an interrogative complement or by a declarative complement. Accordingly, the notion of orthogonality between two questions is redefined in terms of the consistency of every pair of propositions consisting of an answer (or the complement of the union of answers) to each of the two questions respectively.

\(^5\)Here, we specify in the type specification of the Con-function that its argument is an event. This specification makes the type calculation more transparent and correctly accounts for all cases considered in this section. However, it has potential problems in dealing with cases where the external argument of about\(_R\) is an entity, as in (i) below:

(i) The email is about whether Joanna was going. \hfill (Rawlins, 2013: 341)

This problem can be avoided by defining Con as a function on entities and treating events as a sub-type of entities, as done by Rawlins (2013).
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7.3.3 About-PP as a true complement

The semantics of \( \textit{about}_R \)-PPs described above has sufficient flexibility to apply to occurrences of \textit{about} in the complement of other clause-embedding predicates. In particular, Rawlins (2013) argues that \textit{about} appears in the (traditional) complement of veridical preferentials such as \textit{surprise}, based on the predicative view of complementation.

However, it turns out that treating the \textit{about}-PPs in complements of veridical preferentials along the lines of Rawlins (2013) predicts interpretations that are too weak. To see this, consider the following lexical entry for an emotive factive predicate under the Kratzer-Hacquard-style analysis of attitudes:

\[
\text{happy} = \lambda e : \begin{cases} 
\text{Dom}(\text{Con}) \\
\text{happy}_w(e)
\end{cases}
\]

Under this analysis, \textit{be happy} denotes a predicate of eventualities. As I suggested in Sect. 7.2.2, we may further define a meaning postulate so that the experiencer and the content of an eventuality that satisfies this predicate are related according to the denotation of \textit{be happy} under the argument-based analysis we developed in the previous chapter. However, the point I am going to make can be made without committing to a particular analysis of the predicate \textit{happy}.

In the predicative view, a \textit{that}-clause serves as an eventuality-modifier that specifies the content of the relevant content-bearing eventuality. Thus, given the lexical entry for \textit{be happy} in (23), we derive the following truth conditions for a declarative-embedding sentence with \textit{be happy}.

\[
\text{Max is happy that Ann was invited} \iff \exists e [\text{Exprncr}(e) = m \land \text{Con}(e) = \{\text{Ann was invited}\} \land \text{happy}_w(e)]
\]

This is arguably an adequate analysis of the declarative-embedding case. However, the prediction for the \textit{about}+\textit{wh} case, given in (25) below, is problematic.

\[
\text{Max is happy about who was invited} \iff \exists e [\text{Exprncr}(e) = m \land \neg \text{Orthogonal}([\text{who was invited}^w, \text{Con}(e)] \land \text{happy}_w(e))]
\]

According to (25), the sentence is true as long as the content of Max’s happiness is non-orthogonal to the question ‘who was invited’. This incorrectly predicts the sentence to be true in the following situation:

\[
\text{CONTEXT: Emily is a good old friend of Max. Max is happy whenever Emily is happy, and he is happy whenever he is with her. Their mutual friend Paul is going to throw a singles party. Being single, Max is invited to the party. Emily isn’t invited since she recently started dating someone from her yoga class. Max is happy that Emily is no longer single, but he is also sad that Emily won’t be at the party.}
\]

In (26), the proposition ‘Emily is not single’ is non-orthogonal to the question ‘Who is invited to the party’ because the former partially resolves the latter. This means that the truth conditions in (25) are satisfied in (26), given that Max is happy that Emily is not single. This is so since the situation whose content is the singleton set of the
proposition ‘Emily is not single’ meets all the conditions of existential quantification in (25). However, this prediction is not borne out. In the situation described in (25), the sentence Max is happy about who was invited does not sound true.

What the above data suggests is that the about-PP complement of be happy does not merely provide a content that is non-orthogonal to the content of happiness, but rather the content of happiness itself. To capture this fact, I posit the semantically vacuous about∅, and analyze be happy as selecting for a complement providing the content in its lexical semantics, as follows:

(27) \[ [\text{be happy}_C] \] ^w = \lambda Q_{(st,t)} \lambda e: 
\begin{align*}
\text{Con}(e) &= Q \land \exists p \in \text{Con}(e)[p(w) \land B_w(\text{Exprncr}(e), p) \land p \in C]. \\
\exists p'' \in \text{Con}(e) \left[ p''(w) \land B_w(\text{Exprncr}(e), p'') \land p'' \in C \land \\
\text{Pref}_w(\text{Exprncr}(e), p'') > \theta(C) \right].
\end{align*}

This entry is an event-semantic rendition of our previous entry for be happy in the previous chapter, but, crucially, with the internal argument position, pace the predicative analysis. Given the semantically vacuous about∅ and (27), we derive the interpretation for the AP happy about∅ who was invited as follows:

(28) **Complementation with about∅**

\[
\begin{array}{c}
\text{happy} \\
\langle (st, t), vt \rangle \\
\text{PP} \\
\langle st, t \rangle \\
\text{about∅} \\
\langle st, t \rangle \\
\hspace{1cm}\hspace{1cm}\text{who was invited} \\
\langle (st, t), vt \rangle
\end{array}
\]

(29) \[ [\text{who was invited}_C] \] ^w = \lambda e: 
\begin{align*}
\text{Con}(e) &= [\text{who was invited}]^w \land \exists p \in \text{Con}(e)[p(w) \land B_w(\text{Exprncr}(e), p) \land p \in C]. \\
\exists p'' \in \text{Con}(e) \left[ p''(w) \land B_w(\text{Exprncr}(e), p'') \land p'' \in C \land \\
\text{Pref}_w(\text{Exprncr}(e), p'') > \theta(C) \right].
\end{align*}

This analysis correctly captures the fact that the about-PP provides the content of the happiness itself rather than something that is non-orthogonally related to it. Note that aboutR cannot appear in the complement position of happy, due to type mismatch. This is illustrated in the following:

(30) *Complementation with aboutR*

\[
\begin{array}{c}
\text{happy} \\
\langle (st, t), vt \rangle \\
\text{PP} \\
\langle v, t \rangle \\
\text{aboutR} \\
\langle v, t \rangle \\
\hspace{1cm}\hspace{1cm}\hspace{1cm}\hspace{1cm}\text{who was invited} \\
\langle (st, t), vt \rangle
\end{array}
\]
Thus, this analysis captures the unavailability of the weak reading predicted by the Rawlins-style analysis.6

One may wonder if there is an alternative analysis under the predicative view, where \( \textit{about} \) is analyzed as a head that introduces \( \text{Con} \), as follows:

\[
\text{(31)} \quad \lambda e. \text{Con}(e) = Q
\]

With this version of \( \textit{about} \), we can analyze the above data in a way that is more faithful to the predicative analysis, based on the neo-Davidsonian denotation for \( \textit{be happy} \), as follows:

\[
\text{(32)} \quad \text{VP} \langle v, t \rangle
\]

\[
\text{happy} \quad \text{PP} \langle v, t \rangle \quad \text{about} \langle \langle s, t \rangle, vt \rangle \quad \text{who sang} \langle s, t \rangle
\]

\[
\text{(33)} \quad \lambda e_v : e \in \text{Dom} \left( \text{Con} \right). \text{happy}_w (e) \land \text{Con}(e) = \lambda \text{who sang}^w
\]

Assuming that the event predicate \( \textit{happy} \) is associated with a meaning postulate that guarantees that the experiencer of a happy-eventuality is related to its content as stated in (27), the analysis predicts the same interpretation as in (29).

This analysis predicts that both \( \textit{about} \)-wh and \( \textit{about}_R \)-wh clauses are typewise compatible with clause-embedding predicates in general, given that they are analyzed as a neo-Davidsonian event predicate. In the next section, I show that this prediction is not borne out. We have to distinguish between predicates with which an \( \textit{about} \)-clause is interpreted as involving \( \textit{about} \) and those with which it is interpreted as involving \( \textit{about}_R \).

### 7.3.4 Obligatory transitivity

Above, I have suggested that an \( \textit{about} \)-clause can in principle be an event modifier involving \( \textit{about}_R \) or a true complement involving \( \textit{about} \). Based on this, I have hypothesized that the occurrence of \( \textit{about} \)-PPs under veridical preferential predicates such as

\[
\text{(i)} \quad \text{Max is happy about}_R \text{who was invited about}_R \text{who is single.}
\]

Under the analysis, the two constituents \( \textit{be happy about}_R \text{who was invited} \) and \( \textit{about}_R \text{who is single} \) will both be of type \( \langle v, t \rangle \) and thus can be composed by Predicate Modification. The sentence is furthermore predicated to have a coherent interpretation, according to which there is an eventuality where Max is happy, the content of the happiness is provided by the question who was invited, and this content is non-orthogonal to the question of who is single. I have to leave this issue open. I thank an anonymous reviewer for pointing out this interesting problem.
happy and be surprised is better analyzed as cases of true complements with about∅. The data introduced in the beginning of this section (repeated below) can also be fully captured in this setup, once we take into account the transitivity of the predicates.

(15)  a. *Max prefers (about) which students are invited to the party.
     b. *Max hopes/wishes (about) which students are invited to the party.
     c. *Max expects (about) which students are invited to the party.

(16)  a. Pat spoke *(about) who will be invited to the party.
     b. Pat thought *(about) who will be invited to the party.

(17)  a. Pat has a preference about who will be invited to the party.
     b. Pat has a hope/wish about who will be invited to the party.
     c. Pat has an expectation about who will be invited to the party.

In our setup, whether a clause-embedding predicate is transitive or not is reflected in its semantic type. A transitive predicate has type ⟨⟨st, t⟩, vt⟩, just like happy in (27), while an intransitive predicate has type ⟨v, t⟩, just like think in (20). A predicate’s transitivity can be tested independently of its compatibility with about-PPs and its anti-rogative/responsive status. If a predicate can occur without any complement, it is either intransitive or optionally transitive; if a predicate must occur with some kind of complement, it is obligatorily transitive.

The predicates in (15) are all obligatorily transitive, as the ungrammaticality of the following examples suggests.

(34)  a. *Max prefers.
     b. *Max hopes/wishes.
     c. *Max expects.

This means that these predicates have ⟨⟨st, t⟩, ⟨v, t⟩⟩-type lexical entries. As discussed in relation to (30) in the previous subsection, a transitive predicate is incompatible with an about∅-PP for type reasons. Furthermore, we have shown in the discussion above that non-veridical preferential predicates cannot embed interrogative complements due to the predicted semantic triviality. This is true whether or not the interrogative complement involves a semantically vacuous about∅. We thus capture the unacceptability of (15) observed both with and without about.

Moving on to the predicates in (16), the following examples suggest that they are intransitive or optionally transitive.

(35)  a. Pat spoke.
     b. Pat thought for a moment.

This means that there exist ⟨v, t⟩-type entries for think. An about∅-PP is type-wise compatible with these entries, semantically providing a content that is non-orthogonally
related to the content of thought. This accounts for the acceptability of interrogative complements with *about* in (16). 

Finally, the data in (17) fall out straightforwardly once we take into account the status of argument structures for deverbal nouns. As Grimshaw (1990) famously shows, a deverbal noun is ambiguous between an interpretation that involves a full-fledged argument structure (*complex event nominal*; CEN) and other interpretations that lack an argument structure (*simple event nominal*; SEN, and *result nominal*; RN). The possibility of interpretations without argument structure explains the compatibility of deverbal nouns with an *about*+*wh*-clause, regardless of the properties of the predicates they are derived from.

Specifically, following Moulton (2014), we assume that a SEN denotes a one-place predicate of events, as follows.

\[(36)\] 
\[
\begin{array}{l}
\left[ \left[ \text{n}_n \sqrt{\text{hope}_C} \right] \right]^w \\
= \lambda e : \exists p \in \text{Con}(e) \left[ \exists p'' \in \text{Con}(e) \left[ p'' \in C \land \text{Pref}_w(\text{Exprncr}(e), p'') > \theta(C) \right] \right] \\
\end{array}
\]

Here, *n* is the SEN-nominalizer, which existentially closes off the internal argument of the root in Moulton’s (2014) analysis. The denotation in (36) can be compositionally derived by assuming (a) Moulton’s (2014) analysis of the SEN-nominalizer and (b) the event-semantic rendition of our entry for *hope* in the previous chapter as the denotation of the root \(\sqrt{\text{hope}}\). 

Given this denotation for the noun *hope* we can account for the *about*+*wh*-clause as an adjunct involving *about*_R. The type-driven composition of such an adjunction structure is depicted in (37), with the interpretation in (38).

\[(37)\] NP-adjunction with *about*_R

---

7 It is worth noting that the notion of (obligatory) transitivity is independently invoked by Rawlins (2013) to account for the following selection pattern involving *think* and *believe* (following a suggestion by P. Portner, pers. comm. to Rawlins):

(i) a. Alfonso thought about Joanna.

b. *Alfonso believed about Joanna.

c. . Alfonso believed about Joanna that she was clever. (Rawlins, 2013: 340, fn. 5)

The contrast between *think* and *believe* here can be explained by the fact that *think* is not obligatorily transitive while *believe* is.

8 For the purpose of the argument, it suffices that deverbal nouns have an interpretation devoid of argument structure as in (36), as one of the possible readings. Though see Moulton (2014) for an argument that CP-taking deverbal nouns such as the noun *hope* do not have the CEN reading, i.e., they always lack an argument structure.
Here, non-veridical preferentiality of the root noun \( \sqrt{\text{hope}} \) does not lead to any semantic triviality. This is so since the content of the hope itself in (38) need not have the form of a question; it just needs to be non-orthogonally related to a question. For example, the content of the hope can be that Max will be invited to the party, which is non-orthogonally related to the question of who will be invited to the party.

In sum, the initially puzzling selection behavior involving the preposition about in (15-17) can be accounted for as a result of the interplay between the ambiguity of about between the non-orthogonality reading (Rawlins, 2013) and a semantically vacuous reading, and the transitivity of the predicates. In contrast, the purely predicative analysis that treats both about\(R\) and about\(∅\)-clauses as type \(⟨v, t⟩\) predicates, as considered at the end of the previous section, is unable to account for the pattern. This is so because such an analysis is unable to capture the contrast between the obligatorily transitive predicates, with which an about-clause is interpreted as a ‘true’ complement (and hence results in unacceptability due to logical triviality), and intransitive predicates or nominalizations, with which an about-clause is interpreted as a modifier.

It should be mentioned that reliance on obligatory transitivity creates a potential problem with the analysis of predicates such as be happy and be surprised in Sect. 7.3.3—that is, with the notion that they can take an about\(∅\)-PP as a true complement. Since these predicates can appear without any CP complement, as in (39), they must have type \(⟨v, t⟩\) lexical entries.

(39)  

a. Max is happy.

b. Max is surprised.

Given the proposed analysis, this in turn means that they can combine with an about\(R\)-PP as an adjunct, which might appear to conflict with our analysis of these predicates in Sect. 7.3.3. However, it is possible that these predicates are optionally transitive, just like eat, i.e., they may be able to take an about\(∅\)-PP as a true complement while also optionally appearing without any complement. Treating these predicates as optionally transitive accounts for their selectional properties, including the data in (39). Nevertheless, something has to be said about the interpretation of sentences containing be happy+about-wh (discussed in relation to the context involving the singles party in (26)), which suggests that the reading involving an about\(∅\)-complement rather than
7.4. CHAPTER SUMMARY

the one involving an about\(_R\)-adjunct is the default option. This is presumably due to
the Strongest Meaning Hypothesis (Dalrymple et al., 1998), a general pragmatic prin-
ciple to the effect that the strongest available interpretation is preferred. The reading
with about\(_∅\) is stronger than that with about\(_R\) unless the sentence is embedded un-
der a non-upward-entailing operator. Note that the possibility of optional transitivity
does not pose any problem for our analysis of about-wh under nominalizations of non-
veridical preferentials (e.g., preference about who will be invited). This is so since the
about\(_∅\)-complementation option, even if it is type-wise available, is ruled out because
of semantic triviality.

7.4 Chapter summary

In this chapter, I have explored the relevance of the predicative view on complemen-
tation (e.g., Kratzer, 2006, Moulton, 2009)—currently gaining support based on a variety
of empirical evidence—to the issue of proposition-orientation vs. question-orientation.
I have first demonstrated that the division between the proposition-oriented theory and
the question-oriented theory can be reconstructed within the predicative analysis of
complementation, and that my arguments in support of question-orientation as opposed
to proposition-orientation made in the previous chapters of this book can be transposed
to the predicative version of the theories. In the second half of the chapter, I have moved
on to the question of whether there are empirical arguments in favor of adopting the
predicative version of the question-oriented theory, as opposed to the argument-based
version, which I have assumed up to the previous chapter. Based on a class of empirical
issues posed by interrogative complements introduced by about, I have argued that it
is necessary to make lexical distinction between transitive predicates and intransitive
predicates, and that we have to maintain the argument-based view for the analysis of
about-complementation at least for transitive predicates.
Bibliography


Chapter 8

*Shknowing*: constraints on the semantics of clause-embedding predicates

8.1 Introduction

In the previous chapters, I have motivated the question-oriented theory for clause-embedding predicates based on a range of empirical facts. Throughout these chapters, we have seen that the question-oriented theory can adequately account for *prima facie* puzzling behaviors exhibited by various classes of clause-embedding predicates, such as rogative predicates (e.g., *wonder*), predicates of relevance (e.g., *care*), predicates with false-answer sensitivity (e.g., *know*), and non-veridical preferential predicates (e.g., *hope*). The proposition-oriented theory, on the other hand, is not equipped with adequate resources to account for the behaviors of these predicates.

At the same time, the expressive power of the question-oriented theory—which enables the analysis presented so far—poses a concern. The theory might be too powerful. That is, by itself, the theory allows us to define various cross-linguistically non-existent predicates and thus is not constrained enough to provide an explanatory account of the range of interpretations available for clause-embedding predicates in natural language. This issue is pointed out by George (2011: 193–5) as a problem for the question-oriented analysis of responsive predicates.¹ Under the question-oriented theory, denotations of declarative and interrogative complements can be formally distinguished on the basis of whether they are a singleton set or not. Exploiting this formal distinction, any individual-proposition relation \( R \) and any individual-question relation \( R' \) can be combined into a fictitious responsive predicate denotation. To see this, suppose we have a fictitious responsive predicate \( V \) that is interpreted as in (1) depending on the clause type of the complement:

\[
\begin{align*}
(1) \quad & a. \quad \left[ \forall x \, \forall s \, \text{that } p \right]^w_u \iff R(p)(x)
\end{align*}
\]

¹George (2011) calls the question-oriented analysis an ‘inverted reduction’ account.
CHAPTER 8. *SHKNOWING

b. \[ [x \text{Vs} Q]^w \leftrightarrow R'(Q)(x) \]

Under the question-oriented theory, the denotation of \( V \) can be analyzed as in (2), with reference to the cardinality of the denotation of the internal argument of the predicate \( Q \).

(2) \[ [V]^w = \lambda Q_{(st,t)} \lambda x. \ |Q| = 1 \land R(p)(x) \lor |Q| \neq 1 \land R'(p)(x) \]

An example of a fictitious predicate that can be analyzed this way is \( shknow \), discussed by Spector and Egré (2015). The predicate means \( know \) when it takes a declarative complement and \( wonder \) when it takes an interrogative complement. The lexical entry for this predicate can be easily written as follows, according to the recipe in (2):

(3) \[ [shknow]^w = \lambda Q_{(st,t)} \lambda x. \ |Q| = 1 \land K_w(x, p) \lor |Q| \neq 1 \land \text{wonder}_w(x, p) \]

This situation is potentially problematic for the question-oriented theory, as it demonstrates that the theory is not restrictive enough to rule out empirically implausible predicate meanings like the one for \( shknow \) in (3).\(^2\) The proposition-oriented theory, on the other hand, is incompatible with a predicate like \( shknow \), thus providing a potential account for the absence of \( shknow \) in natural language.\(^3\)

A similar issue is well-investigated in the domain of generalized quantifiers (Barwise and Cooper, 1981). Natural languages lexicalize only a small subset of meanings that can in principle be expressed as a generalized quantifier. The generalized quantifier theory has sought to formulate empirically feasible constraints on quantifier/determiner denotations (e.g., conservativity). At the same time, researchers have investigated the question of why such constraints exist from computational and learnability standpoints (e.g., Hunter and Lidz, 2013, Steinert-Threlkeld and Szymanik, 2019). The question-oriented semantics for clause-embedding predicates motivates similar research questions in a new empirical domain: What are cross-linguistically feasible constraints on the lexical semantics of clause-embedding predicates? If there are such constraints, why do such constraints exist?

In this chapter, based on my joint work with Floris Roelofsen (Roelofsen and Uegaki, 2020), I will give some preliminary investigation into these questions. Specifically, in Sect. 8.2, I will consider several recent proposals concerning constraints on the semantics of clause-embedding predicates (Spector and Egré, 2015, Theiler et al., 2018, Uegaki, 2019), and identify counterexamples for each of these proposals. In Sect. 8.3, I will formulate a new constraint, P-TO-Q ENTAILMENT, which rules in the counterexamples to existing proposals and yet rules out many conceivable denotations which have so far not been attested in cross-linguistic research. In Sect. 8.4, I will examine potential counterexamples to P-TO-Q ENTAILMENT. Finally, in Sect. 8.5, I will speculate on potential explanations as to why P-TO-Q ENTAILMENT exists as a potential constraint, although I will have to leave full investigations on the why-question to future research.

\(^2\)A similar argument has been given by Schlenker (2009) against dynamic theories of presupposition projection.

\(^3\)One way to show that \( shknow \) cannot be defined in the proposition-oriented theory is to show that it is not Q-to-P entailing. \( \forall x \shknows Q \)—which means \( \forall x \text{wonders} Q \)—doesn’t entail that there is an answer \( p \) to \( Q \) such that \( \forall x \shknows \text{that} p \)—which means \( \forall x \text{knows} p \)—is true.
8.2 Existing proposals

8.2.1 Veridical Uniformity

Definitions and illustration

Spector and Egré (2015) (henceforth, S&E) propose that all responsive clause-embedding predicates are ‘uniform w.r.t. veridicality’. To spell out what this means, let us first recall when a predicate is veridical w.r.t. declarative/interrogative complements.

A predicate \( V \) is veridical w.r.t. declarative complements if and only if for every declarative complement \( p \):

\[
\forall x \forall p (\neg x \forall s p \implies \neg p) \tag{4}
\]

For instance, \( \text{know} \) is veridical because:

\[
\text{Mary knows that Bill left} \implies \text{Bill left} \tag{5}
\]

Veridicality w.r.t. interrogative complements is somewhat more involved. We follow Theiler et al. (2018) in defining this notion in terms of exhaustivity-neutral interrogative complements, introduced in Ch. 2. Exhaustivity-neutral interrogative complements are ones for which different levels of exhaustivity coincide. They include polar interrogatives like \( \text{"whether Bill left"} \), as well as wh-interrogatives with a uniqueness presupposition such as \( \text{"which boy left"} \). A predicate \( V \) is \( \text{VERIDICAL W.R.T. INTERROGATIVE COMPLEMENTS} \) if and only if for every exhaustivity-neutral interrogative complement \( \neg Q \) and any answer \( \neg p \) to \( \neg Q \):

\[
\forall x \forall Q (\neg x \forall s Q \land \neg p) \land \neg x \forall s p \tag{6}
\]

For instance, \( \text{know} \) is veridical w.r.t. interrogative complements because:

\[
\text{Mary knows whether Bill left} \land \text{Bill left} \implies \text{Mary knows that Bill left} \tag{7}
\]

A responsive predicate is \( \text{UNIFORM W.R.T. VERIDICALITY} \) if and only if it is either veridical w.r.t. both declarative and interrogative complements, or non-veridical w.r.t. both declarative and interrogative complements. Based on this property, S&E posit the following generalization:

\[
\text{As pointed out in Theiler et al. 2018, if we had not restricted ourselves to exhaustivity-neutral complements in the definition of veridicality w.r.t. interrogative complements, then know would have been classified as non-veridical. To see this, consider the following example, in which the complement has a salient non-exhaustive (mention-some) reading.}
\]

\[
\text{Suppose that Rudolph knows that one can get an Italian newspaper at Newstopia, and that he does not falsely believes that one can get Italian newspapers elsewhere. Further suppose that in fact Italian newspapers are sold both at Newstopia and at Paperworld. Then, on the one hand, (6) is true on a non-exhaustive reading. On the other hand, that one can get an Italian newspaper at Paperworld is an answer to the embedded interrogative (still assuming a non-exhaustive reading). But (7) is false, violating the requirement for veridicality w.r.t. interrogative complements.}
\]

\[
\text{Rudolph knows where one can buy an Italian newspaper.}
\]

\[
\text{Rudolph knows that one can buy an Italian newspaper at Paperworld.}
\]
All responsive predicates are uniform w.r.t. veridicality.

Note that *know* is indeed uniform w.r.t. veridicality as it is veridical w.r.t. both declarative and interrogative and interrogative complements. At the same time, *be certain* and *imagine* are also uniform w.r.t. veridicality as they are non-veridical w.r.t. both types of complements. As an example of a predicate that does not satisfy this property, S&E consider the aforementioned fictitious verb *shknow*, meaning ‘know’ when taking a declarative complement and ‘wonder’ when taking an interrogative complement. *Shknow* would be veridical w.r.t. declarative complements, but not w.r.t. interrogative complements. Another example, considered by Steinert-Threlkeld (2020), is the fictitious verb *knopinion*, which would mean ‘be opinionated about’ with a declarative complement and ‘know’ with an interrogative complement. The behavior of *knopinion* is informally illustrated as follows:

<table>
<thead>
<tr>
<th>Example</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>‘Jo is opinionated about whether <em>p</em>’</td>
</tr>
<tr>
<td>b.</td>
<td>‘Jo knows <em>Q</em>’</td>
</tr>
</tbody>
</table>

This predicate is not uniform w.r.t. veridicality because it is veridical w.r.t. interrogative complements but non-veridical w.r.t. declarative complements.

**Problematic cases**

Given the above limited survey of predicates, it seems that S&E’s generalization is indeed supported by the English data. However, Theiler et al. (2018) note that (at least a subset of) English predicates of relevance (PoRs) such as *care* and *be relevant*—considered in Ch. 4—form counterexamples to **Veridical Uniformity**. They are counterexamples to **Veridical Uniformity** because they are veridical w.r.t. declaratives but not w.r.t. interrogatives. To see this, consider the following examples.

<table>
<thead>
<tr>
<th>Example</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>It is relevant to Jo that Sue left.</td>
</tr>
<tr>
<td>b.</td>
<td>It is relevant to Jo that Sue didn’t leave.</td>
</tr>
<tr>
<td>c.</td>
<td>It is relevant to Jo whether Sue left.</td>
</tr>
<tr>
<td>a.</td>
<td>Jo cares that Sue left.</td>
</tr>
<tr>
<td>b.</td>
<td>Jo cares that Sue didn’t leave.</td>
</tr>
<tr>
<td>c.</td>
<td>Jo cares about whether Sue left.</td>
</tr>
</tbody>
</table>

The declarative-embedding examples, (10a-b, 11a-b) entail the complement, i.e., that Sue left or didn’t leave. Thus, the predicates are veridical w.r.t. declarative complements. On the other hand, the interrogative-embedding examples, (10c, 11c), together with the assumption that Sue left, does not entail the corresponding declarative-embedding example, i.e., (10a, 11a). In order for (10a, 11a) to be true, Jo has to know (or at least believe) that Sue left, but this entailment is not there in (10c, 11c). This means that these predicates are non-veridical w.r.t. interrogative complements. **Veridical Uniformity** generalization in (8) only concerns responsive predicates, and is not applicable to rogative and anti-rogative predicates. This is so because the
8.2. EXISTING PROPOSALS

definition of veridicality w.r.t. interrogative complements is stated in terms of interpretations of sentences of the form \( ^{\gamma}x V s \) that \( p \). In the context of S&E’s analysis, this restricted focus of the generalization is reasonable since their aim was to have a unified analysis of responsive predicates; rogative and anti-rogative predicates were outside the scope of their investigation. However, in the current context, where the aim is to investigate constraints on the semantics of clause-embedding predicates in general, this limitation is rather unfortunate. Given that the theory of clause-embedding predicates we are currently considering does not make any type-distinction between responsive, rogative, and anti-rogative predicates, it is preferable that a constraint is applicable regardless of the selectional restrictions of clause-embedding predicates.

Under the question-oriented theory, it is in principle possible to reformulate the definition of veridicality semantically, so that it does not refer to sentences embedding a complement of a specific type. Such semantic formulations of veridicality w.r.t. declarative and interrogative complements look like the following:

(12) Veridicality (semantic formulations)

a. A predicate \( V \) is VERIDICAL W.R.T. DECLARATIVE COMPLEMENTS iff, for every proposition \( p \), every individual \( x \) and world \( w \), \( \llbracket V \rrbracket^w(\{p\})(x) \Rightarrow p(w) \)

b. A predicate \( V \) is VERIDICAL W.R.T. INTERROGATIVE COMPLEMENTS iff, for every exhaustivity-neutral question \( Q \), every proposition \( p \in Q \), every individual \( x \), and every world \( w \), \( \llbracket V \rrbracket^w(Q)(x) \land p(w) \Rightarrow \llbracket V \rrbracket^w(\{p\})(x) \)

Given such semantic formulations of veridicality, the VERIDICAL UNIFORMITY generalization is in principle applicable to rogative and anti-rogative predicates.

The question then is whether they are indeed uniform w.r.t. veridicality, given the definitions in (12). It turns out that rogative predicates are non-uniform w.r.t. veridicality, at least according to the question-oriented analysis for these predicates proposed in Ch. 3. Take, for example, the question-oriented analysis for \textit{wonder}, repeated from Ch. 3:

(13) \( \llbracket \text{wonder} \rrbracket^w = \lambda Q_{(st, r)} \lambda x.e. \neg \exists u'[B_w(x, \text{Ans}_w(Q))] \land E_w(x, Q) \)

The entry says that \( ^{\gamma}x \text{wonders } \varphi \) is true in \( w \) just in case (i) \( x \) does not believe any possible Dayal-answer of the issue expressed by \( \varphi \), and (ii) \( x \)’s entertains the issue expressed by \( \varphi \). In principle, \( \varphi \) here can be a declarative complement. In this case, however, the two conjuncts in the entry for \textit{wonder} always contradict each other. That is, the entry predicts that, when \( \varphi \) is a declarative complement, \( ^{\gamma}x \text{wonders } \varphi \) is always contradictory. Thus, \( \llbracket \text{wonder} \rrbracket^w(\{p\})(x) \) is always false. Indeed, this is how the selectional restrictions of \textit{wonder} are accounted for. But then, \textit{wonder} is veridical w.r.t. declarative complements because the antecedent of the implication in (12a) is always false. On the other hand, it is non-veridical w.r.t. interrogative complements because the consequent of the implication in (12b) is always false.

Hence, in addition to PoRs, rogative predicates pose an empirical problem for the VERIDICAL UNIFORMITY generalization. Although the generalization is non-applicable to rogative predicates given its original formulation, the semantic reformulation of the generalization reveals thatrogatives constitute counterexamples to the generalization.\(^5\)

\(^5\) Anti-rogative predicates like \textit{believe} and \textit{hope} turn out to be uniform in veridicality, according to the
8.2.2 Clausal distributivity

Definitions and illustration

Theiler et al. (2018) consider another constraint on clause-embedding predicates, which is formulated in terms of a property they refer to as CLAUSAL DISTRIBUTIVITY (C-DISTRIBUTIVITY for short). The relevant property and the constraint are stated as follows:

(14) **C-distributivity**

A clause-embedding predicate $V$ is C-DISTRIBUTIVE just in case for any exhaustivity-neutral interrogative complement $Q$:

$\forall x \forall s \exists p$ such that $\forall x \forall s \exists p$

(15) **C-distributivity constraint**

All clause-embedding predicates are C-DISTRIBUTIVE.

For instance, know is C-DISTRIBUTIVE since $\forall x \exists s \exists p$ is true if and only if $\forall x \forall s \exists p$ is true. This is also true of non-veridical predicates like be certain or imagine: $\forall x \forall s \exists p$ is true if and only if $\forall x \forall s \exists p$ is true. On the other hand, shknow is not C-DISTRIBUTIVE since $\forall x \forall s \exists p$ does not imply that either $\forall x \exists s \exists p$ or $\forall x \exists s \exists p$ is true. Steinert-Threlkeld (2020) knopinion is not C-DISTRIBUTIVE either. This is so since $\forall x \exists s \exists p$ does not imply that either $\forall x \exists s \exists p$ or $\forall x \exists s \exists p$ is true. On the other hand, shknow is not C-DISTRIBUTIVE since $\forall x \forall s \exists p$ does not imply that either $\forall x \forall s \exists p$ or $\forall x \forall s \exists p$ is true. Steinert-Threlkeld (2020) knopinion is not C-DISTRIBUTIVE either. This is so since $\forall x \exists s \exists p$ does not imply that either $\forall x \exists s \exists p$ or $\forall x \exists s \exists p$ is true.

Problematic cases

Just like the VERIDICAL UNIFORMITY generalization, the C-DISTRIBUTIVITY constraint seems to be a reasonable hypothesis given these limited sample of predicates. However, it is empirically problematic. In Ch. 4, I have discussed English PoRs, the Estonian contemplative predicate mõtlema, and the Japanese particles daroo and na, and argued that they pose problems for the proposition-oriented theory. The argument is based on the fact that these items are not Q-TO-P ENTAILING although the proposition-oriented theory predicates all responsive predicates to be so. Since C-DISTRIBUTIVITY is stronger than Q-TO-P ENTAILMENT, this also entails that the items are counterexamples to C-DISTRIBUTIVITY. Below, I will briefly repeat the analyses of these items proposed in Ch. 4, and show that they violate the C-DISTRIBUTIVITY constraint according to the analyses.

6 See account discussed in Ch. 6. For example, believe is non-veridical w.r.t. declarative complements. Also, it is non-veridical w.r.t. interrogative complements according to the analysis of its selectional restrictions by Theiler et al. (2019). This is so because, according to the analysis, $\lbrack \text{believe} \rbrack^w(Q)(x)$ is trivially true, and hence the implication $\lbrack \text{believe} \rbrack^w(Q)(x) \land p(w) \Rightarrow \lbrack \text{believe} \rbrack^w((p))(x)$ holds iff the consequent is true if $p(w)$, which is not the case.

6 Indeed, Theiler et al. (2018) already note that PoRs constitute counterexamples to C-DISTRIBUTIVITY and suggest that it is only a statistically robust constraint that allows exceptions. Their aim was not to identify an exceptionless constraint, but rather to state a broad, if not universal, constraint on top of the question-oriented theory of responsive predicates. This is largely in response to Spector and Egré’s (2015) approach where the
First, as already noted by Theiler et al. (2018), PoRs such as care and matter are not Q-TO-P entailing, and therefore not C-distributive, since \((16c)/(17c)\) can be true without either \((16a)/(17a)\) or \((16b)/(17b)\) being true (Elliott et al., 2017):

\[(16)\]
\[\begin{align*}
\text{a. } & \text{It matters to Jo that Sue left.} \\
\text{b. } & \text{It matters to Jo that Sue didn’t leave.} \\
\text{c. } & \text{It matters to Jo whether Sue left.}
\end{align*}\]

\[(17)\]
\[\begin{align*}
\text{a. } & \text{Jo cares that Sue left.} \\
\text{b. } & \text{Jo cares that Sue didn’t leave.} \\
\text{c. } & \text{Jo cares about whether Sue left.}
\end{align*}\]

This is also captured in the analysis for care proposed in Ch. 4:

\[(18)\] \[
\begin{align*}
\left[\text{care}\right]^w &= \lambda Q_{(st,t)} \lambda x_e : B_w(x, \bigcup Q). \exists p \in Q[BOU^w_x \subseteq p \lor BOU^w_x \cap p = \emptyset]
\end{align*}\]

where \(BOU^w_x\) is the bouletic state of \(x\) in \(w\), that is, the set of worlds compatible with \(x\)’s preferences in \(w\).

Because the presuppositional component of \((18)\) is not Q-TO-P entailing, the denotation as a whole is not Q-TO-P entailing and hence not C-distributive.

Moving on to the Estonian contemplative predicates, based on the description by Roberts (2018), I have concluded in Ch. 4 that the predicate mõtlema has two readings: the ‘entertain’ reading and the ‘imagine’ reading. These readings are represented as two disjuncts in the following entry, which employs the entertain modality introduced in Ch. 3:

\[(19)\] \[
\begin{align*}
\left[\text{mõtlema}\right]^w &= \lambda Q_{(st,t)} \lambda x_e : E_w(x, Q) \lor \exists p \in Q[B_w(x, p) \land \text{IMG}^w_x \subseteq p]
\end{align*}\]

where

- \(E_w(x, Q) \iff \forall p \in \text{INQ}^w_x \exists p' \in Q[p \subseteq p']\)

- For each world \(w \in W\) and each agent \(a \in D\), \(\text{INQ}^w_a\) (i.e., the inquisitive state of \(a\) in \(w\))
  - is a downward-closed set of propositions that settle the questions that \(a\) has in \(w\), and
  - satisfies the constraint: \(\bigcup \text{INQ}^w_x = \text{DOX}^w_x\).

- \(\text{IMG}^w_x\) is the set of worlds that are compatible with what \(x\) imagines in \(w\).

To see that mõtlema under this analysis violates Q-TO-P entailment and therefore also C-distributivity, suppose the following situation: Alice entertains the issue whether it is raining but neither believes nor disbelieves that it is raining. In this situation, “Alice mõtlema whether it is raining” is true under the entertain reading. However, both “Alice...
mõtlema that it is raining

môlema that it is not raining

are false. These sentences are false in the situation under the ‘entertain’ reading because the reading boils down to belief when the complement is declarative. Also, they are false under the ‘imagine’ reading because neither Bw(a, raining) nor Bw(a, raining) holds in the situation. This shows that mõtlema as analyzed in (19) is not Q-TO-P ENTAILING, and thus not C-DISTRIBUTIVE, either.

Now on to Japanese sentence-final particles. We have the following entry for the particle daroo in Ch. 4:

(20) [ daroo ] w = λQ(st, t). Ew(sp, Q)

(sp: the speaker)

The lack of Q-TO-P ENTAILMENT with daroo can be easily shown by an example parallel to what we considered for mõtlema above. Suppose, again, that Alice entertains the issue whether it is raining but neither believes nor disbelieves that it is raining. In this situation, Alice can felicitously and truthfully utter ⌜ whether it is raining daroo ⌝ , but she cannot truthfully utter ⌜ it is raining daroo ⌝ , nor ⌜ it is not raining daroo ⌝ . Thus, daroo is not Q-TO-P ENTAILING and hence not C-DISTRIBUTIVE.

Finally, inquisitive predicates like wonder and inquire also constitute a challenge for C-DISTRIBUTIVITY, though at a somewhat different level than PoRs, mõtlema, daroo. Since wonder and inquire are rogative predicates, we might simply assume that a constraint like C-DISTRIBUTIVITY does not apply to such predicates, since the constraint makes reference to cases in which the predicate combines with a declarative complement. As discussed in the case of the VERIDICAL UNIFORMITY generalization above, however, it would be preferable to think of the constraint as applying across clause-embedding predicates, without making reference to selectional restrictions. This is possible in the question-oriented semantics for wonder from Ch. 3 in (13) above. On this account, it is possible to evaluate whether wonder satisfies C-DISTRIBUTIVITY. And the answer is that it doesn’t. After all, ⌜ x wonders Q ⌝ can be true even if for every answer p to Q, ⌜ x wonders p ⌝ is false. The latter, in fact, holds for any p whatsoever.

8.2.3 Strawson C-distributivity

Definition and illustration

Uegaki (2019) notes that it is the presuppositional component of PoRs that makes them counterexamples to C-DISTRIBUTIVITY. To see this, consider the following question-oriented analysis of care, repeated below

(21)  [ care ] w = λQ(st, t). λx : Bw(x, \bigcup Q). \exists p ∈ Q[BOU_p \subseteq p \lor BOU_p \cap p = \emptyset]

This analysis correctly predicts that (22a) has a very weak presupposition (‘Ann believes that some girl left’), while (26b) has a much stronger presupposition (‘Ann believes that x left’).

(22)  a. Ann cares (about) which girl left.
    b. Ann cares that x left.

Because of this, (22a) can be true even if, for no x, the presupposition of (22b) is satisfied. This makes care non-Q-TO-P ENTAILING and hence non-C-DISTRIBUTIVE.
Uegaki (2019) proposes a weaker notion of C-distributivity for which PoR are not counterexamples. This notion is inspired by the notion of Strawson entailment in the literature on NPI licensing (von Fintel, 1999), so we refer to it as Strawson C-distributivity.

(23) **Strawson C-distributivity**
A clause-embedding predicate \( V \) is Strawson C-distributive just in case for any exhaustivity-neutral interrogative complement \( Q \):

a. \( \neg x \ V s \neg Q \neg \rightarrow \) there is an answer \( p \) to \( Q \) such that, if the presuppositions of \( \neg x \ V s \neg that \ p \) are satisfied, then \( \neg x \ V s \neg that \ p \) holds

b. \( \neg x \ V s \neg Q \neg \leftrightarrow \) there is an answer \( p \) to \( Q \) such that \( \neg x \ V s \neg that \ p \)

(24) **Strawson C-distributivity constraint**
All clause-embedding predicates are C-distributive.

To see that this constraint rules in PoRs, suppose that (22a) is true, i.e., Ann cares (about) which girl left. Then, according to the entry for care, there must be a girl \( x \) such that Ann’s preferred worlds are all ones where \( x \) left, or all ones where \( x \) did not leave. But this means that for that girl \( x \)—as long as the presupposition of (22b) is satisfied, i.e., as long as Ann believes that \( x \) left—(22b) is true, i.e., Ann cares that \( x \) left. So the condition in (23a) is satisfied.

**Problematic cases**
Although weakening of C-distributivity to Strawson C-distributivity allows us to rule in PoRs, this does not help with other problematic cases for C-distributivity, i.e., mōlēma, daroo, and wonder. This is so because it is not the presuppositional component of these predicates that brings about the lack of C-distributivity. Presuppositions do not play a role in my arguments above that have shown that these predicates lack C-distributivity. Regardless of whether we disregard the presupposition or not, the entailment from \( \neg x \ V s \neg Q \neg \) to \( \neg x \ V s \neg that \ p \neg \) does not hold for these predicates. Thus, the Strawson C-distributivity constraint also suffers from empirical problems.

8.2.4 **Interim summary**
The cases discussed so far are summarised in Table 8.1, where ✓ means ‘correct prediction’ and ✗ means ‘incorrect prediction’. We see that none of the constraints proposed in the current literature makes correct predictions across the board. Specifically, Veridical Uniformity makes incorrect predictions about care and

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7In fact, Uegaki (2019) does not include the requirement in (b), so his actual constraint is weaker than what we call Strawson C-distributivity here. Since there is no empirical support for this weakening at this point, I keep the constraint as strong as possible, while ensuring compatibility with predicates of relevance.
Table 8.1: Predictions of the three constraints on the semantics of clause-embedding predicates

<table>
<thead>
<tr>
<th></th>
<th>know</th>
<th>shknow</th>
<th>care</th>
<th>mõtlema</th>
<th>daroo</th>
<th>wonder</th>
</tr>
</thead>
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<tr>
<td>VERIDICAL UNIFORMITY</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>C-distributivity</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Strawson C-distributivity</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>

8.3 A new constraint: P-to-Q entailment

We have seen that previously proposed constraints on the denotations of clause-embedding predicates face empirical challenges. I now formulate a new constraint, the P-TO-Q ENTAILMENT constraint, which overcomes these empirical challenges. The property of P-TO-Q ENTAILMENT and the associated constraint are defined as follows:

(25) P-to-Q entailment property
A clause-embedding predicate $V$ is P-TO-Q ENTAILING iff, for any term $\lceil x \rceil$ and any exhaustivity-neutral interrogative complement $\lceil Q \rceil$, if there is an answer $p$ to $Q$ such that $\lceil x \ V s p \rceil$, then it also holds that $\lceil x \ V s Q \rceil$.

(26) P-to-Q entailment constraint
All clause-embedding predicates $V$ are P-TO-Q ENTAILING.

Under the question-oriented theory, the P-TO-Q ENTAILMENT property can also be defined purely in terms of the lexical semantics of the predicate, as follows:

(27) P-to-Q entailment property (semantic formulation)
A predicate $V$ of type $\langle \langle st, t \rangle, et \rangle$ is P-TO-Q ENTAILING if and only if for any term $x$ and any exhaustivity-neutral $Q$: if there is a $p \in Q$ such that $\llbracket V \rrbracket(\{p\})(x)$, then $\llbracket V \rrbracket(Q)(x)$.

P-TO-Q ENTAILMENT is weaker than (STRAWSON) C-DISTRIBUTIVITY since it is limited to the direction from declarative-embedding to interrogative-embedding. Because of this, all predicates that satisfy the latter (e.g., know, predict, surprise) satisfy the former as well. Moreover, as we will argue in Sect. 8.3.1, P-TO-Q ENTAILMENT rules out attested predicates that are problematic for C-DISTRIBUTIVITY: PoRs, mõtlema, daroo, and inquisitive predicates. On the other hand, P-TO-Q ENTAILMENT still rules out fictitious predicates like shknow. These are discussed in Sect. 8.3.2.

---

8P-TO-Q ENTAILMENT relates to VERIDICAL UNIFORMITY as follows. Any P-TO-Q ENTAILING predicate that has the Choice Property, defined in (25) below, and is veridical w.r.t. interrogatives is also veridical w.r.t. declaratives.

(i) A declarative-embedding predicate $V$ has the Choice Property just in case for any two mutually inconsistent declarative complements $p$ and $p'$, $\lceil x \ V s p \rceil$ and $\lceil x \ V s p' \rceil$ cannot be true at the same time.

The proof of this is a straightforward adaptation of the one in Appendix B.3 of Thierl et al. 2018. However, it is not the case that any P-TO-Q ENTAILING predicate that is veridical w.r.t. declaratives is also veridical w.r.t. interrogatives. Counterexamples include predicates of relevance.
8.3. A NEW CONSTRAINT: P-TO-Q ENTAILMENT

8.3.1 Attested predicates satisfying the property

Predicates of relevance

For concreteness, I will focus on one predicate of relevance, namely care. The discussion below equally applies to other predicates of relevance. First, I note that care empirically satisfies P-TO-Q entailment, since all variants of (28a) entail (28b).

(28) a. Ann cares that Peter left.
   b. Ann cares (about) which boy left.

Next, let us consider a formal analysis of care, and check whether that satisfies P-TO-Q entailment as well. I adopt the question-oriented semantics for care in (29), repeated from above:

(29) \[ \text{[care]}^w = \lambda Q_{(st,t)} \lambda x_c : B_w(x, \bigcup Q). \exists p \in Q[BOU^w_x \subseteq p \lor BOU^w_x \cap p = \emptyset] \]

This lexical entry successfully captures the fact that care violates C-distributivity in the direction from interrogative-embedding to declarative-embedding, as discussed in Section 8.2.2. On the other hand, the lexical entry in (29) predicts that care satisfies P-TO-Q entailment. This is so because, if there is an answer p to Q that satisfies the presupposition and the assertion of \( \gamma x \text{ cares } p \gamma \) according to the analysis in (29), it follows that the presupposition and the assertion of \( \gamma x \text{ cares } Q \gamma \) according to the analysis in (29) are also satisfied. More formally, for any term x and any exhaustivity-neutral Q, the following holds: Suppose there is a p \( \in Q \) s.t. \( \text{[care]}^w(\{p\})(x) \). Given (29), this is true iff (i) \( B_w(x, p) \) and (ii) \( BOU^w_x \subseteq p \lor BOU^w_x \cap p = \emptyset \). Now, because \( p \in Q \), (i) entails the presupposition of \( \text{[care]}^w(Q)(x) \), i.e., \( B_w(x, \bigcup Q) \). On the other hand, (ii) entails the assertion of \( \text{[care]}^w(Q)(x) \), i.e., \( \exists p \in Q[BOU^w_x \subseteq p \lor BOU^w_x \cap p = \emptyset] \). Hence, (i) and (ii) together entail \( \text{[care]}^w(Q)(x) \).

Japanese sentence-final particles

We adopt the following analysis of daroo building on Uegaki and Roelofsen (2018) and Hara (2018), repeated from Ch. 4:

(30) \[ \text{[daroo]}^w = \lambda Q_{(st,t)} . E_w(sp, Q) \] (sp: the speaker)

The entry in (30) satisfies P-TO-Q entailment as formulated in (27). This is so because, for any exhaustivity-neutral Q, if there is an answer p to Q such that \( \gamma p \text{-daroo} \gamma \) is true, it follows that \( \gamma Q \text{-daroo} \gamma \) is also true. More formally: suppose there is a p \( \in Q \) s.t. \( \text{[daroo]}^w(\{p\}) \). Then, by (30), we have that \( E_w(sp, \{p\}) \). Given the definition of the E-modality in (19), this is equivalent to \( \forall p' \in \text{INQ}_w^p[p' \subseteq p] \). Since p \( \in Q \), this entails \( \forall p' \in \text{INQ}_w^p[p' \subseteq Q[p' \subseteq p']] \), which is equivalent to \( E_w(sp, Q) \). Hence, \( \text{[daroo]}^w(\{p\}) \) entails \( \text{[daroo]}^w(Q) \).

Thus, our question-oriented analysis of daroo satisfies Q-TO-P entailment. However, the empirical diagnostic for P-TO-Q entailment for daroo and na is somewhat problematic. This is so because the declarative-embedding sentences, as in (31a, 32a), do not intuitively entail the corresponding interrogative-embedding sentences, as in the b-examples in (31b, 32b).
I argue that this is due to an ignorance implicature of the interrogative-embedding sentences (Uegaki and Roelofsen, 2018). That is, utterance of a sentence where daroo/na embeds an interrogative prejacent Q pragmatically implicates that the speaker is not in a position to utter an alternative sentences with a declarative prejacent that expresses a specific answer to Q. Because of this ignorance implication, the entailment from (31a/32a) to (31b/32b) does not intuitively go through. However, crucially, the ignorance implication is due to implicature, and is not encoded in the lexical semantics of daroo. The particles daroo/na semantically encode just the E-modality as in (30), thus licenses the Q-to-P entailment.

Evidence for the lack of the ignorance component in the semantics of daroo is evidenced by the following kind of examples, also discussed in Ch. 4:

(33) Huji-santyoo-de-wa mizu-wa nando-de buttoo-suru {daroo-ka / Mt.Fuji-top-LOC-TOP water-TOP what.degree-in boil-do DAROO-Q / ka-na}. Huji-santyoo-de-wa kiatsu-ga tijoo-no sanbunnoni Q-NA Mt.Fuji-top-LOC-TOP air.pressure-NOM ground.level-GEN two-thirds kurai nanode, mizu-wa yaku 87.7 do de buttoo-suru.

'At what temperature does water boil at the top of Mt. Fuji? Since the air pressure there is about 2/3 of the ground level, it boils at about 87.7°C.'

The speaker of (33) knows the answer to the question embedded by daroo/na, and simply introduces a topic in the first sentence. If ignorance was semantically encoded in daroo/na, this type of usage of the particles would be infelicitous.

**Mütlema**

We have established the following analysis for mütlema, based on Roberts’s (2018) description:

(34) $$\lbrack mütlema\rbrack_w = \lambda Q_{(x,t)} \lambda x_r . E_w(x,Q) \lor \exists p \in Q [B_w(x,p) \land IMG_w x \subseteq p]$$

Let us now ask whether it is P-to-Q entailing. Suppose that Q is an exhaustivity-neutral question and p an answer to Q such that “x mütlema p” is true. On the ‘entertain’ reading (the first disjunct), this means that E_w(x, {p}), which is equivalent to
8.3. A NEW CONSTRAINT: P-TO-Q ENTAILMENT

But then \( \forall x \ mõtlema Q \) is true as well on the ‘entertain’ reading. On the ‘imagine’ reading (the second disjunct), \( \forall x \ mõtlema \ p \) means that \( x \) does not believe \( p \) but imagines what the world would be like if \( p \) were the case. Then it follows that \( \forall x \ mõtlema Q \) is true as well on the imagine reading. So, indeed, \( mõtlema \) is P-TO-Q entailing.

Wonder

Finally, \textit{wonder} as analyzed below, repeated from (13) above, satisfies P-TO-Q ENTAILMENT as well.

\[
\text{\{wonder\}}^w = \lambda Q \langle t, e \rangle \lambda x_e. \neg \exists w' [B_w (x, \text{AnsD}_w (Q))] \land E_w (x, Q)
\]

This is so since \( \text{\{wonder\}}^w (\{p\}) (x) \) is false for any \( x \) and \( p \). This means that P-TO-Q entailment is trivially satisfied.

False-answer sensitivity of \textit{know}

One might wonder if the false-answer sensitivity (FAS) of \textit{know} discussed in Ch. 5 presents a problem for the P-TO-Q ENTAILMENT constraint. After all, in cases that illustrate FAS, the subject knows a specific true answer to a question but is judged not to know a corresponding question, in light of the fact that they incorrectly believe another answer. This is exemplified in the following:

\[
\text{(36) \quad Situation: Alice has three daughters: Bonnie, Carol and Dana. The three have taken a math exam. Bonnie and Carol passed it, but Dana didn’t. Alice knows that Bonnie and Carol passed the exam. She also believes incorrectly that Dana did too.}
\]

a. Alice knows that Bonnie passed the exam.

b. Alice knows which girls among Bonnie, Carol and Dana passed the exam.

Indeed, in the given situation, (36a) is true but (36b) is false (at least in its FAS reading). Although this may seem like a counterexample to P-TO-Q ENTAILMENT, it in fact isn’t because P-TO-Q ENTAILMENT is defined in terms of interrogative complements that are exhaustivity-neutral while the complement in (36b) isn’t. Recall that exhaustivity-neutral interrogative complements are those complements where different levels of exhaustivity coincide. That \textit{which girls passed the exam} in (36b) isn’t exhaustivity-neutral can be seen by the fact that its strongly-exhaustive answer, i.e., ‘Bonnie and Carol but not Dana passed the exam’, is distinct from its the weakly-exhaustive answer, i.e., ‘Bonnie and Carol passed the exam’. Scenarios that exhibit FAS can only be constructed with non-exhaustivity-neutral complements. This is so since FAS scenarios like (36) involve a subject who believe a true answer as well as a false answer, but with exhaustivity-neutral complements, the subject’s belief in a true answer already rules out their belief in other possible answers. Thus, the definition of P-TO-Q entailment in (25) is formulated to avoid issues pertaining to FAS.

Indeed, the false-answer sensitive denotation for \textit{know} I proposed in Ch. 5 conforms to the semantic definition of P-TO-Q ENTAILMENT in (27). To see this, consider the following denotation for the false-answer sensitive \textit{know}, \textit{know}_{\text{FAS}}.
Given the presupposition of \( Q \), suppose \( x \) is an exhaustivity-neutral question and \( p \in Q \) such that \( \text{[knowFAS]}^w = \lambda Q(x,t) \lambda x. \exists p \in \text{AnsF}_w(Q) | K_w(x,p) \land \neg B_w(x, \text{AnsSE}_w(Q)) \)

where \( \text{AnsSE}_w := \lambda Q(x,t). \bigcap \{ p \mid p \in Q \land w \in p \} \cap \{ \bar{p} \mid p \in Q \land w \not\in p \} \)

Suppose \( Q \) is an exhaustivity-neutral question and \( p \in Q \) such that \( \text{[knowFAS]}^w (\{p\})(x) \).

We now turn to *shknow*, the fictitious predicate considered by Spector and Egré (2015). One way to formulate the lexical entry of *shknow* is as follows:

\[
\text{[shknow]}^w = \lambda Q(x,t) \lambda x. \left( \neg B_w(x, \{w\}) \land B_w(x, \bigcup Q) \land \forall p \in Q | \neg B_w(x, \bar{p}) \right)
\]

8.3.2 Non-attested predicates

We have seen that P-to-Q entailment rules in the predicates that pose challenges for previously proposed constraints. At the same time, it is still significant in that it rules out many conceivable but non-attested predicates.

Consider first the predicate in (38), meaning ‘consider all possibilities open’:

\[
\text{[all-open]}^w = \lambda Q(x,t) \lambda x. \forall p \in Q | \neg B_w(x, \bar{p})
\]

This predicate violates P-to-Q entailment, because it is possible for \( x \)’s beliefs to be compatible with some \( p \in Q \) without being compatible with all \( p \in Q \). To my knowledge, this prediction is correct, i.e., no language lexicalizes (38). More generally, this seems true for all predicates that quantify universally over the alternatives in the denotation of their complement. This (prima facie unexpected) general restriction is predicted by P-to-Q entailment.

Next, consider the following fictitious predicate from Steinert-Threlkeld (2020):

\[
\text{[wondows]}^w = \lambda Q(x,t) \lambda x. \left( \neg B_w(x, \{w\}) \land B_u(x, \bigcup Q) \land \forall p \in Q | \neg B_w(x, \bar{p}) \right)
\]

Steinert-Threlkeld (2020) describes this predicate as roughly meaning *know* when taking a declarative complement, while meaning *be uncertain* when taking an interrogative complement. The first and the second requirement posed by *wondows* are that \( x \)’s belief does not rule out the actual world \( w \) and that it entails the union of \( Q \). The third requirement corresponds to that posed by *all-open*. *Wondows* is therefore ruled out by P-to-Q entailment on similar grounds as *all-open*: a belief state may, besides being truthful and supporting \( \bigcup Q \), be compatible with some \( p \in Q \) without being compatible with all \( p \in Q \).

We now turn to *shknow*, the fictitious predicate considered by Spector and Egré (2015). One way to formulate the lexical entry of *shknow* is as follows:

\[
\text{[shknow]}^w = \lambda Q(x,t) \lambda x. \left( \neg B_w(x, \{w\}) \land B_w(x, \bigcup Q) \land \forall p \in Q | \neg B_w(x, \bar{p}) \right)
\]
Note that the first three requirements are those of *wondows* (encoding knowledge when combined with a declarative complement and uncertainty when combined with an interrogative complement). The fourth requirement adds an essential component of the meaning of *wonder*, namely that the subject entertains the issue expressed by the complement, i.e., they want to reach an epistemic state in which the issue expressed by the complement is resolved. This predicate also violates P-TO-Q ENTAILMENT, still essentially because of the requirement stemming from *all-open*.

We should note that the *all-open* requirement forces a very strong level of ignorance (compatibility with all alternatives). Intuitively, it is possible for *x* to wonder, say, who won the race, even if *x* can already rule out some possible winners (see Cremers et al. 2019 for relevant experimental results). Given that *shknow* is intended to mean *wonder* when taking an interrogative complement, one may want to adapt the entry in (40), so as to make room for a weaker ignorance requirement. One way to do so is as in (41), repeated from (3) above.

\[
\langle shknow \rangle^w = \lambda Q . \lambda x . e . \left( \begin{array}{c}
\left[ \left[ Q \right] \right] = 1 \land B_w(x, \bigcup Q) \\
\left[ \left[ Q \right] \right] \neq 1 \land \exists p \in Q [B_w(x, p)] \land E_w(x, Q) \end{array} \right)
\]

Under this analysis, *shknow* still violates P-TO-Q ENTAILMENT. This is because, for any *Q* and any *p* ∈ *Q*, if \( \langle shknow \rangle^w(\{p\})(x) \) is true, then \( \langle shknow \rangle^w(Q)(x) \) is false due to the weak ignorance requirement (in the rectangle) that applies when it takes an interrogative complement.

Finally, let us consider the fictitious predicate *knopinion*, discussed in Steinert-Threlkeld 2020. Intuitively, this predicate means *know* when taking an interrogative complement and *be opinionated* when taking a declarative complement. Steinert-Threlkeld (2020) gives the following lexical entry:

\[
\langle knopinion \rangle^w = \lambda Q . \lambda x . e . \neg B_w(x, \{w\}) \land (\exists p \in Q [B_w(x, p)] \lor B_w(x, \bigcup Q))
\]

To see that this predicate does not satisfy P-TO-Q ENTAILMENT, suppose that Mary correctly believes that Bill did not win the race but doesn’t know who did. Then, (43a) is true while (43b) is false.

\[
(43) \quad \begin{array}{l}
a. \text{Mary knopinions that Bill won the race.} \quad \text{(true)} \\
b. \text{Mary knopinions which athlete won the race.} \quad \text{(false)}
\end{array}
\]

So we have found a subject *x*, an exhaustivity-neutral *Q* and an answer *p* to *Q* such that \( \forall x \ knopinions \ p^* \) is true while \( \forall x \ knopinions \ Q^* \) is false. This means that P-TO-Q ENTAILMENT is violated.

### 8.4 Potential counterexamples

So far, we have considered attested and non-attested predicates for which P-TO-Q ENTAILMENT makes correct predictions. In this section, we highlight some potential coun-
terexamples to P-TO-Q ENTAILMENT from Buryat, Turkish, Tagalog, and English.

8.4.1 Communication predicates

Karttunen (1977a) argued that communication predicates like *tell* are veridical w.r.t. interrogative but non-veridical w.r.t. declarative complements.

(44) Mary told Bill what she bought. Mary bought a new bike.
     |= Mary told Bill that she bought a new bike.
(45) Mary told Bill that she bought a new bike.
     |= Mary bought a new bike.

If this is correct, then *Mary told Bill that she bought a new bike* does not entail *Mary told Bill what she bought*. For it may be that Mary lied about what she bought. But then, communication predicates like *tell* would violate P-TO-Q ENTAILMENT.

However, Tsohatzidis (1993) and Spector and Egré (2015) show that communication predicates do not always receive a veridical interpretation when taking an interrogative complement, based on examples like the following.

(46) Every day, meteorologists tell the population what the weather will be the next day, but they are often wrong.

One can draw either of the following conclusions from this observation: (a) Communication predicates are not veridical w.r.t. interrogative complements at all; or (b) communication predicates are ambiguous. On one reading, they are veridical w.r.t. interrogative complements, but on the other reading they are not (Spector and Egré, 2015).

On either of these hypotheses, communication predicates satisfy P-TO-Q ENTAILMENT.

8.4.2 Buryat *hanaxa* and Turkish *bil*

Bondarenko (2019) investigates the clause-embedding predicate *hanaxa* ‘think/recall’ in Buryat. When combining with a declarative complement, *hanaxa* is non-veridical, as illustrated in (47).

(47) dugar mi:scəi zagaha ad-ja: gəzə han-a: xarin mi:scəi zagaha
     Dugar cat.NOM fish eat-PST comp think-PST but cat fish
     adji-ə:-güj
     eat-PST-NEG
     ‘Dugar thought that a cat ate fish, but the cat didn’t eat fish.’ (Bondarenko 2019:4)

But when combined with an interrogative complement, the predicate is veridical, as illustrated in (48).

---

10Uegaki (2015) adopts this assumption and proposes that the preference for the veridical reading w.r.t. interrogatives can be explained in terms of the Strongest Meaning Hypothesis (Dalrymple et al., 1998) (cf. Mayr, 2019).
8.4. POTENTIAL COUNTEREXAMPLES

(48) bi badma tamxi tata-dag gü gəə hana-na-b
1SG.NOM Badma.NOM tobacco smoke-HAB Q COMP think-PRS-1SG
‘I am recalling (the true answer to the question) whether Badma smokes.’ (Bondarenko 2019: (118))

This sentence does not just convey that the speaker recalls some answer to the question, but that she recalls the true answer. This means that (49a) can be true without (49b) being true, suggesting that hanaxa violates P-TO-Q ENTAILMENT.

(49) a. Mary hanaxa that Bill left.
   b. Mary hanaxa whether Bill left.

However, Bondarenko (2019) argues that hanaxa combines with declarative and interrogative complements in different ways. Specifically, interrogative complements fill an argument slot of the predicate, while declarative complements function as modifications of the event description that the predicate is part of (Kratzer 2006, Moulton 2009; see Ch. 7). Under this account, the empirical observations made so far are compatible with the assumption that hanaxa satisfies P-TO-Q ENTAILMENT (as it reduces to the cases of inquisitive predicates, i.e., those predicates that cannot take a declarative clause as their argument).

Özyildiz (2019) reports that the predicate bi in Turkish has a profile similar to hanaxa in Buryat. A more comprehensive investigation would be needed in order to fully understand how these predicates interact with interrogative complements and whether they constitute counterexample to P-TO-Q ENTAILMENT.

8.4.3 Tagalog magtaka

The Tagalog predicate magtaka is translated as surprise when it takes a declarative complement, and as wonder when it takes an interrogative complement.11

(50) Nagtaka si Sara na dumating si Maria.
magtaka.PFV NOM Sara that arrived.AV NOM Maria
‘Sara was surprised that Maria arrived.’

(51) Nagtaka si Sara kung sino ang dumating.
magtaka.PFV NOM Sara if who NOM arrived.AV
‘Sara wondered who arrived.’

A preliminary investigation suggests that (50) does not imply (51). This would mean that the predicate violates P-TO-Q ENTAILMENT. We must leave a more in-depth investigation of this case for future work.

8.4.4 English explain

Pietroski (2000) and Elliott (2016) argue that when explain takes a declarative complement, this complement does not describe the ‘explanandum’—what is being explained—but rather the content of the explanation, i.e., the ‘explanans’. See (52):

---

11 We are grateful to Henrison Hsieh and Florinda Palma Gil for discussing this case with us and providing native speaker judgments.
(52)  a. Bill asked Mary why she wanted to leave.
    b. Mary explained that she wasn’t feeling well.

Example (52b) does not report that Mary was explaining the fact that she wasn’t feeling well. Rather, she explained why she wanted to leave. The content of the explanation was that she wanted to leave because she wasn’t feeling well. By contrast, if explain takes an interrogative complement, this complement always describes the explanandum rather than the content of the explanation. This is exemplified in (53):

(53) Mary explained how she was feeling.

This sentence reports that Mary gave an explanation of her feelings, not that she described her feelings in order to explain something else, e.g., why she wanted to leave. Based on these examples, it may seem that explain violates P-TO-Q ENTAILMENT. After all, (52b) does not entail (53). The former can convey that Mary explained why she wanted to leave, namely because she wasn’t feeling well. But this does not entail that she gave an explanation of her feelings.

However, before concluding that explain violates P-TO-Q ENTAILMENT, we first have to better understand how the verb combines with declarative and interrogative complements. The discussion in Elliott (2016) is relevant here, although it does not contrast declarative complements with interrogative ones, but rather declarative complements with DP arguments, as in (54).

(54) Mary explained the fact that she wasn’t feeling well.

In this sentence, the DP argument of the verb describes the explanandum, just like in (53), rather than the content of the explanation. To derive the contrast between cases like (52b) and (54), Elliott (2016) suggests that declarative complements are modifiers of an event description, while DPs are thematic arguments. If an account of the contrast between (52b) and (54) on the bases of such a combinatorial difference is on the right track, then it may be extended to capture the contrast between (52b) and (53) as well, in a way similar to how declarative and interrogative complements of hanaxa are treated in Bondarenko (2019). We would have to assume that interrogative complements, like DPs, fill an argument slot of the verb. Whatever fills this argument slot always describes the explanandum, not the content of the explanation. On such an account, the fact that (52b) fails to entail (53) does not imply that explain violates P-TO-Q ENTAILMENT. In (52b) the predicate does not take the declarative clause as its argument. Only clauses that describe the explanandum (rather than the explanans) fill the argument slot of the predicate.

8.5 Chapter summary and remarks on the why question

In this chapter, I considered empirical adequacy of various hypothesized constraints on the semantics clause-embedding predicates: VERIDICAL UNIFORMITY, (STRAWSON) C-DISTRIBUTIVITY, and P-TO-Q ENTAILMENT. A summary of the predictions made by the constraints discussed in this chapter is given in Table 8.2.
Chapter Summary and Remarks on the Why Question

Table 8.2: Predictions of the constraints considered in the chapter

<table>
<thead>
<tr>
<th></th>
<th>*shknow</th>
<th>*knopinion</th>
<th>care</th>
<th>mõtlema</th>
<th>daroo</th>
<th>wonder</th>
<th>magtaka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veridicality Uniformity</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>C-distributivity</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Strawson C-distributivity</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>P-to-Q entailment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

As can be seen in the table, P-to-Q entailment seems to be more empirically satisfactory than Veridical Uniformity or (Strawson) C-distributivity because the former can rule in attested predicates such as care, mõtlema, daroo, and wonder. At the same time, there are predicates that remain to be problematic, e.g., Buryat hanaxa and Tagalog magtaka. All in all, although there may be apparent counterexamples that require further investigations, it seems fair to say that P-to-Q entailment can be considered to be a candidate for a cross-linguistically robust (though perhaps not absolute) constraint on the semantics of clause-embedding predicates. At the same time, I do not rule out the possibility that other constraints, such as Veridical Uniformity and C-distributivity, operate concomitantly with P-to-Q entailment as robust cross-linguistic constraints. I have only surveyed several languages in this chapter that are sampled in a non-systematic manner. Much work remains to be done to evaluate the precise extent to which these constraints hold in the semantics of clause-embedding predicates cross-linguistically.

In this section, I also would like to briefly discuss the issue of the why-question, touched on in Sect. 8.1. In order to achieve an explanatory theory, we must also account for why there is a tendency for clause-embedding predications across languages to conform to these constraints. Concretely, why is it that there aren’t many predicates that are not veridicality uniform and/or P-to-Q entailing?

In the literature, two hypotheses have been proposed. One is based on ease in verification, and it has been proposed for C-distributivity in particular (Theiler et al., 2018). There is an easy (distributive) strategy to verify whether a sentence of the form \( \forall x \, V \, Q \) is true if the predicate \( V \) is C-distributive. Namely, we can consider sentences of the form \( \forall x \, V \, that \, p \), for all answers \( p \) to \( Q \), and as soon as we find that one of these sentences is true, we know that \( \forall x \, V \, Q \) is true as well. Perhaps, in the course of language evolution, clause-embedding predicates that permit such a verification strategy are favoured over ones that don’t. Another hypothesis is based on learnability, and has been proposed in particular for Veridical Uniformity. It may be that the meaning of Veridical Uniform or (Strawson) C-distributive predicates is easier to learn than that of predicates which do not have this property. Some preliminary evidence for this hypothesis is presented in Steinert-Threlkeld (2020). Specifically, Steinert-Threlkeld (2020) has found that predicates that satisfy Veridical Uniformity are easier to learn for off-the-shelf neural network learning models than those predicates that are not. Note that these two hypotheses are not necessarily independent. In particular, it may be that C-distributive predicates are relatively easy to learn because they permit an easy verification strategy.

Now, let us consider these hypotheses in light of P-to-Q entailment. First, note
CHAPTER 8. *SHKNOWING

that if a predicate $V$ is only P-TO-Q ENTAILING (and not Q-TO-P ENTAILING and thus not C-DISTRIBUTIVE), then the verification strategy described above is still sound, but not complete. That is, there may be true sentences of the form $\forall x \forall s Q$, which the strategy would not identify as true sentences. One possible way to explain the empirical robustness of P-TO-Q entailment, which only supports a sound verification strategy, as opposed to C-DISTRIBUTIVITY, which supports sound and complete verification strategy, is the following. If $V$ is P-TO-Q entailment, then finding a $p \in Q$ such that $\forall x \forall s p^\top$ guarantees that $\forall x \forall s Q$ is true. If $V$ is Q-TO-P entailment in addition (and thus C-DISTRIBUTIVE), then it also provides a falsification strategy, in the sense that if there is no $p \in Q$ such that $\forall x \forall s p^\top$, $\forall x \forall s Q^\top$ is guaranteed to be false. Arguably, the verification strategy described above based on P-TO-Q entailment is simpler than the falsification strategy based on Q-TO-P entailment since the former only requires observation about one answer while the latter requires observations about all answers $p \in Q$. Because of this relative complexity of the required falsification strategy, Q-TO-P entailment might not give a predicate significant advantage in the course of the evolution of lexical semantics, at least not in the same way as P-TO-Q entailment does. A hypothesis along these lines may explain why P-TO-Q entailment is empirically robust, even though it only provides an incomplete (although sound) verification strategy, and why Q-TO-P entailment is empirically less robust. The (sound) verification strategy P-TO-Q entailment guarantees is simple as it can be based on observation about one answer. On the other hand, the additional falsification strategy guaranteed by C-distributivity is not simple enough to make a predicate significantly advantageous in the course of language evolution.

To my knowledge, the role of verification strategy in the evolution of lexical semantics has not been investigated extensively (though, see Katzir et al. (2020)). However, it is possible that difficulty associated with verification is a factor that contributes to complexity of lexical meanings, which has been argued to play a significant role in shaping inventories of both content vocabularies (Kemp and Regier, 2012, Regier et al., 2015, Kemp et al., 2018, Carr et al., 2020) and functional vocabularies (Steinert-Threlkeld, 2019, Denić et al., 2020, Uegaki, 2022, van de Pol et al., 2021). One way to empirically test this line of hypothesis is to measure degrees of difficulty in verification for individual clause-embedding predicates and see whether they correlate with an independent measure that can be assumed to track cross-linguistic lexicalization patterns. This is where the learnability hypothesis becomes relevant, as learnability has been argued to track cross-linguistic patterns in a variety of domains in semantics and syntax (Culbertson et al., 2012, Steinert-Threlkeld and Szymanik, 2019).

The learnability hypothesis for P-TO-Q entailment would state that predicates that are P-TO-Q entailment are easier to learn than non-P-TO-Q entailment predicates. This can be tested by empirically comparing the learnability of P-TO-Q entailment and non-P-TO-Q entailment predicates, based on artificial-language learning (ALL) experiments with human participants, in addition to computational simulations based on independently-motivated learning models employed by Steinert-Threlkeld (2020) discussed above. The methodology of ALL experiments has evolved considerably in recent years (see Culbertson and Schuler 2019a,b for recent surveys) and has been applied to a number of empirical domains in semantics, including quantifiers (Chemla et al., 2018), personal pronouns (Maldonado and Culbertson, 2021), gradable adjectives (Carcassi,
among other domains. It is thus possible to apply the same methodology to clause-embedding predicates. Indeed, in my recent study in collaboration with Mora Maldonado and Jennifer Culbertson (Maldonado et al., 2022), we show that adult learners are likely to assume that meanings of artificial predicates are C-DISTRIBUTIVE when they are tasked to extrapolate the interrogative-embedding meaning of the predicates based on evidence involving their declarative-embedding meaning. The study, however, does not target P-TO-Q ENTAILMENT in particular.

I have to leave these further investigations for future research. However, I hope to have shown that the problem associated with the expressive power of the question-oriented theory can in principle be addressed by considering cross-linguistic constraints on the semantics of clause-embedding predicates and uncovering their underlying explanations based on general principles governing the evolution/optimization of lexical meanings. Future research in this area will benefit from methodological developments and theoretical insights from existing research into semantic universals in other vocabularies. At the same time, clause-embedding predicates will provide a new rich empirical domain in which we can test theories and methodologies considered in the current research into the shape and explanations of semantic universals.
Bibliography


Bondarenko, Tanya. 2019. Factivity alternation due to semantic composition: *think* and *remember* in Barguzin Buryat. Ms., MIT.


Elliott, Patrick D. 2016. Explaining DPs vs. CPs without syntax. In *CLS 52*.


Chapter 9

Conclusions

Clausal complementation represents one of the most important empirical domains in formal semantics, given its relevance to numerous central theoretical topics in semantics, such as intensionality, attitudes, clause typing, and selection. At the same time, the highly complex empirical landscape of declarative and interrogative complementation has challenged any semanticist who has tried to achieve a unified analysis of the phenomena. I hope to have shown in the previous chapters that the QUESTION-ORIENTED THEORY offers an attractive unified semantic account of declarative and interrogative clausal complementation. According to this proposal, all clause-embedding predicates semantically select for a set of propositions, and both declarative and interrogative complements are represented as proposition-sets. The arguments for this proposal have come from (a) interpretations of clause-embedding predicates, as represented by entailment relationships between declarative and interrogative complementation (Ch. 4, 5); and (b) possibility of semantic explanations for selectional restrictions (Ch. 3, 6, 7).

The current proposal, if successful, provides further motivations for the uniform semantics of declarative and interrogative clause types in general (whether it is embedded or matrix), something that has been argued by proponents of inquisitive semantics (Ciardelli et al., 2018). Furthermore, the semantic explanations of selectional restrictions presented here will eliminate the need for syntactic subcategorization mechanisms, thus having implications for the grammatical model of selection (cf. Grimshaw, 1979, Pesetsky, 1991). Finally, the proposal provides linguistic arguments for the existence of ‘question-directed attitudes’, maintained by Friedman (2013, 2019) within the philosophical literature.

I would like to conclude by mentioning several key issues that I have to leave open. One concerns the semantic explanations of selectional restrictions I have proposed in Ch. 3 and Ch. 6. The hypotheses considered in the chapters posit specific correlations between semantic properties of clause-embedding predicates and their selectional restrictions. These correlations have to be thoroughly examined based on intra-linguistic and cross-linguistic data (cf. White and Rawlins, 2018, White, 2021). In particular, the fine-grained cross-linguistic variation in the syntax and semantics of clause marking can potentially provide an ideal testbed for examining the hypotheses. For example, in Akan (Kwa, Niger-Congo; Ghana), responsive predicates (e.g. nim ‘know’) and in-
quisitive predicates (e.g. *bisa* ‘ask’) differ not only in whether they are compatible with declarative complements, but also in possible syntactic realization of questions they embed: although questions embedded by inquisitive predicates can be realized as an interrogative clause, those embedded by responsive predicates are obligatorily realized as a relativized DP with a concealed question interpretation (Zimmermann, 2018).\(^1\) Investigating the mechanism underlying the selection of the syntactic form of the embedded question in Akan, in conjunction with the semantic difference between inquisitive and responsive predicates, will allow us to enrich our understanding of the connection between lexical semantics and selectional restrictions. Other open questions concern cross-linguistic constraints on the semantics of clause-embedding predicates. As emphasized in Ch. 8, we need further systematic empirical investigations into the types of existing constraints on predicate meanings, and further theoretical inquiry into the sources of such constraints. Semantic universals and explanations underlying them are actively investigated in the current literature (e.g., Kemp et al., 2018, Steinert-Threlkeld and Szymanik, 2019, Carcassi, 2020, Maldonado and Culbertson, 2021), based on a variety of theoretical perspectives and methodologies. Although I have to leave these investigations to future research, I believe that combining the recent advances in the study of semantic universals with the approach to clause-embedding predicates presented in this book will shed further light on the nature of the semantics of clause-embedding predicates and lexical semantics in general.

\(^1\) An anonymous reviewer has informed me that the same pattern is observed in Navajo, and possibly in other American languages as well as Australian languages.
Bibliography


