Interpreting Questions with Non-Exhaustive Answers

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Interpreting Questions with Non-exhaustive Answers

A dissertation presented
by

Yimei Xiang

to

The Department of Linguistics

in partial fulfillment of the requirements
for the degree of
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in the subject of
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Interpreting Questions with Non-exhaustive Answers

Abstract

This dissertation investigates a variety of issues on question semantics, especially the interpretations of mention-some questions, multiple-wh questions, and questions with quantifiers.

Chapter 1 discusses some basic issues on question semantics. I define question roots as topical properties, which can supply propositional answers and nominal short answers. But distinct from traditional categorial approaches, I treat wh-items as existential quantifiers, which can be shifted into domain restrictors. Moreover, I argue that the quantificational domain of a plural or number-neutral wh-item is polymorphic: it consists of not only individuals but also generalized conjunctions and disjunctions.

Chapter 2 and 3 are centered on the interpretations of mention-some questions. Showing that the availability of mention-some should be grammatically restricted, I attribute the mention-some/mention-all ambiguity to structural variations within the question nucleus. The variations include (i) the scope ambiguity of the higher-order wh-trace and (ii) the absence/presence of a null dou. Further, I solve the dilemma between uniqueness and mention-some by allowing the short answers to be interpreted with wide scope.

Chapter 4 investigates the role of false answers in interpreting indirect questions. I focus on the following two facts: first, FA-sensitivity is involved in interpreting mention-some questions; second, FA-sensitivity is concerned with all types of false answers, not just those that can be complete. These facts challenge the current dominant view that
FA-sensitivity is derived by exhaustifications.

In Chapter 5 and 6, I turn to multiple-\textit{wh} questions and questions with quantifiers. Chapter 5 presents a function-based analysis for the pair-list readings of multi-\textit{wh} questions. Crucially, contra the dominant view, I argue that these readings are \textbf{NOT} subject to domain exhaustivity. Chapter 6 explores two approaches to quantifying-into question effects, namely a higher-order question approach and a function-based approach. Both approaches manage to treat quantifying-into question as regular quantification.

Chapter 7 presents a uniform treatment for the seemingly diverse functions of the Mandarin particle \textit{dou}. I argue that \textit{dou} is a pre-exhaustification exhaustifier that operates on sub-alternatives. This chapter provides a baseline theory for the derivation of disjunctive mention-all.
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Chapter 1

Introducing a hybrid approach
1.1. Introduction

This chapter motivates and develops a hybrid approach to the semantics of questions. My starting point is Caponigro’s (2003, 2004) Generalization on the distributional patterns of questions and free relatives, which shows that short answers with nominal denotations must be derivable out of questions.

The three canonical approaches to semantics of questions, namely Categorical Semantics, Hamblin-Karttunen Semantics and Partition Semantics, define the root denotations of questions as lambda abstracts, Hamblin sets, and partitions, respectively. As this chapter will show, short answers can only be derived out of lambda abstracts; moreover, lambda abstracts have greater expressive power than Hamblin sets and partitions. For these reasons, I define the root denotations as lambda abstracts, and more precisely, topical properties.

The proposed hybrid approach also takes aspects from Hamblin-Karttunen Semantics, so as to overcome the empirical and technical deficiencies with traditional Categorical Semantics. The major improvements are: first, *wh*-items are treated as existential indefinites, instead of lambda operators; second, by the application of an answerhood operator, questions of different kinds generate constituents of the same semantic type (namely, proposition sets) and hence can be naturally coordinated.

At the end of this chapter, I re-evaluate the existential meanings of *wh*-items. For some *wh*-items, their live-on sets (namely, their quantificational domains) are richer than the sets denoted by their NP-complements: for instance, the live-on set of *which books* consists of not only individual books but also generalized conjunctions and disjunctions.
over books. For this reason, I introduce a ‘†-operation’ to the lexicons of wh-items which generates higher-order elements.

1.2. The starting point: deriving nominal short answers

In answering a question in discourse, it is usually more preferable to utter a short answer (also called fragment answer or elided answer). As exemplified in (1a), a short answer is the constituent that conveys only the new information. In comparison, the answer in (1b) which takes a full declarative form is called full answer (also called clausal answer or propositional answer).

(1) What did John buy?
   a. A cake. (short answer)
   b. John bought a cake. (full answer)

It remains debatable, however, whether a short answer in discourse is a bare nominal constituent (Stainton 1998, 2005, 2006; Ginzburg & Sag 2000; Jacobson 2013) or covertly clausal (Merchant 2004; among the others). If it is bare nominal, it should take a nominal interpretation, which therefore calls for a way to derive nominal answers out of a question denotation. If it is covertly clausal, it should be regarded as an elliptical of the corresponding full answer and take a propositional meaning. The ellipsis approach (Merchant 2004) proceeds as follows: the focused constituent moves to a left-peripheral position; next, licensed by a linguistic antecedent provided by the wh-question, the rest of the clause gets elided.
I have no disagreement with the ellipsis approach for short answers in discourse, and I do not think that short answers in discourse necessarily take nominal meanings. Nevertheless, given the interpretations and distributions of free relatives, we still need to construct questions in a way such that short answers with nominal meanings can be derived grammatically.

A free relative takes a nominal interpretation, referring to a nominal item specified by a complete true answer of the corresponding \textit{wh}-question. In (3a), \textit{what John bought} refers to the item or the set of items that John bought; in (3b), \textit{where he can get help} refers to one of the places where John could get help. I call such nominal references “\textbf{nominal short answers}”.

(3) a. Mary ate [what John bought].
    
    b. John went to [where he could get help].

Moreover, Caponigro (2003, 2004) observes that \textit{wh}-words are cross-linguistically more restrictively distributed in free relatives than in questions.

(4) \textbf{Caponigro’s Generalization} (Caponigro 2003, 2004)

If a language uses the \textit{wh}-strategy to form both questions and free relatives, the
*wh*-words found in free relatives are always a subset of those found in questions. Never the other way around. Never some other arbitrary relation between the two sets of *wh*-words.

This generalization conjectures that the derivation of a question should be strictly simpler than that of the corresponding free relative. Otherwise, there should have been some *wh*-constructions that can be used as free relatives but not as questions, contra the generalization. This conjecture allows for two possibilities, as illustrated in the following two figures. Option 1 is that free relatives are derived from questions (Chierchia & Caponigro 2013). This option predicts Caponigro’s Generalization as long as the derivations from questions to free relatives is sometimes blocked, for whatever reason. Option 2 is that free relatives and questions are derived from the same sources but via separate paths, and moreover that the path to free relatives is more likely to be blocked than the path to questions.

(5) a. Option 1 (Op₀ is partial)     b. Option 2 (Op₁ is defined → Op₂ is defined)

Whichever option is correct, it ought to be the case that nominal short answers are derivable from a question denotation or a constituent contained within the denotation.
1.3. Comparing the canonical approaches of question semantics

There have been numerous studies on the semantics of questions in the literature. This section reviews three canonical approaches to question semantics, including Categorical Semantics, Partition Semantics, and Hamblin-Karttunen Semantics. Each of these approaches has its own advantages and disadvantages. For the purposes of this chapter, I will limit my discussion to single *wh*-questions and multiple-*wh* questions with single pair readings. Questions with other types will be discussed in Chapter 5 and Chapter 6.

1.3.1. Categorical Semantics

Categorical Semantics (Hausser & Zaefferer 1979, Hausser 1983; von Stechow & Zimmermann 1984; among the others) defines the root denotation of a question as a *lambda abstract* and *wh*-items as *lambda operators*, as exemplified in (6) and (7), respectively.

(6) a. \[ [\text{who came}] = \lambda x \left[ \text{people}_@^@ (x) \land \text{came}_@ (x) \right] \]
   b. \[ [\text{who bought what}] = \lambda x \lambda y \left[ \text{person}_@^@ (x) \land \text{thing}_@^@ (y) \land \text{bought}_@ (x, y) \right] \]

(7) a. \[ [\text{who}] = \lambda x \lambda P \left[ \text{people}_@^@ (x) \land P(x) \right] \]
   b. \[ [\text{what}] = \lambda x \lambda P \left[ \text{thing}_@^@ (x) \land P(x) \right] \]

Defining a question as a lambda abstract makes it simple to derive nominal short answers: a nominal short answer is a possible argument for the lambda abstract denoted by the question root, and a full answer is a result of applying this lambda abstract to a short
A common criticism to Categorical Semantics is that it assigns different semantic types to different questions. For instance, it predicts the single-\textit{wh} question (6a) to be of type $\langle e, t \rangle$ while the multiple-\textit{wh} question (6b) to be of type $\langle e, \langle e, t \rangle \rangle$. This prediction cannot account for the fact in (8) that the two questions (6a) and (6b) can be naturally conjoined and embedded under the same predicate.

(8)  
\begin{enumerate}[a.]
\item John asked Mary [[who came] and [who bought what]].
\item John knows [[who came] and [who bought what]].
\end{enumerate}

Moreover, treating \textit{wh}-items as lambda operators cannot account for the cross-linguistic fact that \textit{wh}-words behave like existential indefinites in non-interrogatives. In German, Romance, Hindi, Japanese, Italian, and many other languages, polarity items with existential semantics are formed out of \textit{wh}-words (Chierchia 2013). More clearly, Chinese \textit{wh}-phrases like \textit{shenme}-NP simply mean ‘some’-NP when they appear below an existential epistemic modal or within the antecedent of a conditional, as exemplified in (9) (see Liao 2011 for an extensive discussion).

(9)  
\begin{enumerate}[a.]
\item Yuehan haoxiang jian-le shenme-ren  
John perhaps meet-PERF what-person  
‘It seems that John met someone.’
\item Ruguo Yuehan jian-guo shenme-ren, qing gaosu wo.  
If John meet-EXP what-person, please tell me.  
‘If John met someone, please tell me.’
\end{enumerate}

\footnotetext{Traditional Categorical Semantics treats short answers in discourse as bare nominals. This view might and might not be correct, depending on whether there is strong evidence for the ellipsis approach.}
1.3.2. Hamblin-Karttunen Semantics

Hamblin (1973) analyzes the root denotation of a question as a set of propositions, each of which is a possible answer of the underlying question. He treats a non-wh-expression (such as a proper name or a verb) as the singleton set of its regular interpretation, and a wh-expression as the set of objects in the expression’s usual domain of interpretation. The alternative semantics of these expressions are composed via the operation called Point-wise Functional Application. Accordingly, a declarative denotes a singleton proposition set whose only member identifies the declarative itself, as shown in (10a); a question denotes a set of propositions, each of which names an object in the wh-expression’s interpretation domain, as shown in (10b).

\[(10)\]

\[\begin{align*}
\text{a. Mary came.} & \quad \text{b. Who came?} \\
\{\text{came}'(m)\} & \quad \{\text{came}'(m), \text{came}'(j), \ldots\} \\
\text{Mary} & \quad \text{who} \\
\text{came} & \quad \text{came} \\
\{m\} & \quad \{m, j, \ldots\} \\
\{\lambda x.\text{came}'(x)\} & \quad \{\lambda x.\text{came}'(x)\}
\end{align*}\]

\[(11)\] Point-wise Functional Application

If \(\alpha : \langle \sigma, \tau \rangle\) and \(\beta : \sigma\), then

\[\begin{align*}
\text{a. } \llbracket \alpha \rrbracket_g &= D_{\langle \sigma, \tau \rangle} \\
\text{b. } \llbracket \beta \rrbracket_g &= D_{\sigma} \\
\text{c. } \alpha(\beta) : \tau \text{ and } \llbracket \alpha(\beta) \rrbracket = \{f(d) \mid f \in \llbracket \alpha \rrbracket_g, d \in \llbracket \beta \rrbracket_g\}
\end{align*}\]

Karttunen (1977) argues that the root denotation of a question consists of only the true answers. This revision is made to capture the veridicality of indirect questions that use a non-factive interrogative-embedding predicate (such as tell and predict). Compare the
examples in (12) for instance: telling a declarative sentence does not imply that the agent
told something true, while telling a question does imply that the agent told a/the true
answer of this question. This contrast suggests that the veridicality of tell in the indirect
question (12b) comes from the embedded question.²

(12) a. Jack told me that Mary came.
   b. Jack told me who came.

The major assumptions in Karttunen’s semantics of wh-questions are summarized as the
following. First, a proto-question rule shifts the meaning of declarative sentence from a
proposition to a proto-question; for instance, this rule shifts a proposition \( p \) to a set of
true propositions that are identical to \( p \), namely \( \{ q : q(w) \land q = p \} \). Second, wh-items like
who and what are existentially quantified noun phrases just like someone and something
(e.g., \( [\text{who}] = \lambda P.\exists x[\text{people}_@'(x) \land P(x)] \)). Last, the wh-items undertake quantifier raising
(QR) and existentially quantify into the proto-question, yielding a set of true answers.

Heim (1995) and many others transport the Montague Grammar analysis of Karttunen
Semantics into Government and Binding (GB)-style logical forms (see different treatments
in Cresti (1995), Dayal (1996), Rullmann & Beck (1998), and among the others). The exam-
ple in (13) illustrates the most commonly used logical form for a single-wh question.³ The
proto-question rule is ascribed to an identify function at the interrogative C head. The

²Contrary to Karttunen’s claim, Spector & Egré (2015) argue that declarative-embedding tell does admit
a factive/veridical reading (see section 4.2.1).

³Here and throughout the dissertation, I consider only de re readings, where the extensions of the wh-
complements are evaluated under the actual world @. See Sharvit (2002) for a simple extension to de dicto
readings.
wh-word, as an existential quantifier, undertakes QR to the spec of the interrogative CP and leaves an individual trace within IP. Abstracting the first argument \( p \) of the identity function returns a set of possible answers, namely the Hamblin set, which is considered as the root denotation. For instance, with only two individuals John and Mary taken into account, the Hamblin set is as in (14). Finally, an answerhood-operator applies to the Hamblin set \( Q \) and the evaluation world \( w \), returning \( a/ \) the propositional complete true answer in \( w \).

(13) Who came?

\[
\begin{align*}
\text{ANS} & \quad w \\
\langle s, t \rangle & \quad Q: \langle s, t \rangle \\
\lambda p \exists x & \{ \text{people}^\circ (x) \wedge p = \text{came}'(x) \} \\
\exists x & \{ \text{people}^\circ (x) \wedge p = \text{came}'(x) \} \\
\text{who: } & \langle e, t \rangle \\
\lambda f \exists x & \{ \text{people}^\circ (x) \wedge f(x) \} \\
\lambda x. p & = \text{came}'(x) \\
\lambda x & \quad \text{C': } t \\
p & = \text{came}'(x) \\
\lambda p. \lambda q. p & = q \\
\text{IP: } & \langle e, t \rangle \\
\text{came}'(x) & \quad x \text{ came}
\end{align*}
\]

(14) \[ Q = \lambda p. \exists x \{ \text{people}^\circ (x) \wedge p = \text{came}'(x) \} \]

\[ = \{ \text{came}'(x) : x \in \text{people}^\circ \} \]
Various answerhood operators have been proposed in the literature. For instance, in deriving weakly exhaustive answers, Heim (1994) proposes one that returns the conjunction of all the true answers, and Dayal (1996) proposes one that is presuppositional and returns the unique strongest true answer. Setting aside differences of detail among the proposed answerhood-operators, we see that all of these operators introduce truth and bridge answers and questions.

\[
\text{ANS}_{\text{Heim}}(Q)(w) = \cap \{ p : w \in p \in Q \}
\]

\[
\text{ANS}_{\text{Dayal}}(Q)(w) = \exists p [ w \in p \in Q \land \forall q [ w \in q \rightarrow p \subseteq q ] ]
\]

Hamblin-Karttunen Semantics has two major advantages over Categorical Semantics. First, wh-items are analyzed as existential indefinites, which therefore captures the cross-linguistic fact that wh-items take clearly existential meanings in non-interrogatives. Second, all questions are analyzed as propositions sets and uniformly assigned with the type \langle st, t \rangle.

On the negative side, however, Hamblin-Karttunen Semantics is incompatible with Caponigro’s Generalization that free relatives are strictly more limitedly distributed than questions. Since free relatives more or less denote the nominal meanings of short answers, this generalization suggests that nominal short answers should be derivable from the root denotation of a question. Defining questions as proposition sets, Hamblin-Karttunen Se-
mantics loses the capability of deriving nominal short answers out of a question denotation, because individuals can not be retrieved out of propositions, which are just sets of possible worlds. Moreover, Karttunen Semantics even cannot support the ellipsis approach of short answers. Compare the LFs in (17): in (17b) the elided part denotes an abstract over the nucleus, namely $\lambda x.\text{John bought } x$; but in (17a) the sister node of what denotes an abstract over an equation, namely $\lambda x.p = \text{John bought } x$, which does not qualify as an antecedent of ellipsis.\(^{45}\)

(17)  
\begin{itemize}
  \item a. What did John bought?
  \item b. A cake.
\end{itemize}

While Hamblin-Karttunen Semantics uniformly defines questions as proposition sets, it still receives criticisms about its capability in analyzing conjunctions of questions. Conjunction is standardly taken to denote intersection:

\[p = \text{John bought } x\]

4This point is inspired from a personal conversation with Lucas Champollion.

5Danny Fox (p.c.) suggests one way to salvage this problem: the LF of (17a) can be structured as follows, where who takes cyclic movement and leaves two individual traces (viz., $x$ and $y$); the squared part provides a syntactic antecedent for the ellipsis.
(18) \( \alpha \cap \beta = \{ x : x \in \alpha, x \in \beta \} \)

Following this view, if questions denote sets of possible answers, then we would predict a conjunction of two questions to denote the set of common possible answers of these two questions. This prediction is clearly incorrect. In (19), the two coordinated questions have no common answer.

(19) John asked Mary [ [who came] and [who bought what] ].

A simple way to address this concern is to allow conjunctions to be applied point-wise: a point-wise conjunction of two proposition sets returns a set of conjunctive propositions. Hence, the embedded conjunction of questions in (19) denotes the set (21).

(20) **Point-wise conjunction** \( \cap_{PW} \):

Given two sets of propositions \( \alpha \) and \( \beta \), then \( \alpha \cap_{PW} \beta = \{ a \wedge b : a \in \alpha, b \in \beta \} \)

(21) \[
\{ [ [\text{who came}] \text{ and}_{PW} [\text{who bought what}] ] \mid \\
\text{Andy came } \wedge \text{Andy\text{@}Billy bought a cake} \\
\text{Billy came } \wedge \text{Andy\text{@}Billy bought a cake} \\
\text{Andy\text{@}Billy came } \wedge \text{Andy\text{@}Billy bought a cake} \}
\]

### 1.3.3. Partition Semantics

Partition Semantics (Groenendijk & Stokhof 1982, 1984) defines the root denotation of a question as a partition over possible worlds. Two world indices belong to the same cell of

---

\(^6\)A more refined way, proposed in the recently developed Inquisitive Semantics, restores the standard treatment of conjunction as *meet* operation, which is still amount to intersection. See Ciardelli & Roelofsen (2015) and references therein for details.
a partition if and only if the property denoted by the lambda abstract holds for the same set of items in these two worlds. As schematized in (22), two world indices \( w \) and \( w' \) are in the same cell if and only if the very same set of individuals came in \( w \) and \( w' \).

\[
(22) \quad \text{[who came]} = \lambda w.\lambda w'.[\lambda x[\text{came}_w(x)] = \lambda x[\text{came}_{w'}(x)]]
\]

With two individuals John and Mary taken into account, the question *who came* yields the partition illustrated in Table 1.1. Each cell/row stands for a subset of worlds, or equivalently, a strongly exhaustive propositional answer to the considered question. For instance, the first cell refers to the set of worlds where only John and Mary came, and hence is equivalent to the exhaustified proposition that *only John and Mary came*.

<table>
<thead>
<tr>
<th>( w ): only ( j ) and ( m ) came in ( w )</th>
<th>( w ): only ( j ) came in ( w )</th>
<th>( w ): only ( m ) came in ( w )</th>
<th>( w ): nobody came in ( w )</th>
</tr>
</thead>
</table>

Table 1.1: Partition for *who came*

Under Partition Semantics, interpreting a *wh*-question takes three steps, as illustrated in (23). First of all, *wh*-items abstract out the corresponding variables from the question nucleus, forming a lambda abstract. Next, the abstract gets type-shifted, yielding a partition. Last, the world index picks out the cell where it belongs to, yielding an exhaustified proposition.

\[
(23) \quad \text{Who came?}
\]
Compared with Categorical Semantics, shifting a lambda abstract to a partition assigns the same semantic type $\langle s, st \rangle$ to all types of questions. For instance, the single-$wh$ (22) and the multi-$wh$ question (24) uniformly denote proposition sets.

\[(24) \quad [\text{who bought what}] = \lambda w \lambda w'[\lambda x.\lambda y[\text{bought}_w(x,y)] = \lambda x.\lambda y[\text{bought}_{w'}(x,y)]]
\]

On the negative side, however, shifting an abstract to a partition significantly weakens the expressive power: short answers and lambda abstracts cannot extracted out of a partition, just like that from a proposition $f(x)$ it is impossible to extract out the argument $x$ and the predicate $f$. Hence, Partition Semantics has to let questions and free relatives be composed via two different type-shifting (TS) operations, as illustrated in Figure 1.1: TS1 turns a lambda abstract into a partition, forming a question; while TS2 turns a lambda abstract into a nominal element, forming a free relative. This setting is close the Option 2 described in (5). But since the two employed TS-operations work so differently, it is unclear how Partition Semantics can account for Caponigro’s Generalization. (See also Chierchia & Caponigro 2013)
Moreover, a partition is a set of exhaustified propositions. Hence for both mention-some and mention-all questions, Partition Semantics rules in only strongly exhaustive readings (25a)/(26a), which however are too strong (Heim 1994). The desired interpretations, in fact, are what I call false answer (FA)-sensitive readings, as described in (25b)/(26b). FA-sensitive readings require the subject to know a true mention-some/mention-all answer as to the embedded mention-some/mention-all question and have no false belief as to the embedded question. I will motivate and present an analysis for these readings in Chapter 4.

(25) \((w: \text{only Andy and Billy can chair; single-chair only.})\)

John knows who can chair the committee.

a. \(\neg \) ‘John knows that only Andy and Billy can chair.’

b. \(\neg \) ‘John knows that Andy can chair, or John knows that Billy can chair; and John has no false belief as to who can chair the committee.’

(26) \((w: \text{only Andy and Billy came})\)

John knows who came.

a. \(\neg \) ‘John knows that only Andy and Billy came.’

b. \(\neg \) ‘John knows that Andy and Billy came; and John has no false belief as to
1.3.4. Comparing lambda abstracts, Hamblin sets, and partitions

In (27), I rank the three proposed question denotations with respect to the strength of their expressive power, with ‘lambda abstracts’ being the strongest and ‘partitions’ being the weakest. By saying ‘A has greater expressive power than B’, I mean that any information that is derivable from B is also derivable from A, but not the other direction.

(27) Rank of expressive power

Lambda abstracts (topical properties) > Hamblin sets > Partitions

In the following, I will only consider lambda abstracts that are property types, called TOPICAL PROPERTIES. A topical property is a function from individuals to propositions, or say, a function from short answers to propositional answers.

(28) Who came?

\[ P = \lambda x[people_\@^0(x) = 1 \cdot \text{came}^0(x)] \]  
\[ Q = \{ \neg \text{came}^0(x) : people_\@^0(x) = 1 \} \]  
\[ w \cdot \lambda w'[\lambda x[people_\@^0(x) \wedge \text{came}^0_w(x)] = \lambda x[people_\@^0(x) \wedge \text{came}^0_w(x)]] \]

Topical properties are ranked higher than Hamblin sets because all the information that is derivable from a Hamblin set is also derivable from the corresponding topical property; but not the other direction. Let \( P \) stand for a topical property, then the range of

---

7 This point has been discussed by Rooth (1992), Krifka (2006), Beaver & Clark (2008), and Onea (2016: chapter 3).
\( P \) is equivalent to the Hamlin set, and the propositions in the range of \( P \) that are true in \( w \) is equivalent to the Karttunen set in \( w \). In the other direction, however, short answers are derivable from \( P \) but not from the corresponding Hamblin set. For instance, the two properties in (29) share the very same range (namely, \( \{f(a), f(b)\} \)) but different domains: the domain of \( P_1 \) consists of two propositions, while the domain of \( P_2 \) consists of two individuals.

<table>
<thead>
<tr>
<th>{P(\alpha) : \alpha \in \text{Dom}(P)}</th>
<th>\text{Hamblin set}</th>
</tr>
</thead>
<tbody>
<tr>
<td>{P(\alpha) : \alpha \in \text{Dom}(P) \land w \in P(\alpha)}</td>
<td>\text{Karttunen set}</td>
</tr>
</tbody>
</table>

\( \text{Dom}(P) \) the set of possible short answers

\( \{\alpha : \alpha \in \text{Dom}(P) \land w \in P(\alpha)\} \) the set of true short answers

Table 1.2: Deriving answers sets from topical properties

(29)  
\[ \text{a. } P_1 = \lambda p[p \in \{f(a), f(b)\}. p] \]
\[ \text{b. } P_2 = \lambda x[x \in \{a, b\}. f(x)] \]

Partitions have even less expressive power than Hamblin sets. The questions in (30) yield different lambda abstracts and Hamblin sets but the very same partition. Hence, partitions cannot tell the singular-versus-plural contrast with \( wh \)-items, the positive-versus-negative contrast in question nucleuses, or the variation of exhaustivity.

(30)  
\[ \text{a. Who came?} \]
\[ \text{b. Which person came?} \]
\[ \text{c. Who didn’t come?} \]
\[ \text{d. Which person didn’t come?} \]
\[ \text{e. Which person or people } x \text{ is such that only } x \text{ came?} \]
\[ \text{f. Which person or people } x \text{ is such that only } x \text{ didn’t come?} \]
Compare the number-neutral *wh*-question (30a) and the singular one (30b) for instance. With only two individuals John and Mary taken into account, their Hamblin sets would be as in (31a) and (31b), respectively. The live-on set of a singular *wh*-item is smaller than that of a bare *wh*-word, namely the former consists of only atomics while the latter also includes sums (and even generalized quantifiers, see section 1.5); therefore, the Hamlin set yielded by (30b) is smaller than the one yielded by (30a).

(31)  

a. Who came?  
\[ Q = \begin{cases}  
\text{\textsc{came'}}(j) \\
\text{\textsc{came'}}(m) \\
\text{\textsc{came'}}(j \oplus m) 
\end{cases} \]  

b. Which person came?  
\[ Q = \begin{cases}  
\text{\textsc{came'}}(j) \\
\text{\textsc{came'}}(m) 
\end{cases} \]

Nevertheless, (30a-b) yield the very same partition, as illustrated in Table 1.3. In both partitions, for instance, the first cell stands for the set of worlds where only John and Mary came: the one for (30a) is the set of worlds \( w \) such that the set of atomic/sum individuals who came in \( w \) is \( \{j, m, j \oplus m\} \); and the one for (30b) is the set of worlds \( w \) such that the set of atomic individuals who came in \( w \) is \( \{j, m\} \).

Partition yielded by (30a)  
\[
\begin{array}{|c|}
\hline
w: \{x : w \in c(x)\} = \{j, m, j \oplus m\} \\
\hline
w: \{x : w \in c(x)\} = \{j\} \\
\hline
w: \{x : w \in c(x)\} = \{m\} \\
\hline
w: \{x : w \in c(x)\} = \{\emptyset\} \\
\hline
\end{array}
= 
\[
\begin{array}{|c|}
\hline
w: \text{only } jm \text{ came in } w \\
\hline
w: \text{only } j \text{ came in } w \\
\hline
w: \text{only } m \text{ came in } w \\
\hline
w: \text{nobody came in } w \\
\hline
\end{array}
\]

Partition yielded by (30b)  
\[
\begin{array}{|c|}
\hline
w: \{x : w \in c(x)\} = \{j, m\} \\
\hline
w: \{x : w \in c(x)\} = \{j\} \\
\hline
w: \{x : w \in c(x)\} = \{m\} \\
\hline
w: \{x : w \in c(x)\} = \{\emptyset\} \\
\hline
\end{array}
= 
\[
\begin{array}{|c|}
\hline
w: \{x : w \in c(x)\} = \{j, m\} \\
\hline
w: \{x : w \in c(x)\} = \{j\} \\
\hline
w: \{x : w \in c(x)\} = \{m\} \\
\hline
w: \{x : w \in c(x)\} = \{\emptyset\} \\
\hline
\end{array}
\]

Table 1.3: Partitions for (30a-b)
1.3.5. **Summing up**

The advantages of each canonical approach are summarized in Table 1.4. Crucially, only Categorical Semantics can derive nominal short answers grammatically out of question denotations.8

<table>
<thead>
<tr>
<th></th>
<th>Categorical</th>
<th>Partition</th>
<th>Hamblin-Karttunen</th>
</tr>
</thead>
<tbody>
<tr>
<td>coordinating questions</td>
<td>×</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>nominal short answers</td>
<td>√</td>
<td>(✓)</td>
<td>×</td>
</tr>
<tr>
<td>exhaustivity variation</td>
<td>✓</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td><em>wh</em>-items as <em>∃</em>-indefinites</td>
<td>×</td>
<td>×</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 1.4: Comparing the canonical approaches of question semantics

I have also shown that topical properties have greater expressive power than Hamblin sets and partitions. Starting from a topical property, we can reach all the information that is reachable from a Hamblin set or a partition, but not the other direction.

1.4. **A hybrid approach**

Since topical properties have the greatest expressive power, a natural way of thought would be to define the root denotation as a topical property and let the answerhood-operator directly operate on this topical property. Using this way of thought, I propose a hybrid approach to compose the semantics of questions. This approach succeeds the

8Note that here “nominal short answers” mainly refer to the nominal items denoted by *wh*-free relatives, not necessarily include short answers in discourse.
advantages of all the canonical approaches while overcomes their disadvantages. The major ingredients of this approach are summarized as follows.

- The root denotation of a question is a topical property. (§1.4.1)
  
  - Wh-items are existential indefinites (Karttunen 1977).
  
  - A BEDOM-operator converts a wh-item into a domain restrictor.
  
  - Moving BEDOM(whP) to the spec of the interrogative CP yields a partial property that is defined for only individuals in the live-on set of the wh-item.

- An answerhood-operator directly operates on the topical property. It evaluates the exhaustivity/uniqueness requirement (see chapter 3) and returns a set of max-informative true answers. These answers can be nominal or propositional, depending on the employed answerhood-operator. (§1.4.2)

- In the case of coordinating two questions, the conjunction operation is applied above an ANS-operator. This operator convert topical properties uniformly into proposition sets. (§1.4.3)

1.4.1. Topical property

The section provides a compositional derivation for the topical properties of wh-questions. In (32) for instance, the topical property is a function from an atomic boy $x$ to the proposition that $x$ came. Different from traditional Categorial approaches and the more recent approaches to compose topical properties or lambda abstracts of questions (Caponigro 2004; George 2011; Champollion et al. 2015), the proposed derivation maintains the existential semantics of wh-items.
Which boy@ came?

\[ P = \lambda x_e[\text{boy}’(x) = 1.\text{came}’(x)] \]

In (32), the domain of the expected topical property \( P \) equals to the extensional meaning of the \( wh \)-complement \( \text{boy} \), namely the set of atomic boys \( \text{boy}’@ \). This set can be extracted out of the \( wh \)-item as follows: first, following Karttunen (1977), I define \( wh \)-items as existential indefinites; next, I extract out the set \( \text{boy}’@ \) by applying the type-shifter \( \text{BE} \) (Partee 1986) to \( \text{which boy} \). The type-shifter \( \text{BE} \) shifts an existential quantifier to its live-on set, as schematized in (33).

\[(33)\]

\[a. \quad [\text{which boy}@] = \lambda f(e,t).\exists x \in \text{boy}’@[f(x)] \]

\[b. \quad \text{BE} = \lambda P \lambda x[P(\lambda y.y = x)] \]

\[c. \quad \text{BE}([\text{which boy}@]) = \lambda x[(\lambda f(e,t).\exists x \in \text{boy}’@[f(x)])(\lambda y.y = x)] \]

\[= \lambda x[\exists x \in \text{boy}’@[x = x]] \]

\[= \{x : x \in \text{boy}’@\} \]

\[= \text{boy}’@ \]

The next step is to compose the property domain \( \text{BE}([\text{which boy}@]) \) with the property nucleus denoted by the remnant CP, namely \( \lambda x.\lambda w.\text{came}’w(x) \). One might suggest to compose these two pieces via \textit{Predicate Modification}. Nevertheless, such an approach suffers type mismatch. **First**, as shown in (34a): ‘\( \text{BE}(\text{which boy}) \)’ is extensional (of type \( \langle e,t \rangle \)) while its sister node is intensional (of type \( \langle e,si \rangle \)); hence Predication Modification cannot be applied. **Second**, a more serious problem arises in the case of multi-\( wh \) questions. Even if we neglect the extension/intension distinction, the LF in (34b) still suffers type mismatch: ‘\( \text{BE}(\text{which boy}) \)’ is of type \( \langle e,t \rangle \) while its sister node is of type \( \langle e,et \rangle \).
(34)  a. Which boy came?  b. Which boy kissed which girl

\[
\begin{array}{c}
\langle e, t \rangle \\
\lambda x. \text{boy}_@ (x) \\
\text{BE(boy)}
\end{array}
\quad \begin{array}{c}
\langle e, st \rangle \\
\lambda x \lambda w. \text{came}_w (x) \\
\text{BE(boy)}
\end{array}
\quad \begin{array}{c}
\langle e, t \rangle \\
\lambda x \\
\text{BE(boy)}
\end{array}
\quad \begin{array}{c}
\langle e, et \rangle \\
\lambda x \\
\text{BE(boy)}
\end{array}
\quad \begin{array}{c}
\langle e, t \rangle \\
\lambda t \\
\text{BE(girl)}
\end{array}
\quad \begin{array}{c}
\langle e, t \rangle \\
\lambda y \\
\text{BE(girl)}
\end{array}
\quad x \text{kissed}_w y
\]

To incorporate the domain BE(\text{whP}) into the topical property, I introduce a new type-shifter \text{BEDOM}. Briefly, \text{BEDOM} shifts a \text{wh}-item into a domain restrictor. In semantics, \text{BEDOM} is a two-place predicate that applies to an existential quantifier \(\mathcal{P}\) and a property \(\theta\) (with an arbitrary type \(\tau\)). As schematized in (35), \text{BEDOM}(\mathcal{P})(\theta) returns the unique partial property that takes \text{BE}(\mathcal{P}) as its domain and \(\theta\) as its nucleus.

(35)  \textbf{Definition: \text{BEDOM}}

\[
\text{BEDOM}(\mathcal{P})(\theta_\tau) = i \mathcal{P}_\tau ([[\text{Dom}(\mathcal{P}) = \text{BE}(\mathcal{P})] \land \forall \alpha \in \text{Dom}(\mathcal{P})[\mathcal{P}(\alpha) = \theta(\alpha)]])
\]

In syntax, \text{BEDOM} is a DP-adjunct. As illustrated in (36), \text{BEDOM} and \text{which boy} form a DP constituent and move together to the spec of the interrogative CP. This movement is syntactically motivated for the sake of checking off a [+wh] feature within the lexicon of the \text{which boy}. This syntactic derivation resembles the case in (37) with a DP-only: only is a DP-adjunct of \text{JOHN}_F; only-JOHN_F as a whole moves to the spec of FP so as to check off the [+F] feature of \text{JOHN}_F.
(36) Which boy came?  
(37) Only JOHN\textsubscript{F} came.

To see how the computations of single-\textit{wh} and multiple-\textit{wh} questions work out in practice, consider the two examples below. It can be nicely observed how the \textit{BEDOM}-shifter turns a \textit{wh}-phrase into a type-flexible domain restrictor (of type $\langle \tau, \tau \rangle$, where $\tau$ stands for an arbitrary type): the output partial property $P$ has the identical semantic type as the input property $\theta$. Therefore, the compositions of multi-\textit{wh} questions do not suffer type mismatch.

(38) Which boy came?

\begin{verbatim}
P: $\langle e, st \rangle$

\text{DP: $\langle \tau, \tau \rangle$}
 \text{BEDOM $\langle et, t \rangle$}
 \text{which boy@}$
 \lambda x \text{C'}$
 \text{IP: $\langle s, t \rangle$}$\text{x came}$

a. $[\text{IP}] = \text{\textquotesingle came\textquotesingle}(x)$

b. $[\text{which boy@}] = \lambda f_{(e, t)}. \exists x \in boy'_{(f(x)]}$

c. $[\text{BEDOM}] = \lambda P. \lambda \theta_{(e, t)} . [\text{Dom}(P) = \text{BE}(P)] \land \forall \alpha \in \text{Dom}(P)[P(\alpha) = \theta(\alpha)]$

d. $[\text{BEDOM(\text{which boy@})}] = \lambda \theta . \lambda P . [\text{Dom}(P) = boy'_{(\theta)]} \land \forall \alpha \in \text{Dom}(P)[P(\alpha) = \theta(\alpha)]$
\end{verbatim}
(39) Which boy kissed which girl? (single-pair reading)

\[ \begin{align*}
\text{IP} &= \langle e, \langle e, st \rangle \rangle \\
\text{[IP]} &= \langle \tau, \tau \rangle \\
\text{BE Dom} &= \langle et, t \rangle \\
\text{which boy@} &= \lambda x \langle \tau, \tau \rangle \\
\text{BE Dom} &= \langle et, t \rangle \\
\text{which girl@} &= \lambda y \langle e, st \rangle \\
\text{C'} &= \langle e, st \rangle \\
\text{IP} &= \langle s, t \rangle \\
\lambda x \lambda y [\text{girl'}_@ (y) = 1. \cdot \text{kiss}'(x, y)] \\
\lambda x \lambda y [\text{boy'}_@ (x) = 1 \land \text{girl'}_@ (y) = 1. \cdot \text{kiss}'(x, y)]
\end{align*} \]

In (39), the movement of the object-\textit{wh} \textit{which girl} can be either triggered syntactically due to feature checking or semantically due to type-mismatch. Under the former possibility, \textit{which girl} moves covertly to the spec of the interrogative CP so as to check off its [+wh] feature. Under the latter possibility, as illustrated below, ‘BE Dom(\textit{which girl})’ moves to the edge of IP/VP so as to avoid type-mismatch: \textit{kiss} select for an item of type \textit{e} as its
internal argument. The topical properties derived via these two options are identical.

(40) Which boy kissed which girl?

\[
P: \langle e, \langle e, st \rangle \rangle
\]

\[
\text{BEDOM} \quad \langle et, t \rangle \quad \lambda x \quad \text{C'} \quad \text{IP: } \langle e, st \rangle
\]

\[
\text{BEDOM} \quad \langle et, t \rangle \quad \lambda y \quad \langle s, t \rangle \quad x \text{ kiss } y
\]

1.4.2. Answerhood

The topical property directly enters into an answerhood-operation, returning a set of complete true answers. These answers are propositional or short, depending on whether the employed answerhood-operator is ANS or ANS\(^S\).\(^9\) The notion “complete” is a bit obscure and is usually used in a descriptive manner. In this dissertation, an answer being complete means that it is semantically licensed.

\(^9\)Note that the superscript ‘S’ in ANS\(^S\) stands for ‘short’, rather than ‘strong’.
(41) a. For propositional answers  
\[ \langle s, t \rangle \]
\[ f_{ch} \]
\[ \text{ANS}_{w} \]
\[ \text{P}: \langle e, st \rangle \]

b. For short answers  
\[ \langle st, t \rangle \]
\[ e \]
\[ f_{ch} \]
\[ \text{ANS}_{w} \]
\[ \text{P}: \langle e, st \rangle \]

Which answerhood-operator is used is determined by Categorical (C)-selection, namely, whether the embedding predicate selects for a proposition or an entity, as exemplified in (42). Finally, a choice function \( f_{ch} \) is applied to pick out one of these complete true answers. If a question has only one complete true answer, then the output set of employing \( \text{ANS} \) is a singleton set, and \( f_{ch} \) returns the unique member of this set.

(42) a. John told me [whom Mary likes].

John told me \[ \langle_{st} f_{ch} \text{ANS}_{w} \text{ans} [\text{whom Mary likes}]] \]

b. John invited [whom Mary likes].

John invited \[ \langle_{e} f_{ch} \text{ANS}_{w}^{S} [\text{whom Mary likes}]] \]

An important characteristic of framework is that the question formation procedure has no stage that creates a Hamblin set or a Karttunen set. Instead, answerhood-operators directly operate on the topical property and hence they can access any information that is retrievable from the topical property, especially the property domain, or say, the short answers.\(^{10}\) As I will argue in Chapter 3, making the property domain accessible to the

\(^{10}\)This consequence makes the proposed analysis significantly different from George (2011) and the very recent analysis proposed by Champollion et al. (2015) using Inquisitive Semantics. These two analyses also
answerhood-operators is crucial for predicting the uniqueness effects in singular and numeral-modified \textit{wh}-questions.

As for the definitions of answerhood-operators, I adopt Fox’s (2013) view that any \textit{maximally (max)-informative} true answer counts as a complete true answer. A true answer is maximally informative as long as it is not asymmetrically entailed by any true answers. Following Hamblin-Karttunen semantics, Fox defines an answerhood-operator as in (43): it applies to a Hamblin set $Q$ and an evaluation world $w$, returning the set of maximally informative true answers.

\begin{equation}
\text{ANS}_{Fox}(Q)(w) = \{ p : w \in p \in Q \land \forall q \left[ w \in q \in Q \rightarrow q \notin p \right] \}
\end{equation}

Compared with the answerhood-operators proposed by Heim (1994) and Dayal (1996) seen in section 1.3.2, $\text{ANS}_{Fox}$ leaves some space for mention-some: it allows a non-exhaustive answer to be complete and a question to take multiple complete true answers. I will return to this point in section 2.5.1. Adapting (43) to the proposed hybrid semantics of questions, I define the answerhood-operators as in (44). The major difference is replacing the Hamblin set $Q$ with a topical property $P$: $\text{ANS}(P)(w)$ returns the set of max-informative true answers, and $\text{ANS}^S(P)(w)$ returns the set of individuals named by these answers.$^{11}$

\begin{equation}
\text{(44) Definition: Answerhood-operators}
\end{equation}

start with a lambda abstract, but then use a question-formation operator to convert this abstract into a set of propositional answers. Hence, under these two proposals, an answerhood-operator cannot interact with the property domain.

$^{11}$This chapter considers only the asserted components of the answerhood-operators. Chapter 3 will discuss their presuppositions, which are crucial for predicting the uniqueness requirements of singular \textit{wh}-questions.
a. For propositional answers

\[ \text{ANS}(P)(w) \]
\[ = \{ P(\alpha) : \alpha \in \text{Dom}(P) \land w \in P(\alpha) \land \forall \beta \in \text{Dom}(P) \rightarrow w \in P(\beta) \implies P(\beta) \notin P(\alpha) \} \]

b. For short answers

\[ \text{ANS}^S(P)(w) = \{ \alpha : \alpha \in \text{Dom}(P) \land w \in P(\alpha) \land \forall \beta \in \text{Dom}(P) \rightarrow w \in P(\beta) \implies P(\beta) \notin P(\alpha) \} \]

In syntax, I treat the answerhood-operators and the choice function \( f_{ch} \) as CP-adjuncts. The \( \text{ANS} \)-operators select for only interrogative CPs and hence cannot be applied to other constituents of property types, such as noun phrases.

The example in (45) illustrates the applications of \( \text{ANS} \) and \( \text{ANS}^S \) in single-\( \text{wh} \) questions. Here the interrogative-embedding verb \textit{know} (probably with distinct lexical entries) can select for propositions as well as entities, and therefore both \( \text{ANS} \) and \( \text{ANS}^S \) are applicable, forming a question and a free relative, respectively.

(45) John knows [whom Mary likes].

\((w: \textit{Mary only likes Andy and Billy.})\)

\[
\text{John}
\]
\[
\text{knows}_w
\]
\[
f_{ch}
\]
\[
\text{ANS}/\text{ANS}^S
\]
\[
\text{P}
\]
\[
\text{whom Mary likes}
\]

a. \( P = \lambda x[\text{people}^\prime_@ (x) = 1 \cdot \text{like}^\prime (m, x)] \)

b. \( \text{Dom}(P) = \text{people}^\prime_@ \) (possible SAs)
c. \( \mathbf{P}(\alpha) : \alpha \in \text{Dom}(\mathbf{P}) = \{ '\text{like}'(m,x) : x \in \text{people}_@ \} \) (possible PAs)

d. \( \text{ANS}^S(\mathbf{P})(w) = \{ '\text{like}'(m,a@b) \} \) (complete true PAs)

e. \( \text{ANS}^S(\mathbf{P})(w) = \{ a@b \} \) (complete true SAs)

f. \( f_{ch}[\text{ANS}(\mathbf{P})(w)] = '\text{like}'(m,a@b) \)

g. \( f_{ch}[\text{ANS}^S(\mathbf{P})(w)] = a@b \)

Now move on to multi-\( \mathbf{wh} \) questions. The lambda abstract \( \mathbf{P} \) in (46a), strictly speaking, is not a property: it is a function from atomic boys to a property of atomic girls; its domain is not a set of short answers and its range is not a set of propositional answers. Then, how could we derive answers from this \( \mathbf{P} \)? The simplest solution that I have seen so far makes use of tuple types, an idea developed by George (2011: Appendix A). He writes an \( n \)-ary sequence as \( (x_1;x_2;...;x_n) \) which takes a tuple type \( (\tau_1;\tau_2;...;\tau_n) \), and then equivocates between the type \( \langle \tau_1(\tau_2(...(\tau_n,\sigma),... \rangle \) and with the type \( \langle (\tau_1;\tau_2;...;\tau_n,\sigma) \). For instance, \( \langle e;e,st \rangle \) equals to \( \langle (e;e),st \rangle \). Using this idea, we can consider the abstract \( \mathbf{P} \) in (46a) as a property over duple-sequences from an atomic boy to an atomic girl and write its domain as (46b). Then answerhood-operations proceed regularly.

(46) Which boy kissed which girl?

(\( w: \) John kissed only Mary; no other boy kissed any girl.)

a. \( \mathbf{P} = \lambda x.\lambda y.[\text{boy}_@'(x) = 1 \land \text{girl}_@'(y) = 1. 'kiss'(x,y)] \)

b. \( \text{Dom}(\mathbf{P}) = \{(x;y) : x \in \text{boy}_@', y \in \text{girl}_@' \} \) (possible SAs)

c. \( \mathbf{P}(\alpha) : \alpha \in \text{Dom}(\mathbf{P}) = \{ 'kiss'(x,y) : x \in \text{boy}_@', y \in \text{girl}_@' \} \) (possible PAs)

d. \( \text{ANS}(\mathbf{P})(w) = \{ 'kiss'(j,m) \} \) (complete true PAs)

e. \( \text{ANS}^S(\mathbf{P})(w) = \{(j;m) \} \) (complete true SAs)
1.4.3. Coordinating questions

Recall the major criticism to the traditional Categorical Semantics: questions of different kinds are assigned with different semantic types, which is incompatible with the fact that these questions can be naturally coordinated.

(47)  

a. John knows [who came] and [who bought what]

b. John asked Mary [who came] and [who bought what]

The proposed hybrid approach also faces this problem because topical properties take diverse semantic types. In responding to this problem, I argue that the conjunctive and is not directly applied to a root denotation.

Consider the case in (47a) first, where question coordination is embedded under a responsive predicate know. Roughly speaking, knowing a question means knowing a max-informative true answer of this question, and likewise, knowing the conjunction of two questions means knowing a max-informative answer of each question. Therefore, I assume that the conjunctive and is interpreted above the ANS-operator, as illustrated in (48): if and scopes above the choice function \( f_{ch} \), it coordinates two propositions; otherwise and coordinates two proposition sets and is applied point-wise.

(48)  

John knows \([p_1 \text{ who came}] \text{ and } [p_2 \text{ who bought what}]\)

a. \(\text{John knows } [\langle f_{ch} \text{ ANS}_w \text{ P}_1 \rangle \text{ and } \langle f_{ch} \text{ ANS}_w \text{ P}_2 \rangle] \quad (\text{and} > f_{ch} > \text{ANS})\)

12 The claim of reducibility has some insufficiencies; knowing a question has a richer semantics than knowing a max-informative true answer of this question. I will return to this point in Chapter 4. These insufficiencies do not matter here.
b. John knows \( f_{ch} \left[ \left( s,s \right) \text{ANS}_w \text{P}_1 \right] \) and \( \text{PW} \left[ \left( s,s \right) \text{ANS}_w \text{P}_2 \right] \)  
\( (f_{ch} > \text{and}_{PW} > \text{ANS}) \)

A question arises in (47b). Here the question coordination is embedded under a regenerative predicate *ask*, which selects for an interrogative instead of a proposition. For such cases, we can decompose *ask* into *request to tell him* (à la Uegaki’s (2015: chapter 2) treatment with *wonder*), where *tell* is a responsive veridical predicate. The world arguments of \text{ANS} and *tell* are bound by the intensional predicate *request*. Some possible paraphrases of (47b) are shown in (49). See Chapter 4 for more discussions on interpretations of indirect questions.

(49) John requests (me) to tell (him) \([P_1 \text{ who came}] \) and \([P_2 \text{ who bought what}]]\)

a. \( \lambda w[\text{request}_w \subseteq \lambda w'. \text{tell}_w(i, j, f_{ch}[\text{ANS}(P_1)(w') \cap f_{ch}[\text{ANS}(P_2)(w')])]) \)

b. \( \lambda w[\text{request}_w \subseteq \lambda w'. \text{tell}_w(i, j, f_{ch}[\text{ANS}(P_1)(w') \cap \text{PW} \text{ANS}(P_2)(w')])]) \)

1.5. **Live-on sets of wh-items**

1.5.1. **The traditional view**

Under the traditional view, the *live-on* set of a *wh*-phrase is the set denoted by the extension of its NP-complement.\(^{13}\) For instance, *which boys* lives on the set of individuals that are atomic or sum boys in the actual world. Since *wh*-items are existential indefinites, their live-on sets can be extracted via the *BE*-shifter (Partee 1987).

\(^{13}\)A generalized quantifier \( P \) lives on a set \( A \) iff for any set \( B, B \in P \iff B \cap A \in P \) (Barwise & Cooper 1981).
Using the ontology of individuals from Sharvy (1980) and Link (1983), we analyze the denotations of singular and plural NPs as follows: a singular term denotes a set of atomic elements, while a plural term ranges over both atomic and sum elements. This idea is illustrated in Figure 1.2, where \( abc \) each denotes an atomic element.

Formally, the denotation of a plural term is obtained by employing a star (\( * \))-operator (Link 1983) to the denotation of the corresponding singular term. This *-operator closes the denotation of a singular term under sum operations. The two definitions in (51) are identical for any non-empty \( A \) set.\(^{14}\)

\[ (51) \]

**The *-operator**

a. **Definition 1** (Link 1983)

\[ *A = \{ x : \exists A' \subseteq A[x = \bigoplus A] \} \]

(*\( A \) is the set that contains any sum of things taken from \( A \).)

b. **Definition 2**

\(^{14}\)The generalized sum \( \bigoplus \) is only defined for non-empty sets, therefore the definition in (51a) implies that \( A \) is not empty. In (51b), however, \( A \) can be empty, and \( *A \) would also be an empty set.
\[ *A = \text{MIN}[X : A \subseteq X \land \forall a \forall b(a \in X \land b \in X \rightarrow a \oplus b \in X)] \]

(The minimal superset of \( A \) that is closed under sum.)

1.5.2. Disjunctions

Spector (2007, 2008) makes the first empirical argument for the existence of higher-order disjunctive answers. He observes that elided disjunctions can be used as complete answers to questions with universal modals (called “\( \Box \)-questions” henceforth), as exemplified in (52a), where the disjunction takes scope below the universal modal.

(52) Speaker A: “What does John have to read?”

Speaker B: “Syntax or Morphology.”

a. ‘John has to read S or M, and the choice is up to him.’ (\( \text{have to} > \text{or} \))

b. ‘John has to read S or M, I don’t know which exactly.’ (\( \text{or} > \text{have to} \))

To obtain the reading in (52a), Spector proposes that the \( \text{wh} \)-word what can quantify over generalized quantifiers, including generalized disjunctions like \( s \vee m \), and so that the \( \Box \)-question in (52) can take \( \Box \text{read'}(j, s \vee m) \) as a possible answer.

(53) \[ [\text{Syntax or Morphology}] = s \vee m \]

\[ = AP_{(s, m)} \lambda w_s [P_w(s) \vee P_w(m)] \]

Furthermore, Fox (2013) observes that disjunctions cannot completely answer a \( \Box \)-question with a singular \( \text{wh} \)-phrase which book, as exemplified in (54). Using Spector’s diagnose, Fox conjectures that the live-on set of a singular \( \text{wh} \)-phrase does not include generalized conjunctions.
(54) Speaker A: “Which book does John have to read?”

Speaker B: “Syntax or Morphology.”

a. # ‘John has to read S or M, and the choice is up to him.’ (have to > or)

b. √ ‘John has to read S or M, I don’t know which exactly.’ (or > have to)

1.5.3. Conjunctions

Spector (2007) and Fox (2013) have proposed to add conjunctions to the live-on sets of \textit{wh}-items, but they have not discussed any independent evidence for this assumption. I argue for this assumption based on the fact that questions with collective predicates admit conjunctive answers.

First of all, given the contrast in (55), I argue that the predicate \textit{formed a team} does not support covered readings, unlike its plural counterpart \textit{formed teams}.

(55) \( w: \text{The considered four boys } abcd \text{ formed two teams in total: } a + b \text{ formed one, and } c + d \text{ formed one.} \)

a. √ The boys \textbf{formed teams}.

\[ \sim \text{ For some contextually determined cover of the boys, the individuals in each cover member formed a team. } \quad \text{(covered)} \]

\[ \forall w. D(Cov) (\forall x. \text{form-}^*\text{team}_w (x)), \text{ where Cov is a cover of the-boys’} \]

b. # The boys \textbf{formed a team}.

\[ \sim \text{ The boys all together formed one team. } \quad \text{(collective)} \]

\[ \forall w. \text{form-team}'_w (a \oplus b \oplus c \oplus d) \]
Next, compare the sentences in (56) under the same discourse: (56a) suffers presupposition failure because the factive verb *know* embeds a false collective declarative; but (56b), where *know* embeds a interrogative counterpart of the collective declarative, does not suffer presupposition failure.

(56)  
(w: The considered four boys *abcd* formed two teams in total: *a + b* formed one, *c + d* formed one.)

a. # John knows [that the boys formed a team].
   ~\to  The boys *abcd* all together formed one team.

b. √ John knows [which boys formed a team].

Intuitively, for (56b) being true, John needs to know the component members of all the teams formed by the considered boys, namely the conjunctive inference in (57).

(57)  
\[ form-team'(a \oplus b) \wedge form-team'(c \oplus d) \]

(a + b formed a team and c + d formed a team.)

Where does the conjunctive come from? Clearly, it cannot come from the collective predicate *formed a team* or anywhere within the question nucleus, otherwise the embedded clause in (56a) would admit a covered reading. I argue that this conjunctive is obtained from the *wh*-phrase, namely the live-on set of *which boys* includes also generalized conjunctions like *a \oplus b \wedge c \oplus d*, and hence that the embedded question in (56b) can take (57) as a possible answer.

(58)  
[ab and cd] = a \oplus b \wedge c \oplus d

= \lambda P_{(e, st)}. \lambda w [P_w(a \oplus b) \wedge P_w(c \oplus d)]
Similar to the case of disjunctions, conjunctions are not included in live-on sets of *wh*-phrases taking singular or numeral-modified NP-complements (e.g., *which boy, which two boys*). In the following utterances, the elided conjunctive questions are not proper specifications of the preceding *wh*-question, because these conjunctions are not in the live-on sets of the *wh*-phrases in the preceding questions.

(59)  

a. ‘Which boy came? John?’  
b. ‘Which boy came? # John and Bill?’

(60)  

a. ‘Which two boys formed a team? This two guys?’  
b. ‘Which two boys formed a team? # This two guys and that two guys?’

One might argue that the conjunctive in (57) is simply the $\cap$-closure in Heim’s (1994) answerhood-operator, which returns the conjunction of all the true answers:

\[
\cap \{\text{form-team}'(a \oplus b), \text{form-team}'(c \oplus d)\} = \text{form-team}'(a \oplus b) \land \text{form-team}'(c \oplus d)
\]

Nevertheless, this approach cannot capture the contrast in (62): in (62b), the embedded question has a numeral-modified *wh*-phrase and presupposes a uniqueness inference, which however is false in the given discourse.

(62)  

(w: The considered four boys abcd formed two teams in total: $a+b$ formed one, $c+d$ formed one.)

a. $\sqrt{\text{John knows [which boys formed a team].}}$

b. $\# \text{John knows [which two boys formed a team].}$

$\neg\neg$ Exactly two of the boys formed a team.
This uniqueness presupposition is standardly explained by “Dayal’s presupposition” (Dayal 1996): a question is defined only when it has a unique strongest true answer; a strongest true answer is the true answer that entails all the true answers.\textsuperscript{15} With Dayal’s presupposition, the proposed lexical difference between \textit{which boys} and \textit{which two boys} captures the contrast in (62): the live-on set of \textit{which boys} includes generalized conjunctions like $a \odot b \land c \odot d$ and hence the embedded question in (62a) takes (57) as a possible answer, which is also the strongest true answer in the given discourse; in contrast, the live-on set of \textit{which two boys} consists of only dual-individuals of boys, and hence the embedded question in (62b) has only two true answers, namely $\text{form-team'}(a \odot b)$ and $\text{form-team'}(c \odot d)$, none of which counts as the strongest true answer. In sum, (62b) is infelicitous because the embedded question does not satisfy Dayal’s presupposition, and this presupposition failure is inherited by the factive \textit{know}.

1.5.4. Analysis

Given that higher-order answers are only available in questions with number-neutral or plural \textit{wh}-items, we can conclude that a live-on set of a \textit{wh}-item includes higher-order elements if and only if the denotation of its NP-complement is closed under sum operation. For this reason, I propose that the lexicon of a \textit{wh}-closure contains a dagger ($\dagger$)-operation. The $\dagger$-operation closes a set under generalized conjunction and disjunction if and only if this set is closed under sum, as schematized in (64) using set-theoretical notations.

\textsuperscript{15}Dayal’s presupposition is too strong to rule in mention-some readings of questions (see section 2.5.1). Hence in Chapter 3, I weaken Dayal’s presupposition with a simple repair strategy using Montague’s LIFT-operation. This repair strategy preserves all the advantages of Dayal’s presupposition in predicting uniqueness.
(63) \[ \text{[which } A \text{]} = \lambda B. \exists \alpha \in [\!\! \dagger A \cap B \!\!] \]

(64) **The \( \dagger \)-operator**

\[
\dagger A = \begin{cases} 
\min\{X : A \subseteq X \land \forall \tau \forall Y_{(\tau, \ell)} [Y \subseteq X \to \forall Y \in X \land Y \in X]\} & \text{if } \not\! A = A \\
A & \text{otherwise}
\end{cases}
\]

(if \( A \) is closed under sun, then \( \dagger A \) is the minimal superset of \( A \) that is closed under conjunction and disjunction; otherwise \( \dagger A = A \).)

Conjunction and disjunction are defined cross-categorically as in (65), à la meet and join in Inquisitive Semantics (Ciardelli & Roelofsen 2015).

(65) **Conjunction and disjunction**

\[ \alpha_\tau \land \beta_\tau = \{ \langle P_{(\tau, st)}, w \rangle : P_w(\alpha) \cap \{ \langle P_{(\tau, st)}, w \rangle : P_w(\beta) \} = \lambda P_{(\tau, st)} \cdot \lambda w. P_w(\alpha) \land P_w(\beta) \]

\[ \alpha_\tau \lor \beta_\tau = \{ \langle P_{(\tau, st)}, w \rangle : P_w(\alpha) \cup \{ \langle P_{(\tau, st)}, w \rangle : P_w(\beta) \} = \lambda P_{(\tau, st)} \cdot \lambda w. P_w(\alpha) \lor P_w(\beta) \]

Adding this \( \dagger \)-operation to the lexicon of the \( \text{wh} \)-determiner predicts the desired live-on sets for \( \text{wh} \)-items. Singular \( \text{wh} \)-phrases and numeral-modified \( \text{wh} \)-phrases live on sets consisting of only individuals, as exemplified in (66a) and (66b), respectively. While bare \( \text{wh} \)-words and plural \( \text{wh} \)-phrases lives on sets consisting of not only individuals but also existential/universal generalized quantification over individuals, as exemplified in (66c).

(66) a. \( \text{BE([which person])} = \{ a, b, \ldots \} \)

b. \( \text{BE([which two people])} = \{ a \oplus b, b \oplus c, \ldots \} \)

\[
\text{BE([who])} = \text{BE([which people])} = \begin{cases} 
\{ a, b, \ldots, a \oplus b, \ldots \} \\
\{ a \land b, a \lor b, a \land a \oplus b, \ldots \} \\
(a \land b) \lor b, \ldots
\end{cases}
\]

39
If the live-on set of a *wh*-item have items of different types, the semantic type of the highest *wh*-trace determines the semantic type of the topical property. This is so because the input and output of \textsc{Bedom}(whP) are always of the same type. Consider the □-question (67) for a simple illustration. This question is ambiguous between an individual reading (67a) and higher-order reading (67b), as Spector (2007, 2008) observes. Using the proposed analysis, we can reduce this ambiguity to a structural ambiguity within the question nucleus, namely whether or not the *wh*-word takes an IP-internal QR before the *wh*-movement.

(67) What does John have to read?

a. ‘What is an item *x* such that John has to read *x*?’

```
\textbf{P: }\langle e,st \rangle
```

```
\langle \tau,\tau \rangle \quad \langle e,\tau \rangle
```

```
\textsc{Bedom} \quad \text{what} \quad \lambda x \quad \text{C'}
```

```
\text{IP} \quad \text{John has to read } x_e
```

b. ‘What is a generalized quantifier *\pi* such that John has to read *\pi*?’
If the phrase [BEDOM what] directly moves to the spec of the interrogative CP from its base position, as in (67a), then it has only one wh-trace which is of type $e$, and hence the topical property is only defined for elements of type $e$. Alternatively, if [BEDOM what] takes an IP-internal QR (from $x$ to $\pi$) before reaching the spec of the interrogative CP, hence it leaves a higher-order trace of type $\langle est, st \rangle$, and thus the topical property is a property of generalized quantifiers of type $\langle est, st \rangle$.  

Following Cresti (1995) and Rullmann (1995), we can say that the derivation of a higher-order reading involves semantic reconstruction:

(68) **Semantic reconstruction of wh-phrases**

---

16Spector (2007) uses a different way to capture the two distinct readings. He proposes that the $wh$-word *what* is lexically ambiguous: it can live on either a set of individuals or a set of increasing generalized quantifiers, as schematized in (1a) and (1b), respectively.

1. $[\text{what}, S] = \lambda p. \exists x [x \in \text{*thing*} \land p = [S]^{\neg \neg x}]$
2. $[\text{what}, G] = \lambda p. \exists X [\langle (e, c, t), \ell \rangle | X \text{ is increasing and its smallest live-on set belongs to } \text{*thing*} \land p = [S]^{G-X}]$

In comparison, the proposed analysis poses no lexical ambiguity in *what*, but instead attributes the ambiguity to a structural ambiguity within the question nucleus.
The movement of the *wh*-phrase creates an individual trace \( x \) (of type \( e \)) and a higher-order trace \( \pi \) (of type \( \langle \text{ext, st} \rangle \)), and then the compositional interpretation assigns the *wh*-phrase the logical scope corresponding to the site of \( \pi \), yielding a reconstructed reading.

It remains open, however, whether the lexicon of *some* also contains a \( \dagger \)-operator. The sentence (69) is true under the discourse that John’s only reading obligation is ‘Syntax or Morphology’. If the live-on set of *some books* consists of only individual books, the desired interpretation would be obtained by interpreting *some books* below the necessity modal, as in (69a). If the live-on set of *some books* is the same as that of *which books*, we would also have the option of interpreting *some books* with a wide scope, as in (69b). So far I see no reason to rule out any of these options.

(69) John has to read some books.

   a. \( \Box \exists x.[*\text{book}_0(x) \land \text{read}_0(j,x)] \)
   
   b. \( \exists \pi(\langle \text{ext, st} \rangle).[\dagger *\text{book}^\prime(\pi) \land \Box (\lambda x.\text{read}_0(j,x))] \)

### 1.6. Summary

Chapter 2 has presented a hybrid approach to compose the semantics of questions. This approach takes aspects from both Categorical Semantics and Hamblin-Karttunen Semantics. On the one hand, similar to Categorical Semantics, the hybrid approach defines question roots as topical properties, so that short answers and free relatives can be grammatically derived from question roots. On the other hand, like Karttunen Semantics, this
approach treats \textit{wh}-items as existential indefinites. The key technique for composing topical properties is a two-place operator $\text{BEDOM}$, which shifts a \textit{wh}-item into a type-flexible domain restrictor. I have also defined an answerhood to generate answer sets and to solve the problem of coordinating questions.

Moreover, based empirical evidence from $\Box$-questions and question with collective predicates, I showed that the live-on sets of plural and number-neutral \textit{wh}-items consist of not only individuals but also generalized conjunctions and disjunctions. To capture this observation, I added a $\dagger$-operator to the lexical entry of the \textit{wh}-determiner. This operator closes a set under conjunction and disjunction if and only if this set itself is closed under sum.

The idea of deriving answer sets out of properties or abstracts has already been explored in Partition Semantics and other recent works. But different from these approaches, the proposed analysis makes answerhood-operators be applied directly to topical properties, returning complete true answers. As I will show in Chapter 3, this characteristic is crucial in predicting uniqueness effects.

The rest chapters use the hybrid approach of question semantics as a canvas. But their core proposals, except the one on predicting uniqueness in Chapter 3, also apply to other frameworks of questions semantics (e.g., Hamblin-Karttunen Semantics).
Chapter 2

Mention-some questions
2.1. Introduction

This chapter is centered on the interpretations of \textit{wh}-questions like (70), which contains an existential priority modal.\footnote{Priority modals include bouletic, deontic, and teleological modals (Portner 2009).} For simplicity, I call questions of this sort $\Diamond$-questions. What makes $\Diamond$-questions special and puzzling is that they admit mention-some answers (Groenendijk & Stokhof 1984). For example, (70) can be properly answered by naming one of the qualified chair candidates. Hence we say that (70) can take a mention-some reading and call it a ‘mention-some question’. Moreover, (70) admits also mention-all answers and can be answered by specifying all the qualified chair candidates, and hence we say that its interpretation involves a mention-some/mention-all ambiguity.

(70) Who can chair the committee?

In most earlier works, mention-some readings were treated pragmatically and were not distinguished from partial readings, such as the one in (71).

(71) Who came, for instance?

Nevertheless, I show that mention-some readings behave differently from other non-exhaustive readings (such as partial readings and choice readings) in many respects. For instance, unlike a partial answer, a mention-some answer takes a particular form of non-exhaustivity: it specifies exactly one of the possible choices. To this extend, mention-some readings are exclusive to $\Diamond$-questions. Hence, we must pursue a structural approach to predict the limited distribution of mention-some and explain the mention-
some/mention-all ambiguity.

The proposed analysis of mention-some and conjunctive mention-all succeeds and refines the proposal made by Fox (2013). Moreover, I present a simple way to derive disjunctive mention-all, based by observations with the Mandarin particle *dou*: *dou* behaves as an exhaustivity-marker in $\Diamond$-questions and triggers universal free choice inferences in disjunctive declaratives.

At the end of this chapter, I compare my $O_{DOU}$-operator, namely the covert counter-part of *dou*, with other two exhaustifiers that have been employed in deriving free choice inferences, including Fox’s (2007) recursive exhaustifier, and Chierchia’s (2006, 2013) pre-exhaustification operator for domain alternatives.

### 2.2. What is a mention-some reading?

Most *wh*-questions admit only exhaustive answers. For example, to properly answer the question (72), the addressee needs to specify all the actual attendants to the party, as in (72a). If the addressee does not have enough knowledge about this question and can only provide a non-exhaustive answer, he would have to flag the incompleteness of his answer in some way. For instance, he can mark his answer with a prosodic rise-fall-rise (RFR) contour, as in (72b). This RFR contour involves a rising accent on *John*, followed by a fall, and then a final rise at the end of the utterance (in the following indicated by ‘.../’). Given this difference, we call (72a) a *complete answer* while (72b) a *partial answer*. If a partial answer is not properly marked, such as taking a falling tone as in (72c) (in the following indicated by ‘\’), it gives rise to an undesired exhaustivity inference.
(72) Who went to the party?

(w: only John and Mary went to the party.)

a. John and Mary.

b. John did .../ $\leadsto$ I don’t know who else did.

\[ \text{L.H* L-H\%} \]

c. # John did.\ $\leadsto$ Only John did.

\[ \text{H* L-L\%} \]

Nevertheless, as firstly observed by Groenendijk & Stokhof (1984), $\Diamond$-questions admit not only exhaustive answers but also non-exhaustive answers. For instance, the $\Diamond$-question in (73) can be naturally answered by specifying one of the chair candidates, as in (73a). Crucially, while being non-exhaustive, the answer (73c) does not need to carry an ignorance mark: it does not yield an exhaustivity inference even if taking a falling tone. Moreover, an exhaustive answer of (73) can take either a conjunctive form as in (73b), or a disjunctive form as in (73c).\(^2\)

(73) Who can chair the committee?

(w: only John and Mary can chair; single-chair only.)

a. John can.\ $\not\rightarrow$ Only John can chair.

b. John and Mary.\ 

\[ \text{H* L-L\%} \]

\(^2\)Notice that in (73) only an elided disjunctive answer can take an exhaustive reading. Compare, the following full disjunctive answer takes only an ignorance reading.

(1) John or Mary can chair the committee. $\leadsto$ Only one of them can chair, but I don’t know which.
Since it remains controversial whether (73c) is complete or partial, we tag the answers in (73a-c) with respect to a different dimension. (73a) is a mention-some answer, since it specifies only some chair candidate; while (73b-c) are mention-all answers, since they specify all of the chair candidates. Questions admitting and rejecting mention-some answers are called mention-some questions and mention-all questions, respectively. The readings under which a question admits mention-some answers are called mention-some readings.

In addition to the ones in discourse, questions in indirect questions and free relatives also systematically admit mention-some readings, as exemplified in (74) and (75), respectively. In those embeddings, whether the embedded question admits mention-some directly affects the truth conditions of the matrix sentence.

(74) Indirect questions


~~ For every individual x, if x arrived, Jack knows that x arrived.

b. Jack knows who can chair the committee.

~~ For some individual x such that x can chair the committee, Jack knows that x can chair the committee.

(75) Free relatives

a. John ate what Mary cooked for him.

~~ John ate everything that Mary cooked for him.

b. John went to where he could get help.

~~ John went to some place where he could get help.
What’s more, mention-some readings of ◇-questions are also found in “question-answer clauses” (QACs) in American Sign Language (Davidson et al. 2008; Caponigro & Davidson 2011). A QAC is uttered by the very same signer. It consists of two parts, namely a question constituent which looks like an interrogative clause conveying a question, and an answer constituent which resembles a propositional answer or a short answer to that question. As shown below, just like their corresponding discourse-level question-answer pairs in (a), the answer constituent of each QAC in (b) can be mention-some iff the question constituent resembles a ◇-question.

(76) (w: John bought a book and a CD, and a DVD.)

a. Signer A: JOHN BUY WHAT?

‘John bought what?’

Signer B: #BOOK.

‘Book.’

b. JOHN BUY WHAT, # BOOK.

‘What John bought is a book.’

(77) (w: There are two coffee places nearby, Starbucks and Peet’s.)

a. Signer A: CAN FIND COFFEE WHERE?

‘Where can you find coffee?’

Signer B: STARBUCKS.

‘Starbucks.’

b. CAN FIND COFFEE WHERE, STARBUCKS.

‘You can find coffee at Starbucks.’
It is important to notice that the form of non-exhaustivity involved in mention-some readings of ▷-questions is quite unique: a mention-some answer specifies exactly one of the possible options. Hence, it is more precise to call mention-some “mention-one”. In replying a ▷-question, if an answer provides multiple choices and is not ignorance-marked, it will be interpreted exhaustively, as shown in (78b). Moreover, the embedded ▷-question in (79) admits a “mention-one” reading (79b) but not a “mention-three” reading (79c). I will return to this point in section 2.4.1.

(78) Who can chair the committee?
   a. Andy. \(\rightarrow\) Only John can chair.
   b. Andy and Billy. \(\sim\) Only John and Billy can chair.

(79) John knows who can chair the committee.
   a. For some individual \(x\) such that \(x\) can chair, John knows that \(x\) can chair. (OK)
   b. For every individual \(x\), if \(x\) can chair, John knows that \(x\) can chair. (OK)
   c. For some three individuals \(xyz\) such that \(xyz\) each can chair, John knows that \(xyz\) each can chair. (#)

The mention-some reading of a ▷-question can be blocked under three conditions. First, it is blocked if the conversational goal explicitly or implicitly requests an exhaustive answer. For instance in (80), the chair of the job search committee expected the assistant to list out all the candidates who can teach Experimental Semantics; hence an answer without an ignorance mark would be understood exhaustively.

(80) (Context: In making the final decision of a job search, the committee decided to consider only candidates who can teach Experimental Semantics or Field Methods.)
Chair: “Who can teach Experimental Semantics?”

Assistant: “John can.

Among the candidates, only John can teach Experimental Semantics.

Second, mention-some is blocked when an **exhaustivity marker** appears above the existential modal. Exhaustivity markers are found cross-linguistically, such as English *all* in a variety of dialects, German particle *alles*, and Mandarin particle *dou*. For instance, the following (a) questions each demands an exhaustive list of individuals who can teach Introduction to Linguistics, and the following (b) questions each requests an exhaustive list of coffee places in the surroundings.

(81) English *all* (Texan English)

a. Who *all* can teach Introduction to Linguistics?

b. Where *all* can we get coffee around here?

(82) German *alles*

a. Wer kann *alles* Einführung in die Sprachwissenschaft unterrichten?  
   who can all introduction into the linguistics teach  
   ‘Who all can teach Introduction to Linguistics?’

b. Wo kann ich hier überall Kaffee bekommen?  
   where can I here everywhere coffee get  
   ‘Where all can we get coffee around here?’

(83) Mandarin *dou*

---

3I thank Christopher Davis and Robert Henderson for the data.

4I thank Manuel Križ for the data.
(84)  a. Which candidate can teach Morphology?
  \[\sim \text{Only one of the candidates can teach Morphology.}\]

  b. Which two candidates can teach Morphology?
  \[\sim \text{Only two of the candidates can teach Morphology.}\]

To some up, mention-some readings of questions have three characteristics. First, they are systematically available not only in root questions but also in embedded questions (e.g., indirect questions, free relatives, and QACs in ASL). Second, they express a particular form of non-exhaustivity; namely, a mention-some answer specifies exactly one of the possible choices. Third, they can be blocked by exhaustive conversational goals and grammatical factors, such as the presence of exhaustivity-markers and uniqueness effects of singular or numeral-modified \textit{wh}-items.
2.3. **What is not a mention-some reading?**

In addition to $\diamond$-questions, questions with a partiality-marker (e.g., *for example*) (called *EX-questions* henceforth) and questions with an existentially quantificational expression (called $\exists$-questions henceforth) also admit non-exhaustive readings. For instance, the *EX*-question (85) only requests to name some of the party attendants; the $\exists$-question (86) demands just a list of individuals that were voted for by some particular professor.

(85) Who came to the party, *for example*?

(86) Who did one of the professors vote for?

Nevertheless, the non-exhaustive readings of *EX*-questions and $\exists$-questions differ from mention-some readings of $\diamond$-questions in many respects. Hence, I do not consider them as mention-some readings, but instead “partial readings” and “choice readings”, respectively.

### 2.3.1. EX-questions with partial readings

Unlike $\diamond$-questions, *EX*-questions can rarely occur in embeddings. In (87), presence of the partiality-marker *for example* makes these sentences ungrammatical.\(^5\)

---

\(^5\) Beck & Rullmann (1996) find out that some partiality-markers, such as Dutch *zoal* and German *so*, are acceptable in embeddings, as exemplified below.

(1) Jan wil weten wie er *zoal* (niet) op het feest waren.
   Jan wants know who there ZOAL (not) at the party were
   ‘John wants to know who for example were (not) at the party’

(2) Hans will wissen, wer *so* (?nicht) auf dem Fest war.
   Hans wants know who SO (not) at the party was
(87)  
  a. John knows who (*for example) came to the party.
  b. John ate what (*for example) Mary bought.

Therefore, it is more appropriate to treat *for example* as a discourse expression outside the root denotation: it signals that the questioner is tolerant of partial answers.

Moreover, the partial reading of an EX-questions and the mention-some reading of a ◊-questions involve different forms of non-exhaustivity. As discussed in section 2.2, mention-some readings rule in only non-exhaustive answers that specify exactly one of the available choices, or say “mention-one answers”. In contrast, partial readings admit any non-exhaustive answers. For example, in replying to the EX-question in (88), the addressee is free to name any number of attendants: (88a) names one attendant while (88b) names two. Moreover, regardless of how many attendants an answer specifies, this answer does not give rise to an exclusive inference.

(88)  Who went to the party, for example?
  a. John.\(\) \(\not\rightarrow\) Only John did.
  b. John and Mary.\(\) \(\not\rightarrow\) Only John and Mary did.

2.3.2. \(\exists\)-questions with choice readings

There are, quite generally, two main paths to the non-exhaustive readings of \(\exists\)-questions. One path is to treat them as mention-some readings, derived in the same way as the
mention-some readings of ◇-questions (George 2011; Fox 2013). This path is motivated by the fact that ◇-questions and ∃-questions both contain expressions of existential quantification force, namely existential modals and existential generalized quantifiers, respectively. The other path, which I will pursue in Chapter 6, is to treat them as choice readings (Groenendijk & Stokhof 1984), on a par with the pair-list readings of questions with universal quantifiers, abbreviated as ∀-questions henceforth. The following discusses empirical facts in favor of the second path.

On the one hand, unlike mention-some readings of ◇-questions, choice readings of ∃-questions are not blocked by the presence of an exhaustivity-marker or uniqueness effects of singular wh-phrases, as shown in (89). In (89a), the presence of all marks local exhaustivity, which demands the addressee to provide an exhaustive list of candidates that one particular student voted for. Likewise in (89b), the uniqueness inference triggered by the singular wh-phrase is assessed beneath the existential quantifier (Fox 2013); it does not imply that only one of the candidates got votes from the students, but instead that one of the students voted for only one of the candidates. In contrast, in the case of the ◇-question (90), exhaustivity and uniqueness take effects above the existential modal and therefore block mention-some.

\[(89) \quad ∃\text{-questions}\]

\[a. \quad \text{Who all did one of the students vote for?} \quad (∃ > all)\]

\[\leadsto \text{As for one of the students, who are all the individuals that he voted for?}\]

\[b. \quad \text{Which candidate did one of the students vote for?} \quad (∃ > ◇)\]

\[\leadsto \text{As for one of students, who is the unique person that he voted for?}\]
(90) \Diamond\text{-questions}

a. Who all can teach Introductory Chinese? \quad (all > \Diamond)
\sim Who are all the individuals that can teach Introductory Chinese?

b. Which person can teach Introductory Chinese? \quad (\iota > \Diamond)
\sim Who is the unique person that can teach Introductory Chinese?

On the other hand, choice readings of \(\exists\)-questions and pair-list readings of \(\forall\)-questions have similar distributions. Both readings exhibit a subject-object/adjunct asymmetry (Chierchia 1991, 1993): they are more likely to be available when the quantifier serves as the subject and c-commands the \textit{wh}-trace at the object or an adjunct position. For instance, the examples in (91a) illustrate the subject-object asymmetry in choice readings: (91a-i) accepts choice readings, and here the existential quantifier \textit{one of the students} serves as the subject, c-commanding the object \textit{wh}-trace; while (91a-ii) can hardly get choice readings, and here the \textit{wh}-phrase is moved from the subject position.

(91) \textbf{Choice readings of} \(\exists\)-\textbf{questions}

a. Subject-Object

i. Which candidate did [one of the students] vote for? \quad \checkmark choice

ii. Which person voted for [one of the students]? \quad ?choice

b. Subject-Adjunct

i. At which station did [one of the guests] get gas? \quad \checkmark choice

ii. Which guest got gas at [one of the nearby stations]? \quad ?choice

(92) \textbf{Pair-list readings of} \(\forall\)-\textbf{questions}
a. Subject-Object
   
   i. Which candidate did everyone vote for? \(\checkmark\) pair-list
   
   ii. Which voter voted for every candidate? \(\times\) pair-list

b. Subject-Adjunct

   i. At which station did every guest get gas? \(\checkmark\) pair-list
   
   ii. Which guest got gas from every gas station? \(\times\) pair-list

2.4. Earlier approaches of mention-some

The availability of mention-some in \(\Diamond\)-questions challenges the traditional view that questions admit only exhaustive answers. Before getting into the details, we need to first figure out two basic issues, namely whether mention-some is semantically licensed, and whether the distribution of mention-some is grammatically constrained. Based on views and predictions on these two issues, I classify the previous approaches into the following three lines:

   **The pragmatic line:** Complete answers must be exhaustive. Mention-some answers are partial answers that are sufficient for the conversational goal behind the question. (Groenendijk & Stokhof 1984; van Rooij 2004; among the others)

   **The post-structural line:** Mention-some is semantically licensed but pragmatically restricted. Mention-some and mention-all are two independent readings derived via different operations on the root denotations of questions. (Beck & Rullmann 1999; George 2011: chapter 2)
The structural line: The mention-some/mention-all ambiguity is a result of a structural variation within the question nucleus. (Fox 2013)

<table>
<thead>
<tr>
<th></th>
<th>Pragmatic</th>
<th>Post-structural</th>
<th>Structural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mention-some is semantically licensed</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mention-some is grammatically restricted</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 2.1: Summary of current lines of approaches on mention-some

This section reviews the pragmatic line and the post-structural line. Both lines face the problem that they can only restrict the distribution of mention-some by pragmatic factors, which however are not restrictive enough.

2.4.1. The pragmatic line

Most works on questions consider only exhaustive answers as complete answers. Since mention-some answers are non-exhaustive, works holding this view attribute the acceptability of mention-some to pragmatic factors, such as the conversational goal of the question. Consider (93) for instance. If the goal is just to get some gas, the addressee only needs to name one accessible gas station; if the goal is to investigate the local gas market, the addressee needs to list out all the local gas stations.

(93) Where can I get gas?

This pragmatic treatment of mention-some was initiated by Groenendijk & Stokhof (1984) and continued popularity under various frameworks of questions. van Rooij (2004) devel-
ops a theory of utility which gives a formal characterization for the circumstances where mention-some is accepted and preferred.

A commonly seen criticism to the pragmatic view, pointed out by Groenendijk & Stokhof (1984) themselves and reiterated by George (2011), is that pragmatics cannot predict the availability of mention-some in embeddings. As seen in section 2.2, mention-some is available not only in root questions, but also in indirect questions, free relatives, and QACs. In responding to this concern, Ginzburg (1995), Lahiri (2002), and van Rooij & Schulz (2004) build contextual parameters into question denotations and encode sensitivity to the question goals. For instance, Lahiri (2002) proposes that interpreting an indirect question involves picking a sub-question, and that the size of this picked sub-question, compared with the size of the full question, needs to be large enough for the speaker’s purpose.

I do not object to the existence of contextual parameters in question interpretations. I also agree that pragmatics plays a role in distributing mention-some in several respects; for instance, if a question is semantically ambiguous between mention-some and mention-all, a conversational goal that calls for an exhaustive answer can block mention-some. Nevertheless, I doubt that pragmatics is restrictive enough to predict the very limited and systematic distribution of mention-some: mention-some is only available in \( \diamond \)-questions.

In the following, I provide two more empirical arguments against the pragmatic treatment of mention-some. Both arguments are related to what I call mention-intermediate answers. Those answers are, as the name implies, non-exhaustive answers that are stronger than mention-some answers. I show that the pragmatic view cannot capture the differences between mention-some and mention-intermediate: contrary to the case of mention-
some, mention-intermediate is unacceptable in root questions and embedded questions.

First, in answering a mention-some question, mention-intermediate answers, while being informative enough for the question goal, must be ignorance-marked. For instance, assume that the goal of asking (94) is to find a qualified person to chair the committee. Under a discourse where three individuals are qualified, a mention-some answer names one of the candidates, as in (94a), while a mention-intermediate answer names two of the candidates, as in (94b-c). Crucially, while both mention-some and mention-intermediate answers are sufficient for the question goal, the mention-intermediate answers must to be ignorance-marked; otherwise they yield an undesired exhaustivity inference, as seen in (94b’) and (94c’).

(94) Who can chair the committee?

(w: only John, Mary, and Sue can chair; single-chair only.)

a. John.\                  \{\rightonly John can chair.

b. John and Mary.../

b’ # John and Mary.\        \{\rightonly John and Mary can chair.

c. John or Mary.../

c’ # John or Mary.\        \{\rightonly John and Mary can chair.

The obligatory ignorance-marks on mention-intermediate answers suggest the following: in responding to a ◇-question, whether an answer can be interpreted inclusively is primarily determined by the grammatical structure of this answer, rather than the question goal. When taking a falling tone, simple individual answers like (94a) can be interpreted inclusively, while answers taking a conjunctive form or a disjunctive form like (94b-c)
admit only exhaustive readings.

Second, interpretations of indirect questions show that good answers are always “mention one (group)” or “mention all (groups)”, as exemplified in (95a)/(96a) and (95b)/(96b), respectively. The conversational goal of a question, however, can be any “mention N (groups)” where $N$ is a number in the available range. For instance, assume that the dean wants to meet with three chair candidates so as to make plans for the committee, then the goal of the embedded question in (95) would be “mention three”. A pragmatic account predicts (95) to take the mention-three reading (95c), which however is infeasible. A semantic account does not have this prediction: complete answers derived from the possible logical forms of a mention-some question are either mention-one or mention-all, not mention-intermediate.

(95)  John knows who can chair the committee.

    a.  *For some individual $x$ such that $x$ can chair, John knows that $x$ can chair.* (OK)

    b.  *For every individual $x$, if $x$ can chair, John knows that $x$ can chair.* (OK)

    c.  *For some three individuals $xyz$ such that $xyz$ each can chair, John knows that $xyz$ each can chair.* (#)

(96)  John knows who can form the committee.

    a.  *For some group of individuals $X$ s.t. $X$ together can form the committee, John knows that $X$ together can form the committee.* (OK)

    b.  *For every group of individuals $X$, if $X$ together can form the committee, John knows that $X$ together can form the committee.* (OK)

    c.  *For three groups of individuals $XYZ$ s.t. each group among $XYZ$ can form the com-
mittee, John knows that each group among XYZ can form the committee. (#)

2.4.2. The post-structural line

Another commonly seen line, which I call “the post-structural line”, treats mention-some as an independent reading on a par with mention-all. Approaches following this line are sometimes referred to as “semantic approaches”, to the extend that they acknowledge the existence of mention-some in semantics. But I call them “post-structural approaches” so as to distinguish them from the structural approaches. Structural approaches attribute the mention-some/mention-all ambiguity to the structural ambiguity within the question nucleus, which is structurally contained within the root denotation; while post-structural approaches attribute this ambiguity to an operation outside the nucleus or even outside the root denotation.

The rest of this section briefly reviews two representative post-structural approaches, including Beck & Rullmann (1999) and George (2011: chapter 2). Beck & Rullmann attribute the mention-some/mention-all ambiguity of *wh*-questions to answerhood-operators with different quantificational force. While George’s system has only one existential answerhood-operator, and he attributes the ambiguity to the optional use of a strengthening operator within the root denotation.

Beck & Rullmann (1999) assume that the root denotation of a question is the Hamblin-Karttunen intension (of type $\langle s, stt \rangle$), namely a function from a world to the set of propositional answers that are true in this world. The root denotation $Q$ can be operated by different answerhood-operators, yielding different readings. Employing $\text{ANS}_{BR_1}$ returns the
conjunction of all the true propositional answers, yielding a mention-all answer. While employing the higher-order Ansbr3-operator shifts the root denotation into an existential generalized quantifier over a family of sub-question intentions.

(97)  
\[ \text{a. } \text{Ans}_{BR3}(Q)(w) = \cap \{p : Q(w)(p) \land p(w)\} \quad (\text{for mention-all}) \]

\[ \text{b. } \text{Ans}_{BR3}(Q)(w) = \lambda P_{(s, \text{str})}. \exists p[P(w)(p) \land Q(w)(p) \land p(w)] \quad (\text{for mention-some}) \]

As exemplified in (98), interpreting an embedded mention-some question involves quantifier-raising the entire type-shifted question. The existential quantification force within Ansbr3 introduces mention-some.

(98) John knows Q_{MS}.

\[
S: t \\
\exists p[\text{know}_w(j, p) \land Q(w)(p) \land p(w)]
\]

\[
\lambda P_{<s, \text{str}>}. \exists p[P(w)(p) \land Q(w)(p) \land p(w)] \quad \langle s, \text{str} \rangle
\]

\[\text{Ans}_{BR3}(Q)(w) \quad \text{John knows } p\]

The account proposed by George (2011: chapter 2) involves two stages in the question formation, including an abstract formation which denotes the intension of a lambda abstract Abs, and a question formation which produces a set of possible answers via a question-formation operator Q. The mention-some/mention-all ambiguity comes from the absence/presence of a strengthening operator X between Abs and Q, as illustrated in (99).
(99) Who came?

a. \([\text{Abs}] = \lambda x. \text{people}'\_\@)(x) \land \text{came}'\_\@)(x)\]

b. \([\text{Q}] = \lambda \alpha(x, \tau) \lambda p \exists \beta (p = \lambda w. \alpha(w(\beta)))\]

c. \([\text{X}] = \lambda \gamma \lambda \delta (\delta = \gamma)\]

When the \(\text{X}\)-operator is absent, question formation delivers the Hamblin set, as schematized in (100a). When the \(\text{X}\)-operator is present between \(\text{Abs}\) and \(\text{Q}\), question formation delivers a partition, or equivalently, a set of exhaustified propositions of the form that “only the individuals in \(\beta\) came”, as schematized in (100b). Finally, answerhood operation unambiguously applies existential quantification over the output Hamblin set or partition, yielding mention-some and strongly exhaustive, respectively.\(^6\)

(100) a. Without \(\text{X}\): mention-some

\[\text{[Q(Abs)]} = \lambda p(x, \tau) \exists \beta_c[p = \lambda w. \text{people}'(\beta) \land \text{came}'(\beta)]\]

\[= \{\lambda w. \text{people}'(\beta) \land \text{came}'(\beta) : \beta \in D_c\}\]

\[= \{\text{came}'(\beta) : \beta \in \text{people}'\}\]

b. With \(\text{X}\): strongly exhaustive

\[\text{[Q(X(Abs))]} = \lambda p(x, \tau) \exists \beta_{(x, \tau)}[p = \lambda w (\lambda x. \text{people}'(x) \land \text{came}'(x) = \beta)]\]

\[= \{\lambda w (\lambda x. \text{people}'(x) \land \text{came}'(x) = \beta) : \beta \in D_{(x, \tau)}\}\]

Regardless of the technical details, post-structural approaches all face the problem that they do not restrict the availability of mention-some grammatically. For instance,

\(^6\)A non-trivial assumption that George (2011: chapter 2) makes is that mention-some and weakly exhaustive are the same reading, derived in absence of the \(\text{X}\)-operator.
no grammatical factor blocks the use of Beck & Rullmann’s ANSBR₃-operator or forces the presence of George’s X-operator. Hence, post-structural approaches predict that mention-some is always semantically licensed, and that its limited distribution come from pragmatic restrictions. These predictions, however, lead to the very same problems that we just saw with the pragmatic line.

2.5. **A structural approach: Fox (2013)**

The structural line attributes the interpretation ambiguity of a question to a structural variation within the question nucleus. George (2011: chapter 6) proposes the first grammatical treatment of mention-some/mention-all ambiguity. But this treatment only applies to \( \exists \)-questions, which however are not considered as mention-some questions in this dissertation, as seen in section 2.3.2. As far as I know, only Fox (2013) has made a structural treatment for the mention-some/mention-all ambiguity in \( \Diamond \)-questions.\(^7\) This treatment has two major assumptions. First, any maximally informative true answer counts as a complete true answer. Second, the mention-some/mention-all ambiguity comes from the scope ambiguity of distributivity with the question nucleus.

2.5.1. **Completeness and Answerhood**

Earlier works assume that complete answers are always exhaustive. As one of the most popular views, Dayal (1996) assumes that a complete true answer is the *strongest true* answer.

\(^7\)Since Danny Fox has not written out his analysis into a paper by the time when this dissertation gets started, the work ‘Fox (2013)’ refers to the handouts of a series of lectures on mention-some that he gave since 2013 at MIT and other occasions. Please be aware of any updates.
answer, namely the unique true answer that entails all the true answers. This view of completeness leaves no space for mention-some, as we saw in section 2.4.1. To rule in mention-some answers as complete answers, Fox (2013) weakens the definition of completeness and proposes that any maximally (max)-informative true answer counts as a complete true answer. A true answer is max-informative as long as it is not asymmetrically entailed by any of the true answers.

(101) Given a set of propositions $\alpha$,

a. the **strongest member** of $\alpha$: $\{ p \in \alpha \land \forall q [q \in \alpha \rightarrow p \subseteq q] \}$

(The unique member that entails all the members of $\alpha$.)

b. the **max-informative members** of $\alpha$: $\{ p : p \in \alpha \land \forall q [q \in \alpha \rightarrow q \notin p] \}$

(The members that are not asymmetrically entailed by any members of $\alpha$.)

For a simple illustration of the two notions in (101a-b), compare the two proposition sets in (102). Set $\alpha$ is closed under conjunction; it has only one max-informative member, which is also the strongest member. Set $\beta$ has no strongest member but two max-informative members.

(102) Let $p$ and $q$ be two semantically independent propositions

a. $\alpha = \{ p, q, p \land q \}$

i. The strongest member of $\alpha$: $p \land q$

ii. The max-informative member(s) of $\alpha$: $p \land q$

b. $\beta = \{ p, q \}$

i. The strongest member of $\beta$: None
The comparison in (102a) shows that the two views of completeness by Dayal and Fox make no difference in cases where the answer space is closed under conjunction. But, defining completeness as max-informativity leaves space for mention-some: it allows non-exhaustive answers to be complete and a question to have multiple complete true answers. Under Fox’s view, a mention-some answer is a maxi-informative true answer that is non-exhaustive, a question is interpreted as mention-some if it can have multiple max-informative true answers, and a question does not take mention-some if its answer space is closed under conjunction.

Using the weaker definition of completeness, Fox defines the answerhood-operator as in (103): the root denotation of a question is a Hamblin set; $\text{ANS}_{\text{Fox}}$ applies to the Hamblin set $Q$ and the evaluation world $w$, returning the set of max-informative true answers of $Q$ in $w$. A question is interpreted as mention-some if and only if the output set of employing $\text{ANS}_{\text{Fox}}$ can be non-singleton.

\begin{equation}
\text{ANS}_{\text{Fox}}(Q)(w) = \{ p : w \in p \in Q \land \forall q[w \in q \in Q \rightarrow q \notin p]\}
\end{equation}

\begin{align*}
(p : p \text{ is true answer of } Q \text{ in } w; \text{ and } p \text{ is not asymmetrically entailed by any of the true answers of } Q \text{ in } w. \})
\end{align*}

### 2.5.2. Deriving the ambiguity

Fox (2013) attributes the mention-some/mention-all ambiguity to the scopal ambiguity of distributivity: in a $\Diamond$-question, mention-some is available when distributivity takes scope below the existential modal, and is blocked otherwise.
This proposal is inspired by observations with the particle *alles* in Austrian German: as exemplified in (104), the presence of *alles* above the existential modal blocks mention-some (Martin Hackl and Manuel Križ p.c. to Fox 2015). This contrast is also observed with the distributor *all* in several English dialects.

(104)   a. \( (\text{all} > \Diamond > \text{with \( \mathbf{€} 3\) }) \)

> Was *alles* kann ich mit 3 Euro kaufen?
What *alles* can I with 3 Euro buy

> ‘What are all the things that I can buy for \( \mathbf{€} 3\).’ (mention-all)

b. \( (\Diamond > \text{with \( \mathbf{€} 3\) > all}) \)

> Was kann ich *alles* mit 3 Euro kaufen?
What can I all with 3 Euro buy

> ‘What is a set of items s.t. with \( \mathbf{€} 3\) I can buy them all?’ (mention-some)

Given the contrast above, Fox adds a covert distributor *EACH* to the LF as a phrase-mate of the *wh*-trace *X*. *EACH* distributes over the atomic subparts of *X*:

(105) \[ [X \text{ EACH}] = \lambda f(x,t). \forall x \leq X[\text{ATOM}(x) \rightarrow f(x)] \]

In a \( \Diamond \)-question, the distributive phrase ‘*X EACH*’ flexibly takes scope above or below the existential modal. As an illustration, the two LFs in (106) for the question nucleus differ only with respect to the scope of ‘*X EACH*’ relative to the modal *can*.

(106)   a. Who can chair the committee?

   a. Global distributivity

   b. Local distributivity
The two LFs yield the Hamblin sets in (107a) and (107b), respectively. For a more intuitive comparison, see the two pictures in (108). Each square stands for an answer space (viz., a Hamblin set); shading marks the true answers; underlining marks the max-informative true answers; arrows indicate entailments.

(107)  a. \{EACH(X)(\lambda x. chair'(x)) : X \in people'@\}           \text{Global distributivity}

 b. \{\Diamond EACH(X)(\lambda x. chair'(x)) : X \in people'@\}           \text{Local distributivity}

(108)  \text{(w: only Andy and Billy can chair the committee; single-chair only.)}

\begin{tabular}{ll}
\text{a. Global distributivity}    & \text{b. Local distributivity} \\
\begin{tikzpicture}[scale=0.8]
    \node (1) at (0,0) {$\Diamond f(a) \land \Diamond f(b)$};
    \node (2) at (1,0) {$\Diamond f(a)$};
    \node (3) at (2,0) {$\Diamond f(b)$};
    \draw[->] (1) -- (2);
    \draw[->] (1) -- (3);
    \draw[<-] (2) -- (3);

    \node (4) at (0,-1) {$\Diamond f(a)$};
    \node (5) at (1,-1) {$\land$};
    \node (6) at (2,-1) {$\Diamond f(b)$};
    \draw[->] (4) -- (5);
    \draw[->] (5) -- (6);
\end{tikzpicture} & \begin{tikzpicture}[scale=0.8]
    \node (1) at (0,0) {$\Diamond [f(a) \land f(b)]$};
    \node (2) at (1,0) {$\Diamond f(a)$};
    \node (3) at (2,0) {$\Diamond f(b)$};
    \draw[->] (1) -- (2);
    \draw[->] (1) -- (3);
\end{tikzpicture}
\end{tabular}

The answer space in (108a) is closed under conjunction; hence it has and can have only one max-informative true answer, yielding a mention-all reading. In contrast, the answer space (108b) is not closed under conjunction due to the entailment asymmetry in \Diamond\text{-environments (namely, } [\Diamond f(a) \land \Diamond f(b)] \nRightarrow \Diamond [f(a) \land f(b)])\text{; it has two max-informative true answers in the given discourse, yielding a mention-some reading.}

Fox has considered only questions with distributive predicates. In case distributivity distributes down to subgroups instead of atoms, an easy revision would be to re-
place EACH with the generalized distributor $D$ (Schwarzschild 1996). This $D$-operator distributes over subgroups of the $wh$-trace $X$ that are members of the contextually determined cover variable $Cov$:

\[
[X \, D] = \lambda f(x), \forall x \leq x \in Cov \rightarrow f(x)
\]

where $Cov$ is a contextually determined cover of $X$

2.5.3. **Advantages and remaining issues**

Fox’s (2013) treatment of mention-some makes two major breakthroughs. First, mention-some answers and mention-all answers are uniformly treated as complete answers. Compared with the pragmatic approaches, this treatment captures the systematic availability of mention-some in root and embedding environments. Second, mention-some and mention-all are derived via employing the very same $ANS$-operator; the mention-some/mention-all ambiguity comes from a structural variation within the question nucleus. Compared with the post-structural approaches, this treatment provides a grammatical constraint as to the distribution of mention-some: mention-some is possible only when an answer space is not closed under conjunction.

This analysis still has a couple remaining issues. First of all, as pointed out by Fox himself, allowing a question to have multiple max-informative true answers makes it difficult to predict the uniqueness effects of singular and numeral-modified $wh$-questions.

As we saw briefly in section 2.2, questions with a singular or numeral-modified $wh$-phrase can have only one true answer. For instance, (110a) is incoherent because the singular question evokes a uniqueness inference that *only one of the boys came to the party*, which
contradicts the second clause; in contrast, this incoherency disappears if the singular wh-phrase *which boy* is replaced with the plural one *which boys* or the bare wh-word *who*.

(110)  a. “Which boy came to the party? # I heard that many boys did.”

   b. “Which boys came to the party? I heard that many boys did.”

   c. “Who (among the boys) came to the party? I heard that many boys did.”

Dayal (1996) captures this uniqueness effect using a presuppositional $\text{ANS}_{\text{Dayal}}$-operator: $\text{ANS}_{\text{Dayal}}(Q|w)$ presupposes the existence of the strongest true answer of $Q$ in $w$. In a singular question, this presupposition is not satisfied if this question has multiple true answers, which therefore gives rise to a uniqueness effect. Clearly, the presupposition of $\text{ANS}_{\text{Dayal}}$ cannot be directly incorporated into Fox’s analysis of mention-some: for Dayal, to avoid a presupposition failure, a question must have a unique strongest true answer; while for Fox, to get a mention-some reading, a question needs the possibility of having multiple max-informative true answers instead of a unique strongest true answer. To solve this dilemma, Fox (2013) proposes a weaker presupposition using innocently exclusive exhaustifications. But this solution still faces some problems. I will discuss this dilemma in more details and offer a solution in Chapter 3.

Second, in certain cases, good mention-some answers are predicted to be partial answers. Consider the $\Diamond$-question (111) for instance. Intuitively speaking, both (111b-c) are good mention-some answers; but with a monotonic predicate *serve on the committee*, (111b) is asymmetrically entailed by (111c) and hence would be predicted to be a partial answer under Fox’s analysis. In section 2.6.1, I refine Fox’s analysis of mention-some and solve this problem by inserting a local exhaustifier below the existential modal.
Who can serve on the committee?

\(w: \text{the committee can be made up of Andy and Billy; it also can be made of Andy, Billy, and Cindy.}\)

a. \(\# \text{ Andy.} \quad \Diamond [\text{serve}'(a)]\)

b. \(\sqrt{\text{ Andy and Billy.}} \quad \Diamond [\text{serve}'(a) \land \text{serve}'(b)]\)

c. \(\sqrt{\text{ Andy, Billy, and Cindy.}} \quad \Diamond [\text{serve}'(a) \land \text{serve}'(b) \land \text{serve}'(c)]\)

Last, Fox has not discussed the derivation of mention-all answers taking disjunctive forms, which however are more commonly used than the conjunctive ones. In section 2.6.3, I offer an analysis of disjunctive mention-all based on empirical observations with the Mandarin particle \textit{dou}.

Who can chair the committee?

a. \text{John and Mary.} \quad \text{(conjunctive mention-all)}

b. \text{John or Mary.} \quad \text{(disjunctive mention-all)}

2.6. Proposal

In this section, I firstly refine Fox’s (2013) treatment of mention-some and then argue for two structural methods to derive mention-all readings. In particular, conjunctive mention-all is derived by interpreting the higher-order \textit{wh}-trace above the existential modal, and disjunctive mention-all is derived by employing a covert \(O_{\text{DOU}}\)-operator above the existential modal.
2.6.1. Deriving mention-some

I adopt Fox’s (2013) view that a max-informative true answer counts as a complete true answer. Adapting the definition of $\text{ANS}_{\text{Fox}}$ in (103) to the proposed hybrid semantics, I define the $\text{ANS}$-operator as in (113): $\text{ANS}$ applies to the topical property $P$ and the evaluation world, returning the set of max-informative true propositions in the range of $P$.

\[(113)\quad \text{ANS}(P)(w) = \{P(\alpha) : \alpha \in \text{Dom}(P) \land w \in P(\alpha) \land \forall \beta \in \text{Dom}(P)[w \in P(\beta) \rightarrow P(\beta) \notin P(\alpha)]\}\]

My treatment of mention-some is close to Fox’s (2013) in the sense that it also relies on the narrow scope interpretation of the $wh$-item; but my treatment has two different assumptions related to the structure of the question nucleus, as illustrated in (114).

\[(114)\quad \text{Who can chair the committee?} \]

First, the $wh$-phrase (in company with the $\text{BEDOM}$-operator) takes a mandatory local QR (from $x$ to $\pi$) before it moves to the spec of the interrogative CP. These movements create two $wh$-traces, namely an individual trace $x$ and a higher-order trace $\pi$. Second, the existential modal embeds an exhaustivity $O$-operator associated with the individual $wh$-trace $x$.  

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The local QR of the \textit{wh}-phrase is to rule in generalized conjunctions and disjunctions as possible answers. As we have seen in (67), the semantic type of a topical property is determined by the semantic type of the highest \textit{wh}-trace: if the \textit{wh}-item directly moves from the base position to spec of the interrogative CP, the topical property is a property of individuals and hence only individuals of type \textit{e} can be possible short answers; in contrast, if the \textit{wh}-item firstly takes a local QR, the domain of the topical property ranges over generalized conjunctions and disjunctions of type $\langle \textit{est}, \textit{st} \rangle$. The motivation for ruling in higher-order answers will be explained in Chapter 3: briefly, if a question does not have a strongest true answer, then it would be undefined unless the domain of its topical property includes generalized conjunctions.

The insertion of a local \textit{O}-operator is motivated by observations in cases like (111), repeated below. The contrast between (115a) and (115b-c) suggests that mention-some answers involve local exhaustivity: in (115), a good mention-some answer needs to specify the all the component members of a possible committee. Intuitively, (115b) means that it \textit{is possible to have only Andy and Billy serve on the committee}.

(115)  Who can serve on the committee?

\begin{quote}
(w: the committee can be made up of Andy and Billy; it also can be made of Andy, Billy, and Cindy.)
\end{quote}

\begin{itemize}
\item[a.] # Andy.\, $\diamondsuit O[serve'(a)]$
\item[b.] $\forall$ Andy and Billy.\, $\diamondsuit O[serve'(a \oplus b)]$
\item[c.] $\forall$ Andy, Billy and Cindy.\, $\diamondsuit O[serve'(a \oplus b \oplus c)]$
\end{itemize}

Following the \textit{grammatical view of exhaustifications} (Chierchia 2006, 2013; Fox 2007; Chier-
chia et al. 2013; Fox & Spector to appear; among the others), I capture the local exhaustivity by inserting a covert O-operator below the existential modal. This O-operator has a meaning close to the exclusive focus particle only; it affirms the prejacent and negates the alternatives that are not entailed by the prejacent.\[^8\]

\[(116) \quad O(p) = p \land \forall q \in \text{Alt}(p)\left[p \not\in q \rightarrow \neg q\right] \]

\[(p \text{ is true, and any alternative of } p \text{ that is not entailed by } p \text{ is false})\]

Inserting an O-operator rules out the infelicitous answer (115a): under the common knowledge that a committee consists of multiple members, it is impossible to have only Andy serve on the committee. Moreover, as a non-monotonic operator, this O creates a non-monotonic environment with respect to the individual wh-trace, which therefore makes (115b) semantically independent from (115c) and preserves (115b) as a max-informative true answer.

More generally speaking, the insertion of an O-operator ensures all the individual answers to be semantically independent, and then the presence of an existential modal ensures these answers NOT to be mutually exclusive. Hence, mention-some is available in \(\Diamond\)-questions. In comparison, if the existential modal is dropped or replaced with a universal modal, these locally exhaustified answers become mutually exclusive:

\[^8\]The alternatives associated with the individual wh-trace are the items of the same semantic type as \(t_{wh}\). The alternatives are composed point-wise in the same way as the alternatives of focus (Rooth 1985, 1992, 1996) and the Hamblin sets.

\[(1) \quad \begin{align*}
\text{a. } & \text{Alt}(t_{wh}) = \{a : \text{TYPE}(a) = \text{TYPE}(t_{wh})\} \\
\text{b. } & \text{Alt}(f(t_{wh})) = \{f(a) : a \in \text{Alt}(t_{wh})\}
\end{align*}\]
A concrete example for the derivation of mention-some is given in (118).

(118) Who can chair the committee?

\((w: \text{Only Andy and Billy can chair the committee; single-chair only.})\)

\[
\begin{align*}
\langle s, t \rangle \\
\text{f}_{ch} & \quad \langle st, t \rangle \\
\text{ANS} & \quad w \\
\text{P: } & \quad \langle \langle est, st \rangle, st \rangle \\
\text{BE} & \quad \text{Dom} \\
\lambda \pi & \quad \text{IP} \\
\text{who} & \quad \text{can} \\
\pi_{\langle est, st \rangle} & \quad \lambda x. O \text{chair}(x) \\
\end{align*}
\]

a. \[\text{[IP] } = \diamond \pi (\lambda x. O[\text{chair'}(x)]) \quad \text{(question nucleus)}\]

b. \[\text{[1] } = \lambda \pi_{\langle est, st \rangle}. \lambda w. \diamond w. \pi (\lambda x. O[\text{chair'}(x)])\]

c. \[\text{[who] } = \lambda f_{\langle \tau, \tau \rangle}. \exists x. [\lambda \text{people'@}(x) \land f(x)]\]

d. \[\text{[BE} \text{Dom}] = \lambda P. \lambda f_{\langle P \rangle}[[\text{Dom}(P) = \text{BE}(P)] \land \forall x \in \text{Dom}(P)[P(x) = f(x)]]\]

e. \[\text{[2] } = \lambda \theta_{\langle P \rangle}[[\text{Dom}(P) = \lambda \text{people'@} \land \forall x \in \text{Dom}(P)[P(x) = \theta(x)]]\]

f. \[\text{P } = \lambda \pi_{\langle est, st \rangle}. \lambda w_{\langle \rangle}. \lambda \text{people'@}(\pi) \land \diamond w. \pi (\lambda x. O[\text{chair'}(x)]) \quad \text{(root denotation)}\]
g. \( \text{ANS}(P)(w) = \{\Diamond O[\text{chair}'(a)], \Diamond O[\text{chair}'(b)]\} \) (complete true answers)

The meaning of (118) proceeds as follows:

(i) At Node 1, abstracting over the question nucleus generates a total chairing-property of generalized quantifiers, as in (118a-b).

(ii) The \textit{wh}-word \textit{who} is an existential quantifier living on \( \uparrow \text{people}' \). This set consists of not only atomic and sum individuals in \textit{people}_@ but also conjunctions and disjunctions over these individuals. At Node 2, employing B\textsc{e}D\textsc{om} returns a domain restrictor, as in (118c-e).

(iii) Composing Nodes 1-2 via Functional Application derives the topical property \( P \), as in (118f). It is a partial chairing-property defined for conjunctions and disjunctions over human individuals of type \( \langle \text{est}, \text{st} \rangle \). The answer space yielded by \( P \) is illustrated in Figure 2.1: arrows indicate entailments; shading marks the true answers; underlining marks the max-informative true answers.

\[ \Diamond [Of(a) \land Of(b) \land Of(a \oplus b)] \]
\[ \Diamond [Of(a) \land Of(b)] \quad \Diamond [Of(a) \land Of(a \oplus b)] \quad \Diamond [Of(b) \land Of(a \oplus b)] \]
\[ \Diamond Of(a) \quad \Diamond Of(b) \quad \Diamond Of(a \oplus b) \]
\[ \Diamond [Of(a) \lor Of(b)] \quad \Diamond [Of(a) \lor Of(a \oplus b)] \quad \Diamond [Of(b) \lor Of(a \oplus b)] \]
\[ \Diamond [Of(a) \lor Of(b) \lor Of(a \oplus b)] \]

Conjunctive
(contradictory)

Individual
(independent)

Disjunctive
(partial)

Figure 2.1: Answer space of (118), where \( f = [\text{chair the committee}] \)

This answer space involves three types of answers, namely conjunctive answers (row
1-2), individual answers (row 3), and disjunctive answers (row 4-5). The conjunctive answers are all contradictory, due to the presence of the local $O$-operator. The individual answers are all semantically independent, and hence each true individual answer counts as a max-informative true answer. Disjunctive answers are asymmetrically entailed by some individual answers. Moreover, as illustrated in Figure 2.2, a disjunctive answer is semantically equivalent to the disjunction of the corresponding individual answers; hence, disjunctive answers are always partial: whenever a disjunctive is true, there must be a true individual answer that asymmetrically entails this disjunctive answer.

Figure 2.2: Disjunctive answers versus individual answers in mention-some

The overall shape of the answer space is independent from whether the predicate *chair the committee* is interpreted distributively or collectively; due to the non-monotonicity of the $O$-operator, the plural answer $\Diamond Of(a \oplus b)$ is semantically independent from the other individual answers.

(iv) Applying ANS to the topical property $P$ and the evaluation world $w$ returns a set of max-informative true answers in $w$, as in (118g). Each of these max-informative true answers counts as a complete true answer. Applying $f_{ch}$ picks out one of the max-informative true answers.
2.6.2. Conjunctive mention-all

Conjunctive mention-all answers are derived by moving the higher-order \( wh \)-trace \( \pi \) above the existential modal. Since the value of \( \pi \) can be a generalized conjunction, this approach is essentially the same as Fox’s (2013) idea of global distributivity, but it has the advantage of being applicable to questions with collective predicates.

As a simple illustration, the two LFs in (119) for the question nucleus differ only with respect to the scope of the higher-order \( wh \)-trace \( \pi \) relative to the modal \( \text{can} \).

(119) Who can chair the committee?

\[
\begin{align*}
\text{a. } & \quad \Diamond > \pi \\
\text{b. } & \quad \pi > \Diamond
\end{align*}
\]

\[
\begin{array}{c}
... \\
\text{IP} \\
\text{can} \\
\pi_{(est, st)} \\
\lambda x \quad O \\
\text{VP} \\
\overbrace{x \text{ chair}}^3
\end{array}
\]

The two LFs yield the topical properties in (120a) and (120b). The answer space yielded by these two topical properties are illustrate in (121a) and (121b), respectively: shading marks the true answers; underlining marks the max-informative true answers. For simplicity, I ignore answers about the plural individual \( a \oplus b \).

(120) \[
\begin{align*}
\text{a. } & \quad \lambda \pi_{(est, st)} \lambda w[\uparrow \text{people}'_{@}(\pi) \land \Diamond_w \pi(\lambda x. O[\text{chair}'(x)])] \\
& \quad \Diamond > \pi \\
\text{b. } & \quad \lambda \pi_{(est, st)} \lambda w[\uparrow \text{people}'_{@}(\pi) \land \pi(\lambda x. \Diamond_w O[\text{chair}'(x)])] \\
& \quad \pi > \Diamond
\end{align*}
\]

(121) (w: only Andy and Billy can chair the committee; single-chair only.)
The answer space in (121a) can have multiple max-informative true answers and hence yields a mention-some reading; moreover, the conjunctive answer is contradictory. In contrast, the answer space in (121b) is closed under conjunction and hence yields a mention-all reading; moreover, the conjunctive answer is the unique max-informative true answer and hence serves as a conjunctive mention-all answer.

2.6.3. Disjunctive mention-all

Recall that mention-all answers of a \(\Diamond\)-question can take disjunctive forms. Moreover, as shown in (122), an elided disjunction can take an existential reading or a free choice reading, used as a partial answer and a mention-all answer, respectively.

(122) Who can chair the committee?

- a. John or Mary.../ I don’t know which. (partial: existential)

  ~ 'Either John or May can chair the committee, but I don’t know which.'

- b. John or Mary. \(\backslash\) (mention-all: free choice)

  ~ 'Both John and Mary can chair the committee. No one else can.'

I argue that the mention-some/mention-all ambiguity of a \(\Diamond\)-question correlates the existential/free-choice ambiguity of the corresponding disjunctive answers: a \(\Diamond\)-question takes a mention-
all reading if its disjunctive answers take free choice readings.

2.6.3.1. Evidence from Mandarin particle *dou*

The functions of the Mandarin particle *dou* suggest a parallel between the mention-all readings of $\Diamond$-questions and the free choice interpretations of disjunctions. In a $\Diamond$-question, similar to the cases of German *alles* and English *all*, presence of *dou* above the existential modal blocks mention-some, as shown in (123). [Brackets] indicate the items associated with *dou*. Following Beck & Rullmann (1999), I descriptively call this function an “exhaustivity-marker”.

(123) a. *(Dou)* [shui] keyi jiao jichu hanyu?
   DOU who can teach Intro Chinese
   Without *dou*: ‘Who can teach Intro Chinese?’
   With *dou*: ‘Who all can teach Intro Chinese?’

   b. Women *(dou)* keyi zai [nali] mai dao kafei?
      we DOU can at where buy get coffee
      Without *dou*: ‘where can we get coffee?’
      With *dou*: ‘where all can we get coffee?’

Under the exhaustivity-marker use, *dou* ought to appear on the right side of the subject if the subject is not a *wh*-item, as seen in (123b). This fact suggests that *dou* is posited within IP. Moreover, *dou* must c-command the *wh*-item at the surface structure, as exemplified in (124): *dou* functions as an exhaustivity-marker when appearing above *shenme* ‘what’, while as a distributor when appearing below *shenme* ‘what’.

(124) *(w: John can give all the apples to Mary; he can also give some of the cookies to Mary.)*
a. Yuehan **dou**  keyi  ba  [shenme]  gei  Mali?

John  **DOU**  can  **BA**  what  give  Mary

‘What all is John allowed to give to Mary?’  (exhaustivity-marker)

Proper reply: ‘The apples or some of the cookies.’

b. Yuehan keyi  ba  [shenme]  **dou**  gei  Mali?

John  can  **BA**  what  **DOU**  give  Mary

‘What *x* is such that John can give all of *x* to Mary?’  (distributor)

Proper reply: ‘The apples.’

Given that Mandarin is a *wh*-in-situ language and that *wh*-items take covert movement at LF (Huang 1982), I conjecture that at LF **dou** is interpreted somewhere within the question nucleus (namely, inside IP) that c-commands the *wh*-trace. Hence the surface structures and logical forms of (123a-b) are as follows.

(125)  **Surface structure**

a.  

b.  

(126)  **Logical Form**

a.  

b.  

Despite the similarity between **dou** and *alles/all* in questions, **dou** should not be analyzed simply as a distributor or a quantifier (Compare Lin 1996; Jie Li 1995; Xiaoguang Li 19979). In declaratives, **dou** has more functions than *alles/all*: in a general way of

---

9Xiaoguang Li (1997) assumes that, under the exhaustivity-marker use, **dou** is associated with a covert
classification, *dou* can be used as a universal quantifier-and-distributor, a free choice item (FCI)-licenser, and a scalar marker. For the issues that are concerned with in this section, let us focus on its FCI-licenser use: in a ◇-declarative, associating *dou* with a pre-verbal disjunction evokes a universal free choice inference, as exemplified in (127).

(127) a. [Yuehan huozhe Mali] (**dou**) keyi jiao  hanyu.
John or Mary **DOU** can teach Chinese

Without *dou*: ‘Either John or Mary can teach Chinese.’ (existential)

With *dou*: ‘Both John and Mary can teach Chinese.’ (free choice)

b. Women zai [Xingbake huozhe Maidanglao] (**dou**) keyi mai dao kafei.
we at Starbucks or McDonalds **DOU** can buy get coffee

Without *dou*: ‘From S or M, we can get coffee.’ (existential)

With *dou*: ‘From both S and M, we can get coffee.’ (free choice)

Chapter 7 motivates and presents a uniform semantics of *dou* to capture its seemingly diverse functions. I define *dou* as a pre-exhaustification exhaustifier that operates only on sub-alternatives.

\[
[dou](p) = \exists q \in \text{Sub}(p). p \land \forall q \in \text{Sub}(p)[\neg O(q)]
\]

adverbial denoting multiple events and quantifies over events. This analysis cannot predict the unavailability of mention-some in ◇-questions like (1a). If here *dou* were associated with a covert quantificational adverbial over events, then (1a) should admit pair-list mention-some or individual mention-some readings, as observed in (1b). For example, if Starbucks is always accessible to John while J.P. Licks is sometimes accessible to John, “Starbucks” is a proper answer to (1b) but not to (1a).

(1) a. Yuehan **dou** keyi qu [nali] mai kafei?
John **DOU** can go where buy coffee?

‘Where all can John buy coffee?’ (mention-all)

b. Yuehan [mei-ci] **dou** keyi qu nali mai kafei?
John each-time **DOU** can go where buy coffee?

‘Each time, where can John buy coffee?’ (pair-list mention-some)

‘John always can buy coffee from where?’ (individual mention-some)
a. Presupposition: \( p \) has a sub-alternative.

b. Assertion: \( p \) is true, while for each sub-alternative of \( p \), its exhaustification is false.

Sub-alternatives are simply the opposites of Fox’s (2007) innocently excludable alternatives, namely the alternatives that are not innocently excludable and distinct from the prejacent. An alternative is innocently excludable if and only if the inference of affirming the prejacent and negating this alternative is consistent with negating any excludable alternative(s). For the purpose of this section, it is enough to know that the sub-alternatives of a conjunction/disjunction are its conjuncts/disjuncts. See Chapter 7 for a more detailed discussion.

\[(129)\]

(a. **Excludable alternatives**

\[\text{Excl}(p) = \{q : q \in \text{Alt}(p) \land p \not\in q\}\]

(\{q: q \text{ is not entailed by the prejacent } p\})

b. **Innocently (I)-excludable alternatives**

\[\text{IExcl}(p) = \{q : q \in \text{Alt}(p) \land \exists \exists q' \in \text{Excl}(p)[p \land \neg q' \rightarrow q']\}\]

(\{q: the inference } p \land \neg q \text{ does not entail any excludable alternatives\})

c. **Sub-alternatives**

\[\text{Sub}(p) = \text{Alt}(p) - \text{IExcl}(p) - \{p\}\]

(the alternatives that are not I-excludable and distinct from the prejacent.)

The computation in (130) illustrates the derivation of the universal free choice infer-
ence in (127a): the prejacent clause is a disjunction\footnote{Notice that the disjunction takes scope above the existential modal. We are, unfortunately, unable to check the semantic consequences of associating dou with a disjunction across an existential modal, because dou has to be associated with an preceding item when it functions as a FCI-licenser in declaratives.} the sub-alternatives are the disjuncts; employing dou affirms the prejacent and negates the exhaustification of each sub-alternative, yielding a conjunctive inference.

(130) [John or Mary]**dou** can teach Intro Chinese.

a. Prejacent: $\Diamond f(j) \lor \Diamond f(m)$  \hfill (f = [teach Intro Chinese])

b. Sub($\Diamond f(j) \lor \Diamond f(m)$) = $\{\Diamond f(j), \Diamond f(m)\}$

c. $[[\text{dou}][\Diamond f(j) \lor \Diamond f(m)]]$

$$= [\Diamond f(j) \lor \Diamond f(m)] \land \neg O \Diamond f(j) \land \neg O \Diamond f(m)$$

$$= [\Diamond f(j) \lor \Diamond f(m)] \land [\Diamond f(j) \rightarrow \Diamond f(m)] \land [\Diamond f(m) \rightarrow \Diamond f(j)]$$

\footnote{Notice that the disjunction takes scope above the existential modal. We are, unfortunately, unable to check the semantic consequences of associating dou with a disjunction across an existential modal, because dou has to be associated with an preceding item when it functions as a FCI-licenser in declaratives.}

(1)

a. *Ni **dou** keyi mai [pingguo huozhe binggan].
   You **dou** can buy apples or cookie
   Intended: ‘You can buy apples or cookies.’

b. **Ni [pingguo huozhe binggan]** **dou** keyi mai.
   You apples or cookie **dou** can buy
   Intended: ‘You can buy apples and you can buy cookies.’

Considering that universal free choice and existential free choice inferences are semantically equivalent in $\Diamond$-declaratives, as exemplified in (2), one might wonder why in (130) we do not interpret disjunction below the existential modal.

(2)

a. Anyone can be invited (by you). \hfill universal FC

b. You can invite anyone. \hfill existential FC

This is so because associating dou with a pre-verbal disjunction exhibits a modal obviation which is only observe in the case of universal FCI-licensing. Compare:

(3) Anyone *can/*must be invited.

(4) a. *Ni [pingguo huozhe binggan]**dou** mai-le.
   You apples or cookie **dou** can buy

b. *Ni [pingguo huozhe binggan]**dou** must mai.
   You apples or cookie **dou** must buy

See Chapter 7 for an explanation of this modal obviation effect.
\[\Diamond f(j) \vee \Diamond f(m) \land [\Diamond f(j) \iff \Diamond f(m)]\]

\[= \Diamond f(j) \land \Diamond f(m)\]

Readers who are familiar with the grammatical view of exhaustifications might find the proposed definition of *dou* similar to the operation of recursive exhaustification proposed by Fox (2007) and the pre-exhaustification operator $O_{\text{D-EXH}}$-operator used by Chierchia (2006, 2013). See section 2.7 for a comparison.

2.6.3.2. Deriving disjunctive mention-all

Based on the empirical observations with the Mandarin particle *dou*, I propose that disjunctive mention-all answers are derived by employing a covert $O_{\text{DOU}}$-operator above the existential modal. This $O_{\text{DOU}}$-operator is a non-presuppositional counterpart of the Mandarin particle *dou*.

\[(\text{131})\quad O_{\text{DOU}}(p) = p \land \forall q \in \text{Sub}(p)[\neg O(q)]\]

\[\quad(p \text{is true, while for each sub-alternative of } p, \text{its exhaustification is false.})\]

Briefly speaking, applying an $O_{\text{DOU}}$-operator above the existential modal turns a disjunctive answer into a free choice statement, making the answer space closed under conjunction and yielding mention-all. A concrete example is given in (132). An $O_{\text{DOU}}$-operator is optionally present within the question nucleus and associated with the higher-order wh-trace $\pi$ across the existential modal *can*.

\[\text{11}^\text{The additive presupposition of *dou* comes from the economy condition that an overt operator cannot be used vacuous. Hence, the covert counterpart should not have this presupposition.}\]
Who can chair the committee?

a. Andy or Billy. I don’t know who exactly. (partial)

b. Andy or Billy. \ (mention-all)

With absence/presence of the global $O_{DOU}$-operator, this LF yields the topical property in (133a)/(133b) and the answer space in (134a)/(134b). Again, shading marks the true answers, and underlining marks the max-informative true answers.

(133)  
\[
P = \lambda \pi_{(est, st)} \lambda w[\uparrow \text{people}'(\pi) \land \diamond w \pi(\lambda x. O[\text{chair}'(x)])] \tag{without $O_{DOU}$}
\]
\[
P = \lambda \pi_{(est, st)} \lambda w[\uparrow \text{people}'(\pi) \land O_{DOU} \diamond w \pi(\lambda x. O[\text{chair}'(x)])] \tag{with $O_{DOU}$}
\]

(134)  \textit{(w: Only Andy and Billy can chair the committee; single chair only.)}

a. Without $O_{DOU}$: mention-some

b. With $O_{DOU}$: disjunctive mention-all

In both answer spaces, the conjunctive answers are contradictory. In (134a), the disjunctive answer is asymmetrically entailed by the individual answers and is semantically
equivalent to the **disjunction** of the individual answers; hence, here the disjunctive answer is partial while the individual ones are complete. While in (134b), with the application of the \( O_{\text{DOU}} \)-operator, the disjunctive answer takes a free choice interpretation and is semantically equivalent to the **conjunction** of the individual answers (see computation in (135)); hence here the disjunctive answer is complete and the individual ones are partial.

\[(135)\quad O_{\text{DOU}} \Box [O_f(a) \lor O_f(b)] \]
\[= \Box [O_f(a) \lor O_f(b)] \land \neg O_f(a) \land \neg O_f(b)\]
\[= \Box [O_f(a) \lor O_f(b)] \land [\Box O_f(a) \rightarrow \Box O_f(b)] \land [\Box O_f(b) \rightarrow \Box O_f(a)]\]
\[= \Box [O_f(a) \lor O_f(b)] \land [\Box O_f(a) \leftrightarrow \Box O_f(b)]\]
\[= \Box O_f(a) \land \Box O_f(b)\]

**2.6.3.3. Disjunctive answers in non-modalized questions**

In non-modalized questions, disjunctions take only existential readings and must be used as partial answers.

\[(136)\quad \text{Who came?}\]
\[\quad \text{a. Andy or Billy .../ I don’t know which.}\]
\[\quad \text{b. # Andy or Billy.}\]

If the answer space of (136) is like (137a), then the partiality of disjunctive answers can be predicted easily. The disjunctive answer is semantically equivalent to the disjunction of two individual answers, which are strictly stronger. Hence, a disjunctive answer can never be a max-informative true answer: whenever it is true, there must be a stronger
answer that is simultaneously true. Nevertheless, a problem arises once we allow the presence of an $O_{DOU}$-operator: as the answer space (137b) shows, $O_{DOU}$ strengthens a disjunctive answer and makes it semantically equivalent to the corresponding conjunctive answer (see computation in (138)). Then, why is that a conjunctive answer can be complete while a disjunctive one cannot?

\[(137)\]

<table>
<thead>
<tr>
<th>a. Without $O_{DOU}$</th>
<th>b. With $O_{DOU}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(a) \iff f(b)$</td>
<td>$O_{DOU}[f(a) \iff f(b)]$</td>
</tr>
<tr>
<td>$f(a)$</td>
<td>$O_{DOU}[f(a)] \iff O_{DOU}[f(b)]$</td>
</tr>
<tr>
<td>$f(b)$</td>
<td>$O_{DOU}[f(b)]$</td>
</tr>
<tr>
<td>$f(a) \lor f(b)$</td>
<td>$O_{DOU}[f(a) \lor f(b)]$</td>
</tr>
</tbody>
</table>

\[(138)\]  

$O_{DOU}[f(a) \lor f(b)]$

$= [f(a) \lor f(b)] \land \neg f(a) \land \neg f(b)$

$= [f(a) \lor f(b)] \land [f(a) \rightarrow f(b)] \land [f(b) \rightarrow f(a)]$

$= [f(a) \lor f(b)] \land [f(a) \leftrightarrow f(b)]$

$= f(a) \land f(b)$

I argue that strengthening a plain disjunction with an $O_{DOU}$-operator is deviant because the output conjunctive inference contradicts the scalar implicature of this disjunction, as shown in (139). This claim is supported by the fact in (140) that associating the Mandarin particle *dou* with a disjunction in a non-modalized sentence causes ungrammaticality. (See Chapter 7 for more details.)

\[(139)\]  

For $f(a) \lor f(b)$
a. Scalar implicature: \( \neg[f(a) \land f(b)] \) \[ \text{Contradictory} \]

b. \( O_{DOU}[f(a) \lor f(b)]: \quad f(a) \land f(b) \) \[ \text{Consistent} \]

(140) \[ \text{Yuehan huoze Mali} (\text{*dou}) jiao jichu hanyu.} \]
John or Mary \text{ DOU teach intro Chinese}

‘John or Mary (*dou) teach Introductory Chinese.’

In \( \Diamond \)-questions, however, the scalar implicature of a disjunctive answer is tautological due to the presence of the local exhaustifier, as shown in (141); therefore applying \( O_{DOU} \) does not cause a contradiction.

(141) \( \Diamond [Of(a) \lor Of(b)] \)

a. Scalar implicature: \( \neg \Diamond [Of(a) \land Of(b)] = \top \) \[ \text{Consistent} \]

b. \( O_{DOU} \Diamond [Of(a) \lor Of(b)]: \quad \Diamond Of(a) \land \Diamond Of(a) \)

2.7. Comparing the exhaustifiers in free choice

This section compares the following three exhaustifiers that have been coined for the derivation of free choice inferences, including the \( O_{DOU} \)-operator for sub-alternatives in the proposed analysis, the recursive exhaustifier \( O_R \) in Fox (2007), and the \( O_{D-EXH} \)-operator for domain (D)-alternatives in Chierchia (2006, 2013).

The operation of “recursive exhaustification” (abbreviated as \( O_R \) henceforth) proposed Fox (2007) has two major characteristics: first, exhaustification negates only alternatives that are innocently excludable; second, exhaustification is applied recursively. The definition of innocently excludable alternatives is repeated below: an alternative is innocently excludable if and only if the inference of affirming the prejacent and negating this alter-
native is consistent with negating any excludable alternative(s).

\[(142) \quad \text{IExcl}(p) = \{q : q \in \text{Alt}(p) \land \neg \exists q' \in \text{Excl}(p)[p \land \neg q \rightarrow q']\} \]

where \(\text{Excl}(p) = \{q : q \in \text{Alt}(p) \land p \not\in q\}\)

See (143) for a concrete example. The first exhaustification negates the scalar alternative and focus alternatives; the D-alternatives are not negated in this round because they are innocently excludable: \([\Diamond(p \lor q) \land \neg \Diamond p] \rightarrow \Diamond q\). The second exhaustification negates the pre-exhaustified domain alternatives.

\[(143) \quad \textbf{Recursive exhaustifications} \quad \text{(Fox 2007)}\]

\[O_R \Diamond [p \lor q]\]

a. The first exhaustification:

\[O \Diamond [p \lor q] = \Diamond[p \lor q] \land \neg \Diamond[p \land q] \land \neg \Diamond r\]

b. The second exhaustification:

\[O'O \Diamond [p \lor q]\]

\[= O \Diamond [p \lor q] \land \neg O \Diamond (p) \land \neg O \Diamond (q)\]

\[= O \Diamond [p \lor q] \land [\Diamond p \rightarrow \Diamond q] \land [\Diamond q \rightarrow \Diamond p]\]

\[= [\Diamond[p \lor q] \land \neg \Diamond[p \land q] \land \neg \Diamond r] \land [\Diamond p \leftrightarrow \Diamond q]\]

\[= \Diamond p \land \Diamond q \land \neg \Diamond[p \land q] \land \neg \Diamond r\]

For an easier comparison with \(O_{DOU}\), I simplify the definition of \(O_R\) as (144a): \(O_R\) affirms the prejacent, negates the exhaustification of each sub-alternative, and negates the innocently excludable alternatives.\(^{12}\) It can be easily seen that \(O_{DOU}\) is semantically

\(^{12}\)In particular cases, the definition in (144a) yields different inferences: if the exhaustification of a sub-
weaker than $O_R$, because $O_{DOU}$ does not negate the innocently excludable alternatives.

(144)  
a. $O_R(p) = p \land \forall q \in \text{Sub}(p)[\neg O(q)] \land \forall q' \in \text{IExcl}(p)[\neg q']$

b. $O_{DOU}(p) = p \land \forall q \in \text{Sub}(p)[\neg O(q)]$

Chierchia (2006, 2013) proposes an $O_{D-EXH}$-operator for D-alternatives to derive free choice inferences. I summarize this idea as follows. **First**, the lexicon of a disjunction carries a grammatical feature [+D], which activates a set of D-alternatives and must be checked off by a c-commanding $O_D$ or $O_{D-EXH}$-operator. **Second**, in semantics, employing $O_D$ negates the D-alternatives, while employing $O_{D-EXH}$ negates the exhaustification of each D-alternative.

(145) **Exhaustifiers for D-alternatives** (Chierchia 2006, 2013)

a. $O_D(p) = p \land \forall q \in \text{D-Alt}(p)[\neg q]$

b. $O_{D-EXH}(p) = p \land \forall q \in \text{D-Alt}(p)[\neg O(q)]$

The choice between $O_D$ and $O_{D-EXH}$ is arbitrary unless employing one of them leads to a contradiction. Compare the following two sentences for a demonstration. In checking alternative is still not innocently excludable, the exhaustification of this sub-alternative would not be negated by $O_R$ under Fox’s original definition. For instance in (1), if we use the definition in (144a), affirming the prejacent and negating the exhaustification of each sub-alternative yield a contradiction. In contrast, if we follow Fox’s definition strictly, the D-alternatives $O\phi_3$ and $\phi_\forall$ are not innocently excludable even if pre-exhaustified; hence applying $O_R$ does not exhaustify the D-alternatives and does not yield a contradiction.

(1) John read (only) some or all of the books.

a. Prejacent: $O\phi_3 \lor \phi_\forall$

b. Sub($O\phi_3 \lor \phi_\forall$) = \{O\phi_3, \phi_\forall\}

c. [$O\phi_3 \lor \phi_\forall] \land \neg O\phi_3 \land \neg O\phi_\forall = [O\phi_3 \lor \phi_\forall] \land \neg [\phi_3 \land \neg \phi_\forall] \land \neg \phi_\forall = [O\phi_3 \lor \phi_\forall] \land \neg \phi_3 = \bot
off the [+D] feature of the disjunctive or, the ◇-sentence (146) must use $O_{D-EXH}$ while the □-sentence (147) must use $O_D$, otherwise giving rise to a contradiction.\footnote{The disjunct $\phi_3$ is locally exhaustified due to the well-known Hurford’s Constraint (Hurford 1974): a sentence that contains a disjunctive phrase of the form ‘S or T’ is infelicitous if S entails T or T entails S.}

(146) You can read some or all of the books.

a. $\Diamond [O\phi_3 \lor [+D] \phi_I]$ \hspace{1cm} prejacent

b. $\Diamond [O\phi_3 \lor \phi_I] \land \neg \Diamond O\phi_3 \land \neg \Diamond \phi_I = \bot$ \hspace{1cm} $\text{#applying } O_D$

c. $\Diamond [O\phi_3 \lor \phi_I] \land \neg O \Diamond O\phi_3 \land \neg O \Diamond \phi_I = \Diamond O\phi_3 \land \Diamond \phi_I$ \hspace{1cm} $\text{OK applying } O_{D-EXH}$

(You can read some of the books, and you can read all of the books.)

(147) You must read some or all of the books.

a. $\Box [O\phi_3 \lor [+D] \phi_I]$ \hspace{1cm} prejacent

b. $\Box [O\phi_3 \lor \phi_I] \land \neg \Box O\phi_3 \land \neg \Box \phi_I = \Box \phi_3 \land \Diamond O\phi_3 \land \Diamond \phi_I$ \hspace{1cm} $\text{OK applying } O_D$

(You must read some or all of the books, you can read some of them, and you can read all of them.)

c. $\Box [O\phi_3 \lor \phi_I] \land \neg O \Box O\phi_3 \land \neg O \Box \phi_I = \Box O\phi_3 \land \Box \phi_I = \bot$ \hspace{1cm} $\text{#applying } O_{D-EXH}$

As a major difference, $O_{D-EXH}$ and $O_{DOU}$ target at D-alternatives and sub-alternatives, respectively. D-alternatives are defined grammatically; they are the ones that grow pointwise from disjuncts or sub-domains. Sub-alternatives are defined purely semantically; they are the ones that are not innocently excludable and distinct from the prejacent. Therefore, if a D-alternative is innocently excludable, it will be used by $O_{D-EXH}$ but not by $O_{DOU}$;

I use (146) and (147) to demonstrate Chierchia’s (2006, 2013) system so as to avoid the complexities from scalar implicatures of disjunctions. The scalar implicature of $O\phi_3 \lor \phi_I$, namely $\neg [O\phi_3 \land \phi_I]$ is a tautology.
if a sub-alternative is not grammatically derived from a disjunct or a sub-domain, it will be used by $O_{DOU}$ but not by $O_{D-EXH}$.

For a simple illustration of this difference, let us revisit the two modalized sentences above. In (146), the D-alternatives are not innocently excludable and hence $O_{DOU}$ yields the same effect as $O_{D-EXH}$ does. While in (147), the D-alternatives are innocently excludable and are not sub-alternatives: $[\square [O\phi_3 \lor \phi_I] \land \neg \square O\phi_3] \not\vdash \square \phi_I$. Then, as schematized in (148a), applying $O_{DOU}$ is vacuous; when needed, we can further apply a regular $O$-operator to use up the D-alternatives as in (148b)\textsuperscript{14}, which yields the desired existential free choice inference.

(148) You must read some or all of the books.

a. $O_{DOU} \square [O\phi_3 \lor \phi_I] = \square [O\phi_3 \lor \phi_I]

b. $O[O_{DOU} \square [O\phi_3 \lor \phi_I]] = \square [O\phi_3 \lor \phi_I] \land \neg \square O\phi_3 \land \neg \square \phi_I = \square \phi_I \land \diamond O\phi_3 \land \diamond \phi_I$

In comparison, Fox’s (2007) $O_R$-operator negates innocently excludable alternatives and pre-exhaustified sub-alternative, and hence he can handle the interpretations of (146) and (147) with a single $O_R$.

(149) a. You can read some or all of the books.

$O_R \diamond [O\phi_3 \lor \phi_I] = \diamond [O\phi_3 \lor \phi_I] \land \neg O \diamond O\phi_3 \land \neg O \diamond \phi_I = \diamond O\phi_3 \land \diamond \phi_I$

b. You must read some or all of the books.

$O_R \square [O\phi_3 \lor \phi_I] = \square [O\phi_3 \lor \phi_I] \land \neg \square O\phi_3 \land \neg \square \phi_I = \square \phi_I \land \diamond O\phi_3 \land \diamond \phi_I$

Table 2.2 summarizes the three approaches of free choice in modalized sentences.

\textsuperscript{14}The presence of $DOU$ in (148b) is optional.
Table 2.2: Comparison of exhaustifiers in free choice

<table>
<thead>
<tr>
<th>You can read some or all of the books.</th>
<th>Proposed $O_{DOU}$</th>
<th>Chierchia $O_{D-EXH}$</th>
<th>Fox $O_R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>You must read some or all of the books.</td>
<td>$O(+O_{DOU})$</td>
<td>$O_D$</td>
<td>$O_R$</td>
</tr>
</tbody>
</table>

In section 2.6.3, I have shown that in $\Diamond$-questions applying an $O_{DOU}$-operator above the existential modal derives disjunctive mention-all answers. This approach coincides with the fact that the presence of the Mandarin particle *dou* above the existential modal blocks mention-some. What will happen if we instead use $O_R$ or $O_{D-EXH}$?

These two exhaustifiers are of course not covert counterparts of the Mandarin particle *dou*. The $O_R$-operator invokes an exclusive inference, which however is not observed with *dou*. For example, ‘John and Mary *dou* came’ does not suggest that only John and Mary came. The $O_{D-EXH}$-operator always operates on D-alternatives; therefore, it cannot capture the other functions of *dou*, such as the distributor use and the scalar marker use. See Chapter 7 for discussions of these uses.

Put aside the facts of *dou* for a moment. Consider, can we use these two exhaustifiers to derive disjunctive mention-all answers? See (150) for a concrete example, where a $\Diamond$-statement is embedded under a universal quantifier.\(^{15}\) Intuitively, the disjunctive answer provided by Speaker B is a true mention-all answer, interpreted as *everyone can get gas from A*, and *everyone can get gas from B*.

\[15\]

\(w:\) As for the considered three gas stations ABC, A and B are accessible to everyone, but

---

\(^{15}\)With the condition that none of the stations can serve all the people, the existential modal must take scope below the universal quantifier, otherwise the question has no true answer in the given discourse.
C is only accessible to John; each station has very limited stock and cannot serve all the people.

Speaker A: ‘Where can everyone get gas?’

Speaker B: ‘Station A or station B.’

The proposed analysis predicts the following LF for the question nucleus, where an $O_{DOU}$-operator is inserted right above the existential modal and is associated with the higher-order wh-trace $\pi$.

(151) Where can everyone get gas?

\[\ldots\]
\[\text{IP}\]
\[\text{everyone}\]
\[\lambda x\]
\[O_{DOU}\]
\[\text{VP}\]
\[\text{can } [\pi(\lambda y. O[x \text{ get gas from } y])]\]

The disjunctive answer ‘Station A or station B’ is interpreted as in (152):

(152) $\forall x \in man'_{@}O_{DOU}^\Diamond [Of(x,a) \lor Of(x,b)] = \forall x \in man'_{@}^\Diamond [Of(x,a) \land Of(x,b)]$

(Everyone is such that he can get gas from A and he can get gas from B)

Chierchia’s (2006, 2013) $O_{D-EXH}$-operator also works in (150), but with some technical problems. On the positive side, employing $O_{D-EXH}$ yields the desired free choice inference regardless of whether it is applied below or above the universal quantifier. This is so because the $O_{D-EXH}$-operator always negates the pre-exhaustified D-alternatives, regardless
of whether the domain alternatives are innocently excludable.

\[(153)\quad a. \; \forall x \in \text{man'}_{O_{D\text{-EXH}}} \Diamond [O_f(x,a) \lor O_f(x,b)] = \forall x \in \text{man'}_{[\Diamond O_f(x,a) \land \Diamond O_f(x,b)]}
\]

\[b. \; O_{D\text{-EXH}} \forall x \in \text{man'} \Diamond [O_f(x,a) \lor O_f(x,b)]
\]

\[= \forall x \in \text{man'}_{[\Diamond O_f(x,a) \land \Diamond O_f(x,b)]} \land
\]

\[\neg \forall x \in \text{man'} \Diamond O_f(x,a) \land \neg \forall x \in \text{man'} \Diamond O_f(x,b)
\]

\[= \forall x \in \text{man'}_{[\Diamond O_f(x,a) \land \Diamond O_f(x,b)]} \land
\]

\[\forall x \in \text{man'}_{[\Diamond O_f(x,a) \leftrightarrow \forall x \in \text{man'} \Diamond O_f(x,b)]}
\]

\[= \forall x \in \text{man'} \Diamond O_f(x,a) \land \forall x \in \text{man'} \Diamond O_f(x,b)
\]

On the negative side, the application of \(O_D\) is assumed to be motivated by the syntactic requirement of checking off a [+D] feature. Under Chierchia’s analysis, this [+D] feature is encoded with the lexicon of a disjunction or an existential indefinite (e.g., any). To license the presence of \(O_D\) in (151), one would have to assume that the wh-trace \(\pi\) is lexically encoded with a [+D] feature, which however seems to be quite odd.

Fox’s (2007) \(O_R\)-operator, however, yields an overly strong inference. Regardless of whether \(O_R\) is applied below or above the universal quantifier everyone, it yields an inference that is false in the given discourse. If \(O_R\) is applied below everyone, it yields the inference that nobody can get gas from C. If \(O_R\) is applied above everyone as in (154b), the D-alternatives are innocently excludable and hence are negated; thus applying \(O_R\) would directly negate the true individuals answers like everyone can get gas from station A.

\[(154)\quad a. \; \forall x \in \text{man'}_{O_R} \Diamond [O_f(x,a) \lor O_f(x,b)]
\]

\[= \forall x \in \text{man'}_{[\Diamond O_f(x,a) \land \Diamond O_f(x,b) \land \neg \Diamond O_f(c)]}
\]

(Everyone is such that he can get gas from A, from B, but not from C)
b. \( O_R \forall x \in \text{man} \land [O_f(x,a) \lor O_f(x,b)] \)
\[ = \forall x \in \text{man} \land [\Diamond O_f(x,a) \land \Diamond O_f(x,b)] \land \]
\[ \neg \forall x \in \text{man} \land O_f(x,a) \land \neg \forall x \in \text{man} \land O_f(x,b) \land \ldots \]

(Every can get gas from A or B, but not everyone can get gas from A, and not everyone can get gas from B, ...) 

To salvage this problem, Fox has the option of applying \( O_R \) locally as in (154a) and further assuming that the focus alternative \( \Diamond O_f(x,c) \) is contextually pruned.

### 2.8. Summary

This chapter has argued that mention-some readings are special species of non-exhaustive readings and must be treated grammatically. The proposed treatment of mention-some successes the advantages of Fox’s (2013) analysis and overcomes its insufficiencies. As a desired prediction, any individual answer that specifies one full possible choice can be used as a mention-some answer.

I have also developed two approaches to capture the mention-some/mention-all ambiguity, both of which attribute this ambiguity to a structural ambiguity within the question nucleus. One approach is based on the scope ambiguity of the higher-order \( \text{wh} \)-trace (\( a \ la \) the idea of wide scope of distributivity by Fox (2013)): interpreting the higher-order \( \text{wh} \)-trace above the existential modal yields a conjunctive mention-all answers. The other approach is based on the optional presence of the covert \( O_{\text{DOU}} \)-operator: applying a covert \( O_{\text{DOU}} \)-operator above the existential modal generates disjunctive mention-all. The second approach is inspired by observations with the Mandarin particle \( \text{dou} \): \( \text{dou} \) functions as
an exhaustivity-marker in ◇-questions and evokes universal free choice inferences in disjunctive declaratives.
Chapter 3

Solving the dilemma between uniqueness and mention-some
3.1. Introduction

This chapter proposes a solution to the dilemma between uniqueness and mention-some. As we saw briefly in section 1.5.3 and section 2.5.3, a *wh*-question with a singular or a numeral-modified *wh*-phrase triggers a uniqueness effect, namely that this question can have only one true answer, as exemplified in the following.

(155)  a. Which boy went to the party?

\[
\rightarrow \text{Only one of the boys went to the party.}
\]

b. Which two boys went to the party?

\[
\rightarrow \text{Only two of the boys went to the party.}
\]

This uniqueness effect is standardly analyzed as a result of the so-called “Dayal’s presupposition” (Dayal 1996), which requires a question to have a **strongest true answer**.

Nevertheless, a dilemma arises between uniqueness and mention-some. Dayal’s presupposition predicts that a question is undefined if it lacks a strongest true answer. While in Chapter 2, the generalization of mention-some that I adopt from Fox (2013) predicts that a question takes a mention-some reading if and only if this question can have multiple max-informative true answer instead of a strongest true answer. Hence, if we stick to Dayal’s presupposition, then mention-some would never be grammatically licensed. Alternatively, if we stick to Fox’s generalization of mention-some, then we cannot capture the uniqueness effects exemplified in (155).

Moreover, Dayal’s presupposition is also needed in interpreting questions like (156) which has a non-monotonic collective predicate. Without Dayal’s presupposition, Fox’s
generalization of mention-some would predict (156) to be a mention-some question, contra the fact.

(156) Which boys formed a team? (#mention-some; OK mention-all)

To solve this dilemma, I propose a repair strategy using internally lifted interpretations of short answers. This repair strategy preserves the merits of Dayal’s presupposition, and also leaves room for mention-some readings. Briefly speaking, if the topical property of a question is defined for generalized conjunctions, internally lifting a generalized conjunction forces this conjunction to take a wide scope reading; if a topical property is only defined for non-scopal elements (for instance, individuals of type $e$), this repair strategy makes no difference.

3.2. Dayal’s presupposition

This section introduces Dayal’s presupposition. Section 3.2.1 focuses on the merits of this presupposition in analyzing uniqueness effects of singular and numeral-modified $wh$-items. Section 3.2.2 provides a solution to eliminate some unwelcome predictions in interpreting questions with non-monotonic collective predicates.

3.2.1. Uniqueness effects

As a well-known fact, a singular question is subject to a uniqueness requirements (Srivastav 1991), namely, it can only have one true answer. We tag a $wh$-question as “singular” if the NP-complement of its $wh$-phrase is marked as singular. Compare the examples in (157)
for an illustration of this requirement. (157a) is infelicitous because the singular question
implies a uniqueness inference that only one of the boys came, which is inconsistent with the
second clause. By contrast, this inconsistency disappears if the singular wh-phrase which
boy is replaced with a plural one which boys or a bare wh-word who, as shown in (157b)
and (157c), respectively.

(157)  a. ‘Which boy came? # I heard that many boys did.’

       b. ‘Which boys came? I heard that many boys did.’

       c. ‘Who (among the boys) came? I heard that many boys did.’

As discussed briefly in section 1.5.3, a numeral-modified question, namely a wh-question
in which the NP-complement of the wh-phrase is numeral-modified, is also subject to a
uniqueness requirement. For example, the numeral-modified questions in (158a) and
(158b) imply that only two of the boys came and that only two or three of the boys came, respec-
tively, which contradict the second clauses.

(158)  a. ‘Which two boys came? # I heard that three boys did.’

       b. ‘Which two or three boys came? # I heard that five boys did.’

Dayal (1996) provides an elegant solution to capture the uniqueness requirements of
singular questions. This solution is also applicable to the case of numeral-modified ques-
tions. First of all, she defines a presuppositional answerhood-operator, as schematized
in (159): $\text{ANS}_{\text{Dayal}}(Q)(w)$ returns the strongest true answer and presupposes the existence
of this strongest true answer. This presupposition of $\text{ANS}_{\text{Dayal}}$ is usually called Dayal’s
presupposition.¹

(159) Definition: Dayal’s answerhood-operator

\[ \text{ANS}_{\text{Dayal}}(Q)(w) = \exists p[w \in p \land \forall q[w \in q \rightarrow p \subseteq q]]. \]

\[ \land p[w \in p \land \forall q[w \in q \rightarrow p \subseteq q] \]

(\text{ANS}_{\text{Dayal}}(Q)(w) \text{ is defined if and only if the set of answers in } Q \text{ that are true in } w \text{ has a strongest member; when defined, } \text{ANS}_{\text{Dayal}}(Q)(w) \text{ returns this unique strongest true answer.})

Next, Dayal adopts the ontology of individuals from Sharvy (1980) and Link (1983): as exemplified in (160), a singular NP \textit{boy} denotes a set of atomics, while a plural NP \textit{boys} denotes a set closed under mereological sum formation, ranging over both atomic and sum domains. Applied to \textit{wh}-phrases, Dayal gets an existential quantifier that lives on the set of atomic boys for \textit{which boy}, and an existential quantifier that lives on the set consisting of both atomic and sum boys for \textit{which boys}.

(160) \[ *\text{boy} = \{ \bigoplus X : X \subseteq \text{boy} \}, \text{ where } \bigoplus X \text{ refers to the sum of all the members of } X. \]

¹Another commonly seen way to formulate the definition of \text{ANS}_{\text{Dayal}}\text{ is as in (1): } \text{ANS}_{\text{Dayal}}(Q)(w) \text{ asserts the conjunction of all the true answers, the same as } \text{ANS}_{\text{Heim}}(Q)(w) \text{ (Heim 1994), and presupposes that this conjunction is a possible answer.}

(1) a. \[ \text{ANS}_{\text{Dayal}}(Q)(w) = \bigcap \{ p : w \in p \land \forall q[w \in q \rightarrow p \subseteq q] \}
\]

b. \[ \text{ANS}_{\text{Heim}}(Q)(w) = \bigcap \{ p : w \in p \land \forall q[w \in q \rightarrow p \subseteq q] \} \]
Finally, adopting Hamblin-Karttunen Semantics, Dayal predicts that the Hamblin set yielded by a plural question (161a) is richer than the one yielded by its singular counterpart (161b): the former set includes both singular answers (namely, propositions naming atomic boys) and plural answers (namely, propositions naming sum boys), while the latter consists of only singular answers. As a consequence, under a discourse where both Andy and Bill came, (161a) has a strongest true answer $\text{came}^\prime (a \oplus b)$ while (161b) does not. Then employing $\text{Ans}_{Dayal}$ in (161b) gives rise to a presupposition failure. To avoid this presupposition failure, (161b) can only be evaluated in a world where only one of the boys came, which therefore explains its uniqueness requirement.

(161)  \(w: \text{Among the boys, only Andy and Billy came.}\)

a. Which boys came?
   i. $Q = \{\text{came}^\prime(x) : x \in ^*\text{boy}^\prime_@\}$
   ii. $Q_w = \{\text{came}^\prime(a), \text{came}^\prime(b), \text{came}^\prime(a \oplus b)\}$
   iii. $\text{Ans}_{Dayal}(Q)(w) = \text{came}^\prime(a \oplus b)$

b. Which boy came?
   i. $Q = \{\text{came}^\prime(x) : x \in \text{boy}^\prime@\}$
   ii. $Q_w = \{\text{came}^\prime(a), \text{came}^\prime(b)\}$
   iii. $\text{Ans}_{Dayal}(Q)(w)$ is undefined

Generally speaking, a question constantly fulfill Dayal’s presupposition only if its answer space satisfies the following condition:\(^2\)

---

\(^2\)This condition is necessary but not yet sufficient. For instance, in accounting for the negative island
Condition to fulfill Dayal’s presupposition constantly

\[ \forall p \in Q \forall q \in Q[(p \land q \neq \bot) \rightarrow (p \land q) \in Q] \]

(For any two propositions in Q, if they are not mutually exclusive, then their conjunction is also in Q.)

Two categories of questions satisfy this condition. One category is formed by the questions whose possible answers are all mutually exclusive, such as yes-no questions and questions taking only exhaustified answers, as exemplified in (163a) and (163b), respectively. Those questions can have only a unique true answer.

(163)  a. Did John come?

        b. Only John came or only Mary came?

The other category is formed by the ones whose answer space is closed under mereological conjunction formation, such as the plural question in (161a). Questions falling in this category can have multiple true answers. An answer space Q is closed under conjunction if and only if the conjunction of any propositions in Q is also a member of Q (formally: \[ \forall p \in Q \forall q \in Q[(p \land q) \in Q] \]).

Effect in the degree question (1), Fox & Hackl (2007) analyze the true answer set of this question as an infinite set, which satisfies the constraint in (162) but does not have a strongest member.

(1) How fast didn’t John drive?
    \[ Q_{\text{nr}} = \{ \neg \text{run’}(j,d) : d > d_0 \} \] where \( d_0 \) is John’s actual driving speed.
3.2.2. Questions with collective predicates

Dayal (1996) has considered only *wh*-questions with distributive predicates. In a question of this sort, as we saw above in (161), its answer space is closed under conjunction as long as the NP-complement of the *wh*-phrase denotes a set closed under sum.

Nevertheless, this generalization does not extend to the case of questions with non-monotonic collective predicates. If *which boys* quantifies over *boy*, as Dayal assumes, then the Hamblin set yielded by (164) would be like (164a). This set, however, does not have a strongest true member under the discourse that the considered boys formed multiple independent teams. Hence, Dayal’s analysis incorrectly predicts a uniqueness requirement for the question (164).

(164) Which boys formed a team?

\((w: \text{the considered boys formed two teams in total: } ab \text{ formed one, and } cd \text{ formed one.})\)

a. \(Q = \{\text{form}'(x) : x \in *\text{boy}_@\}\)

b. \(Q_w = \{\text{form}'(a \oplus b), \text{form}'(c \oplus d)\}\)

c. \(\text{ANS}_{Dayal}(Q)(w)\) is undefined \((# \text{ uniqueness})\)

This undesired prediction can be avoided using my account of *wh*-items (see section 1.5.3). Under this account, the Hamblin set can also include conjunctive answers like \(\text{form}'(a \oplus b) \land \text{form}'(c \oplus d)\). First, the live-on set of *wh*-NP is closed under conjunction and disjunction if and only if this NP is closed under sum, by virtue of a \(\dagger\)-operation in the *wh*-determiner.

(165) \textbf{Definition: *wh*-determiner}
\[ [w_h] = \lambda A. \lambda P. \exists x \in \dagger A[P(x)] \]

where \( \dagger = \lambda A. \)

\[
\begin{cases} 
\min \{ X : A \subseteq X \land \forall Y [Y \subseteq X \rightarrow \exists Y \in X \land Y \in X] \} & \text{if } *A = A \\
A & \text{otherwise} 
\end{cases}
\]

(\( \dagger A \) is closed under \( \land \) and \( \lor \), if and only if \( A \) is closed under sum.)

Accordingly, the live-on set of a plural or number-neutral \( w_h \)-item consists of not only individuals but also generalized disjunctions and conjunctions. For instance, the live-on set of \( \text{which boys} \) is \( \dagger * \text{boy} \), which consists of not only the individual domain \( * \text{boy} \) but also generalized conjunctions and disjunctions over \( * \text{boy} \).

\[
(166) \quad \text{BE}[\text{which boys'}] = \dagger * \text{boy'} = \begin{cases} 
\{ a, b, \ldots, a \oplus b, \ldots \} \\
\{ a \land b, a \lor b, a \land a \oplus b, \ldots \} \\
(a \land b) \lor b, \ldots 
\end{cases}
\]

Second, items that are of the same semantic type as the highest \( w_h \)-trace can be used to form propositional answers. For instance, as illustrated in (167a) using a Karttunen-style way of composition, if \( \text{which boys} \) undertakes a local QR from \( x \) to \( \pi \) before moving to the spec of CP, then the Hamblin set will be derived based on generalized conjunctions and disjunctions over \( * \text{boy'} \). The obtained Hamblin set (167b) is closed under conjunction. Applying \( \text{ANS}_{\text{Dayal}} \) returns the following conjunctive answer: \( ab \) formed a team and \( cd \) formed a team.

(167) Which boys formed a team?

\( (w: \text{the considered boys formed two teams in total: } ab \text{ formed one, and } cd \text{ formed one.}) \)
By contrast, if *which boys* does not take a local QR before the *wh*-movement, as illustrated in the LF (168a), then only individual boys can be used to form propositional answers. The resulted Hamblin set is not closed under conjunction and does not support Dayal’s presupposition, just like we just saw in (164).

(168) Which boys formed a team?

*(w: the considered boys formed two teams in total: *ab* formed one, and *cd* formed one.*)
Thinking about this issue from a different perspective, we can also say that Dayal’s presupposition motivates the local QR in (167a). With this local QR, this question takes a higher-order reading (169b), which yields an answer space closed under conjunction; without this local QR, the question takes an individual reading (169a), which yields an answer space not closed under conjunction.

(169) Which boys formed a team?

a. **Individual reading**

   What is an item \( x \) s.t. \( x \) is a plural boy and \( x \) formed a team?

   \[ Q = \{ \text{form}'(x) : x \in \dagger^*\text{boy}_@ \} \]
   (Q is not closed under conjunction)

b. **Higher-order reading**

   What is a generalized quantifier \( \pi \) s.t. \( \pi \) is a conjunction or disjunction over boys and that \( \pi \) formed a team?

   \[ Q = \{ \pi(\lambda x \text{form}'(x)) : \pi_{\text{(est, st)}} \in \dagger^*\text{boy}_@ \} \]
   (Q is closed under conjunction)
3.3. The dilemma

A dilemma arises between Dayal’s presupposition and the generalization of mention-some adopted from Fox (2013): Dayal predicts that a question is undefined if it does not have a strongest true answer; while Fox predicts that a question takes a mention-some reading if and only if it can take multiple max-informative true answers instead of a unique strongest true answer.

If we follow Dayal’s presupposition, then every question must be interpreted exhaustively, and hence mention-some can never be grammatically licensed. For an illustration, let us revisit the mention-some question (106), repeated below. For the purpose of this section, it does not matter whether we use Fox’s (2013) derivation of mention-some (see section 2.5.2), which predicts the true answer set (170a), or the proposed derivation (see section 2.6.1), which predicts the true answer set (170b). Both sets have two max-informative members but no strongest member. Employing Dayal’s presuppositional answerhood-operator (159) based on one of these sets yields a presupposition failure.

(170) Who can chair the committee?

(w: Andy and Billy can chair the committee; single-chair only.)

a. \( Q_w = \{\Diamond chair'(a), \Diamond chair'(b)\} \) (following Fox 2013)

b. \( Q_w = \{\Diamond Ochair'(a), \Diamond Ochair'(b), \Diamond Ochair'(a) \lor \Diamond Ochair'(b)\} \) (following my proposal)

c. \( \text{ANS}_{\text{Dayal}}(Q(w)) \) is undefined

To avoid this presupposition failure, we would have to make the answer space of (170)
closed under conjunction using whichever strategies (see section 2.6.2 and section 2.6.3 for possible strategies); but then only mention-all readings can be grammatically produced. Hence, due to Dayal’s presupposition, we would have to attribute the availability of mention-some to pragmatic factors. Nevertheless, as I argued in section 2.4.1, the pragmatic view of mention-some faces a couple of empirical problems.

Alternatively, if we stick to Fox’s generalization of mention-some and discard Dayal’s presupposition, we would have to face the following unwelcome consequences: (a) unable to capture the uniqueness requirements in singular and numeral-modified questions; and (b) overly predicting mention-some readings.

Recall that Fox (2013) uses a weaker definition of completeness (see section 2.5.1): a true answer is complete as long as it is max-informative, namely, not asymmetrically entailed by any of the true answers. On this definition of completeness, a question takes a mention-some reading if and only if it can have multiple max-informative true answers. Applying this generalization to the singular question (171), however, we predict an unwelcome mention-some reading, because both of the true answers are max-informative. Hence, Fox’s generalization of mention-some predicts that singular questions are mention-some questions, which is apparently incorrect.

(171) Which boy came?

\(w: \text{Among the boys, only John and Bill came.}\)

a. \(Q_w = \{\text{came}'(j), \text{came}'(b)\}\)

b. \(\text{ANS}_{\text{Fox}}(Q)(w) = \{\text{came}'(j), \text{came}'(b)\}\) (\(\times\) mention-some)

Moreover, discarding Dayal’s presupposition also causes problems in interpreting
questions with non-monotonic collective predicates. Recall that the question (169), repeated below, yields an answer space closed under conjunction only under its higher-order reading. In case the boys formed multiple teams, employing Dayal’s presupposition yields a desired result: it blocks the individual reading due to presupposition failure, and yields a mention-all answer based on the answer space created under the higher-order reading. Without Dayal’s presupposition, however, we cannot block the individual reading. Then, as shown in (172a), applying Fox’s generalization of mention-some predicts a mention-some reading, contra the fact.

(172) Which boys formed a team?

(w: the considered boys formed two teams in total: ab formed one, and cd formed one.)

a. What is an item $x$ s.t. $x$ is a plural boy and $x$ formed a team?

i. $Q = \{\text{form}'(x) : x \in \dagger^*\text{boy}@\}$

ii. $Q_w = \{\text{form}'(a \oplus b), \text{form}'(c \oplus d)\}$

iii. $\text{ANS}_{\text{Dayal}}(Q)(w)$ is undefined

iv. $\text{ANS}_{\text{Fox}}(Q)(w) = \{\text{form}'(a \oplus b), \text{form}'(c \oplus d)\}$ (× mention-some)

b. What is a generalized quantifier $\pi$ s.t. $\pi$ is a conjunction or disjunction over boys and that $\pi$ formed a team?

i. $Q = \{\pi(\lambda x.\text{form}'(x)) : \pi_{(\text{est}, \text{st})} \in \dagger^*\text{boy}@\}$

\[
\begin{align*}
\text{form}'(a \oplus b), \text{form}'(c \oplus d) \\
\text{form}'(a \oplus b) \land \text{form}'(c \oplus d) \\
\text{form}'(a \oplus b) \lor \text{form}'(c \oplus d)
\end{align*}
\]

ii. $Q_w = \{\text{form}'(a \oplus b) \land \text{form}'(c \oplus d)\}$

iii. $\text{ANS}_{\text{Dayal}}(Q)(w) = \text{form}'(a \oplus b) \land \text{form}'(c \oplus d)$ (✓ mention-all)
iv. $\text{ANS}_{\text{Fox}}(Q)(w) = \{\text{form}'(a \oplus b) \land \text{form}'(c \oplus d)\}$ \quad (\checkmark \text{mention-all})

To sum up the dilemma, Dayal’s presupposition and Fox’s generalization of mention-some are inconsistent. If we stick to Dayal’ presupposition, then mention-some can never be grammatically licensed; if we abandon Dayal’s presupposition and follow Fox’s generalization of mention-some, then the following two types of questions would be incorrectly predicted to be mention-some questions: (a) questions that are subject to uniqueness requirements; (b) questions with non-monotonic collective predicates.

### 3.4. Fox (2013) on uniqueness

To solve the dilemma between uniqueness and mention-some, Fox (2013) adds two assumptions to his initial proposal (see section 2.5 for the initial proposal). First, contrary to the case of singular $wh$-questions, number-neutral $wh$-questions can obtain propositional answers based on generalized conjunctions and disjunctions. Motivation for this assumption has been explained in section 1.5. Briefly speaking, this assumption was firstly made to capture the contrast of the following two questions: the disjunction can be interpreted as scoping below the universal modal in (173) but not in (174).

\begin{align*}
\text{(173) a. What does John have to read?} \\
& \text{b. Syntax or Morphology.} \quad (\text{OK or have to; OK have to > or})
\end{align*}

\begin{align*}
\text{(174) a. Which book does John have to read?} \\
& \text{b. Syntax or Morphology.} \quad (\text{OK or have to; # have to > or})
\end{align*}

Due to Spector (2007), the narrow scope reading of an elided disjunction arises when
the underlying question takes the following higher-order reading: for which increasing generalized quantifier \( G \) is such that John has to read \( G \)? To obtain this reading, the \( wh \)-item needs to be quantifying over of set of increasing generalized quantifiers. For instance in (173), what is semantically ambiguous, it either lives on a set of individuals \(*\text{thing}'_@\), or a set of increasing generalized quantifiers over \(*\text{thing}'_@\).³ Fox adopts this idea and assumes that a singular \( wh \)-phrase lives on a set of atomic individuals, which therefore predicts the absence of the narrow scope reading of the disjunction in (174). Extending this idea to \( \Diamond \)-questions, Fox predicts the following contrast: compared with the case of (175a), (175b) has one more true answer based on the generalized disjunction \( j \lor m \).

(175) \( (w:\text{the committee can and can only be chaired by either John or Mary.}) \)

a. Which professor can chair the committee?

\[ Q_w = \{\Diamond \text{chair}'(j), \Diamond \text{chair}'(m)\} \]

b. Who can chair the committee?

\[ Q_w = \{\Diamond \text{chair}'(j), \Diamond \text{chair}'(m), \Diamond \text{chair}'(j \lor m)\} \]

Second, Fox proposes that a question is defined if and only if it has a possible answer whose innocently exclusive (IE)-exhaustification is true. This requirement is weaker than Dayal’s presupposition and therefore leaves some space for mention-some.

(176) \( \text{Ans}_{\text{Fox}}(Q)(w) \) is defined iff

\[ \exists p \in Q[w \in \text{IE-Exh}(p, Q)] \]

(There exists a possible answer \( p \) such that the inference of IE-exhaustifying \( p \)

³What I proposed in section 1.5.4 is slightly difference from Spector’s and Fox’s assumptions.
with respect to the set of possible answers is true.)

Compared with traditional exhaustification, IE-exhaustification negates only innocently excludable alternatives (Fox 2007), as defined in (177).

\[(177) \quad \text{Innocently exclusive exhaustification} \]

\[\text{IE-Exh}(p, Q) = p \land \forall q \in \text{IEExcl}(p, Q)[\neg q] \]

The definition of innocently excludable alternatives is repeated below. An proposition \(q\) is innocently excludable to \(p\) with respect to \(Q\) if and only if \(q\) satisfies the following two conditions: (i) \(q\) is in \(Q\); (ii) \(p \land \neg q\) is consistent with negating any other proposition in \(Q\) that is not entailed by \(p\).

\[(178) \quad \text{Innocently excludable alternatives} \]

\[\text{IEExcl}(p, Q) = \{q : q \in Q \land \exists q' \in \text{Excl}(p)[p \land \neg q' \rightarrow q']\} \]

where \(\text{Excl}(p) = \{q : q \in Q \land p \not\in q\}\)

The presupposition of \(\text{ANS_Fox}\) is satisfied in (175b) but not in (175a), due to the distinction with respect to the availability of the higher-order disjunctive answer. In (175b), among the three true answers, the individual answers are not innocently excludable to the disjunctive answer, because affirming the disjunctive answer and negating one of the individual answer entails the other individual answer (formally: \[\Diamond chair'(j \lor m) \land \neg \Diamond chair'(j) \rightarrow \Diamond chair'(m)]\); hence, IE-exhaustifying \(\Diamond chair'(j \lor m)\) does not yield the negation of any of the true answers. In contrast, (175a) has no answer whose IE-exhaustification is true: IE-exhaustifying \(\Diamond chair'(j)\) yields the negation of the other true answer \(\Diamond chair'(m)\), and vice versa.
Fox’s account of uniqueness, however, yields problematic predictions in questions with quantifiers. The presupposition of \( \text{Ans}_{\text{Fox}} \) is still too strong to rule in individual mention-some readings of questions with universal quantifiers. Consider the question (180) for a concrete example. Due to the scope ambiguity of the universal quantifier, this question has two types of mention-some readings, as paraphrased below.

(179) Where can everyone get gas?

a. Individual mention-some reading:

\[\text{tell me one of the places where everyone can get gas.}\]

b. Pair-list mention-some reading:

\[\text{for each individual, tell me one of the places where he can get gas.}\]

Let us focus on the individual mention-some reading. Extending Fox’s analysis to this question, we obtain a Hamlin set as in (180a). The true answer set (180b) consists of two individual answers and a disjunctive answer.

(180) Where can everyone get gas?

\(w: \text{Only station A and station B are accessible to everyone; everyone is only allowed to go to one gas place. Moreover, AB both have a limited stock, and thus not everyone can get gas from them}^{4}\)

a. \(Q = \{ \forall y \in \text{man'} [\Diamond \text{get-gas'(} y, x \text{)}] : x \in \text{'place'} \}\)

\(^{4}\text{The latter condition rules out the reading where everyone scopes below can. For instance, the following proposition is false: } \Diamond \forall y \in \text{man'} [\text{get-gas'(} y, a \lor b \text{)}]\)
Unlike the case in (175a), here the true individual answers are innocently excludable to the true disjunctive answer. Thus, as schematized in (175c), IE-exhaustifying the disjunctive answer negates the individual ones, yielding a false inference that some but not all of the people can get gas from A, the others can get gas from B. Therefore, the presupposition of \( \text{Ans}_{\text{Fox}} \) defined in (176) predicts that (180) is undefined in the given discourse, contra the fact.

This problem also extends to the following questions:

a. Where can half of your friends get gas?

b. Where can most of your friends get gas?

### 3.5 Proposal

We have seen a couple of good reasons to keep Dayal’s presupposition. In the case that a question takes a mention-some reading, we need a repair strategy to salvage the presupposition failure. I propose that, in search of the strongest true answer, short answers can be interpreted as if they took a wide scope, or say, scope reconstruction can be ne-
glected. In a $\diamond$-question, interpreting the short answers with a wide scope yields conjunctive mention-all, which easily fulfills Dayal’s presupposition. Technically, this wide scope interpretation can be obtained via the type-shifting operation called internal lift: internally lifting a generalized quantifier yields a wide scope interpretation of this quantifier (Shan & Barker 2006; Barker & Shan 2014; Charlow 2014).

3.5.1. Scope ambiguity and type-lifting

There are, quite generally, two ways to model quantifier scope ambiguity. One way is to determine quantifier scope syntactically by quantifier raising (QR) (May 1985). The other way conceives this scope ambiguity semantically as a result of type-shifting. Representative type-shifting operations are argument raising for verbs (Hendriks 1993), function-argument flip flop (Partee & Rooth 1983), and the CPS (continuation passing style) transforms used in continuation-based works (Shan & Barker 2006; Barker & Shan 2014; Charlow 2014).

In the tradition of Montague grammar, a type-shifting operation $\text{LIFT}$ turns a proper name like $\text{John}$ (of type $e$) into a generalized quantifier (of type $\langle et, t \rangle$): $\text{LIFT}([\text{John}]) = \lambda P_{\langle e, t \rangle}. P(j)$. With the development of type theories, $\text{LIFT}$ is conceived as a more liberal operation. For instance, Partee & Rooth (1983) generalize $\text{LIFT}$ as an operation called “argument-to-function flip flop”, which can be applied successively. The semantics of $\text{LIFT}$ is generalized as in (182) due to Partee (1987): $\text{LIFT}$ turns an item of type $\tau$ to a higher-order item of type $\langle \tau t, t \rangle$.

\begin{equation}
\text{LIFT}(m_\tau) = \lambda k_{\langle \tau t, t \rangle}. k(m) \quad \tau \Rightarrow \langle \tau t, t \rangle
\end{equation}
In the case of type-lifting a generalized quantifier, the continuation-based grammar (Barker 2002; Shan & Barker 2006; Barker & Shan 2014; among the others) allows \textsc{Lift} to be applied externally or internally, as defined in (183a) and (183b), respectively. Following Charlow (2014), I use ‘↑’ for external lift, which is simply the classic \textsc{Lift}, and ‘↑↑’ for internal lift. Crucially, internally lifting an expression to a higher type can allow it to take wider scope, including scoping over elements that precede it.

\begin{align*}
(183) \quad m &= \lambda k.m(\lambda v.k(v)) \\
&= \lambda Q.(\lambda k.m(\lambda v.k(v))) & \text{External lift} \\
&= \lambda Q.(\lambda v.(\lambda k.k(v))) & \text{Internal lift}
\end{align*}

I will not get to the actual system of the continuation-based grammar, but simply borrow its idea of internal lift for achieving wide scope readings of generalized quantifiers. Consider the sentence (184) for an illustration. For the sake of simplicity, I use the extensional type \( t \) as oppose to the intensional type \( \langle s, t \rangle \), and consider \textit{John must invite} a predicate taking the generalized quantifier \textit{someone} as an argument. In (184c), applying \textit{John must invite} to the generalized quantifier \textit{someone} yields a surface scope reading (\textit{must} > \textit{someone}): \textit{John must invite someone, and the choice is up to him}.

\begin{align*}
(184) \quad \text{John must invite someone.} \\
&= \lambda P.\exists x[P(x)] & \langle et, t \rangle \\
&= \lambda x.invite'(j, x) & \langle ett, t \rangle \\
&= \square \exists x[ invite'(j, x)] & (\square > \exists)
\end{align*}

Now consider the consequences of applying external or internally lift to \textit{someone}. In (184d-
e), both type-lifting operations raise the semantic type of someone from \(<et,t>\) to \(<ett,t>\), and hence someone becomes a function that takes John must invite as an argument. Nevertheless, as schematized in (184f-g), composing the two type.lifted forms of someone with John must invite yield inferences of distinct scopal orders: applying someone↑ maintains the narrow scope reading for someone relative to must, while applying someone↑↑ yields a wide scope reading for someone relative to must.

d. \[\text{someone}↑ = λQ. Q(λP. ∃x[P(x)]) \quad <ett,t>\]
e. \[\text{someone}↑↑ = λQ. ∃x[Q(λP.P(x))] \quad <ett,t>\]
f. \[\text{someone}↑(\text{[John must invite]})\]
   \[= [λQ. Q(λP. ∃x[P(x)])](λ\pi. □(λx.invite'(j,x)))\]
   \[= □∃x[invite'(j,x)] \quad (□ > ∃)\]
g. \[\text{someone}↑↑(\text{[John must invite]})\]
   \[= [λQ. ∃x[Q(λP.P(x))]](λ\pi. □(λx.invite'(j,x)))\]
   \[= ∃x[□invite'(j,x)] \quad (∃ > □)\]

3.5.2. Preserving mention-some

Recall that the proposed hybrid semantics defines the root denotation of a question as a topical property \(P\). The domain of \(P\) is the set of possible short answers, and the range of \(P\) is the Hamblin set. Adapting to the hybrid semantics, I schematize Dayal’s presupposition as follows. The strongest true proposition in a Hamblin set is now the strongest true proposition in the range of \(P\).
(185) **Dayal’s presupposition** (adapted)

\[ \text{ANS}_{Dayal}(P)(w) \text{ is defined if and only if} \]
\[ \exists \alpha \in \text{Dom}(P)[w \in P(\alpha) \land \forall \beta \in \text{Dom}[w \in P(\beta) \rightarrow P(\alpha) \subseteq P(\beta)]] \]

(there is an item \( \alpha \) in the domain of \( P \) such that \( P(\alpha) \) is the strongest true proposition in the range of \( P \).)

Note that here the \( \text{ANS} \)-operator has a direct access to the short answers, namely the items in the domain of \( P \). This accessibility makes it possible for the \( \text{ANS} \)-operator to interact with short answers.

In the previous chapters, I have adopted Fox’s generalization of mention-some:

(186) **Fox’s generalization of mention-some**

A question takes a mention-some reading only if it can have multiple max-informative true answers.

To salvage the conflict between Fox’s generalization and Dayal’s presupposition, I propose that, in search of the strongest true answer, short answers can be interpreted as if they took a wide scope. Technically, scope flexibility can be achieved by type-shifting, as we just saw in section 3.5.1. Using this technique, I weaken Dayal’s presupposition as follows, which allows the strongest true answer to be obtained based on a type-lifted variant of a short answer.

(187) **Definition:** \( \uparrow \)-shifter

\[ \alpha^{\uparrow} = \begin{cases} 
\alpha^{\uparrow} & \text{if } \alpha^{\uparrow} \text{ is defined} \\
\alpha & \text{otherwise}
\end{cases} \]
(188) Presupposition of the ANS-operator

\[ \text{ANS}(P)(w) \text{ is defined iff} \]
\[ \exists \alpha \in \text{Dom}(P)[w \in P(\alpha^\circ) \land \forall \beta \in \text{Dom}(P)[w \in P(\beta^\circ) \rightarrow P(\alpha^\circ) \subseteq P(\beta^\circ)]] \]

(there is an item \( \alpha \) in the domain of \( P \) such that, based on a type-lifted variant of \( \alpha, P \) yields a true proposition that entails all the true answers.)

Clearly, if the original answer space of a question already contains a strongest true answer, this weakening strategy makes no difference .

In questions taking mention-some readings, the required strongest true answer can always be obtained based on the internal-lifted variant of a generalized conjunction. Before getting into the solution, let me remind you how we derived the ambiguity between mention-some and mention-all (see section 2.6.2): a \( \diamond \)-question like (189) takes a mention-some reading when the higher-order wh-trace \( \pi \) takes scope below the existential modal \textit{can}, and a conjunctive mention-all reading otherwise.

(189) Who can chair the committee?

a. \( \diamond > \pi \): mention-some

\[
\ldots \quad \text{IP} \quad \text{can} \quad \pi_{(est, st)} \quad \lambda x \quad O \quad \text{VP} \quad x \text{ chair}
\]

b. \( \pi > \diamond \): conjunctive mention-all

\[
\ldots \quad \text{IP} \quad \pi_{(est, st)} \quad \lambda x \quad \text{can} \quad O \quad \text{VP} \quad x \text{ chair}
\]

In (189b), the wide scope reading of higher-order answers is syntactically derived by quantifier raising. But, just like the case in (184), this wide scope reading can also be obtained semantically by internally lifting the higher-order answers. Thus, given the topical
property of a mention-some reading, we can retrieve the conjunctive mention-all answer by internally lifting the higher-order short answers.

To be more concrete, see (190) for a demonstration. We start with a topical property for the mention-some reading, which is compositionally derived based on the LF in (189a). The domain of this property is a set of generalized conjunctions and disjunctions over human individuals. Compare the derivations in (190e) and (190f): while composing with the same property $P$, a basic conjunction $a \land b$ yields a contradiction, and the internal-lifted conjunction $(a \land b)^\dagger$ yields a conjunctive mention-all answer.

(190) Who can chair the committee?

(w: Only Andy and Billy can chair; only single-chair is allowed.)

a. $P = \lambda \pi_{(est,st)} \lambda w[\uparrow \text{people' } @ (\pi) \land \diamond_w \pi(\lambda x. \text{Ochair'}(x))]$

b. $\text{Dom}(P) = D_{(est,st)} \cap \uparrow \text{people' } @ = \{a, b, a \lor b, a \land b, \ldots\}$

c. $a \land b = \lambda P[(j \land m)(\lambda x. P(x))] = \lambda P[P(a) \land P(b)]$

d. $(a \land b)^\dagger = \lambda \theta[(a \land b)(\lambda x. \theta(\lambda P.P(x)))]$

$$= \lambda \theta[\theta(\lambda P.P(a)) \land \theta(\lambda P.P(b))]$$

$$= \lambda \theta[\theta(a^\dagger) \land \theta(b^\dagger)]$$

e. $P(a \land b) = \Diamond[\text{Ochair'}(a) \land \text{Ochair'}(b)]$ \hspace{1cm} ($\Diamond > \land$)

f. $(a \land b)^\dagger(P) = [(\lambda \pi. \Diamond \pi(\lambda x. \text{Ochair'}(x)))(a^\dagger)] \land [(\lambda \pi. \Diamond \pi(\lambda x. \text{Ochair'}(x)))(b^\dagger)]$

$$= [\Diamond a^\dagger(\lambda x. \text{Ochair'}(x))] \land [\Diamond b^\dagger(\lambda x. \text{Ochair'}(x))]$$

$$= \Diamond \text{Ochair'}(a) \land \Diamond \text{Ochair'}(b)$$ \hspace{1cm} ($\land > \Diamond$)

g. $\text{ANS}(P)(w) = \{\Diamond \text{Ochair'}(a), \Diamond \text{Ochair'}(b)\}$

From Figure 3.1, it can be nicely seen that a true proposition obtained based on $(a \land b)^\dagger$
entails all the true answers, even though the original answer space (the squared part) does not have a strongest true answer. Hence, the presupposition of \textsc{Ans} defined in (188) is satisfied. Employing \textsc{Ans} picks out the max-informative true propositions in the original answer space, yielding a set of mention-some answers.

\[
\begin{array}{c}
(a \land b)^\ddagger(P) \\
\downarrow \\
P(a) \quad \land \\
\quad \quad P(b) \\
\downarrow \\
P(a \lor b)
\end{array}
\]

Figure 3.1: The answer space of (190) under a mention-some reading

where \( P = \lambda \pi_{(ext,st)} \lambda w[\uparrow \text{people'}(\pi) \land \downarrow w \pi(\lambda x.\text{Chair'}(x))] \)

\subsection{3.5.3. Preserving the merits of Dayal’s presupposition}

Type-shifting a non-scopal expression has no scopal effect. For instance in (191), whichever type-lifting operation is employed, the obtained inference is \textit{Andy came}.\(^5\)

\begin{enumerate}
\item[(191)] Andy came.
\item[a.] \( \llbracket\text{Andy}\rrbracket = a \)
\item[b.] \( \llbracket \text{came}\rrbracket(\llbracket\text{Andy}\rrbracket) = \text{came'}(a) \)
\item[c.] \( \llbracket\text{Andy}\rrbracket^\dagger = \lambda P.P(a) \)
\item[d.] \( \llbracket\text{Andy}\rrbracket^\dagger(\llbracket\text{came}\rrbracket) = \text{came'}(a) \)
\item[e.] \( (\llbracket\text{Andy}\rrbracket^\dagger)^{\dagger\dagger} = \lambda \theta. a(\lambda x. \theta(\lambda P.P(x))) = \lambda \theta. \theta(a^\dagger) \)
\end{enumerate}

\(^5\)As Simon Charlow (p.c.) points out, the internal-lift operation is not defined on a proper name. But it is possible to internally lift a lifted proper name: \((a^\dagger)^{\dagger\dagger} = \lambda \theta. a(\lambda x. \theta(\lambda P.P(x))) = \lambda \theta. \theta(a^\dagger)\).
f. \((\text{[Andy]}^{\downarrow})^{\uparrow}(\text{[came]}^{\downarrow}) = \text{came}^\uparrow(a^\downarrow) = \text{came}'(a)\)

Hence, in the case that the topical property of a question is defined for only non-scopal items (such as individuals of type \(e\)), or say, this question takes an individual reading, the repair strategy would not add any proposition to the original answer space. The merits of Dayal’s presupposition are thus preserved.

3.5.3.1. Uniqueness requirements

The singular \(wh\)-phrase \(which \ boy\) lives on a set consisting of only atomic boys (see section 1.5.3), which is therefore the only possible domain for the topical property of (193). Type-shifting an atomic element, whichever operation is employed, does not change the corresponding propositional answer. For instance, let \(a\) stand for the atomic boy \(Andy\), \(P(a)\) and \(a^\uparrow(P)\) both return the singular answer that \(a \ came\). Hence, the proposed repair strategy makes no change to the answer space. In the case that multiple boys came, the presupposition of \(ANS\) is not satisfied, which therefore explains the uniqueness requirement. This analysis also extends to numeral-modified questions.

(192) \(BE([\text{which boy}_@]) = \uparrow\text{boy}_@ = \text{boy}_@\)

(193) Which boy came?

\(w: Among \ the \ boys, \ only \ Andy \ and \ Billy \ came.\)

a. \(P = \lambda x.\lambda w[\text{boy}_@'(x) \land \text{came}'_w(x)]\)

b. \(\text{Dom}(P) = \{a, b, \ldots\} = \text{boy}_@\)

c. true answers: \(\{\text{came}'(a), \text{came}'(b)\}\)

d. \(ANS(P)(w)\) is undefined
3.5.3.2. Questions with non-monotonic collective predicates

As seen in example (172), re-formulated below using the proposed hybrid semantics, in case that a question has a non-monotonic collective predicate, its individual reading gives rise to an unwelcome mention-some interpretation and must be ruled out.

(194) Which boys formed a team?

\((w: \text{the considered boys formed two teams in total: } ab \text{ formed one, and } cd \text{ formed one.})\)

a. **Individual reading** \(\rightsquigarrow \text{mention-some } \#\)

What is an item \(x\) s.t. \(x\) is a plural boy and \(x\) formed a team?

i. \(P = \lambda x.\lambda w[\dagger *\text{boy}_@ (x) \land \text{form}'_w (x)]\)

ii. \(\text{Dom}(P) = \dagger *\text{boy}_@ \cap D_e = *\text{boy}_@\)

iii. True answers: \{\text{form}'(a@b),\text{form}'(c@d)\}

b. **Higher-order reading** \(\rightsquigarrow \text{mention-all } \sqrt{\}\)

What is a generalized quantifier \(\pi\) s.t. \(\pi\) is a conjunction or disjunction over boys and that \(\pi\) formed a team?

i. \(P = \lambda \pi(\text{est}, st) . \lambda w [\dagger *\text{boy}_@ (\pi) \land \pi(\lambda x.\text{form}'_w (x))]\)

ii. \(\text{Dom}(P) = \dagger *\text{boy}_@ \cap D_{(\text{est}, st)} = \{a, b, a \land b, \ldots\}\)

iii. True answers: \{\text{form}'(a@b),\text{form}'(c@d),\text{form}'(a@b) \land \text{form}'(c@d)\}

Since the proposed repair strategy makes no difference to individual readings, the presupposition of ANS in (188) has the same effects as Dayal’s presupposition: in case that the considered boys formed multiple teams, (194) cannot obtain an exhaustive answer.
based on individual boys; hence the individual reading is ruled out due to presupposition failure.

3.5.4. Weak island effects

The proposed analysis for preserving mention-some relies on the scope ambiguity of generalized quantifiers. In a $\Diamond$-question, to obtain a mention-some reading without violating the presupposition of the ANS-operator, the topical property needs to be defined for generalized conjunctions, or equivalently, this question needs to take a higher-order reading. Moreover, the derivation of a higher-order reading involves scope reconstruction (see section 1.5.4), which is sensitive to weak islands. For these reasons, I predict that mention-some readings are subject to weak island constraints.

The sensitivity to weak island effects is illustrated in the following examples, taken from Spector (2007). In these examples, the narrow scope readings of the elided disjunctions are blocked due to negative islands and factive islands.

(195) Speaker A: “Which books didn’t Jack read?”

Speaker B: “The French novels or the Russian novels.”

a. $\not\exists$ Jack either read the French novels or Russian novels

b. $\exists$ Jack either didn’t read the French novels or didn’t read Russian novels.

(196) Speaker A: “Which books did Mary discover that Jack read?”

Speaker B: “The French novels or the Russian novels.”

a. $\not\exists$ Mary discovered [that Jack either read the French novels or the Russian novels].
(This inference could be true in the following scenario: Jack read the French novels but not the Russian ones, and Mary discovered that Jack read either the French novels or the Russian novels without knowing that he in fact read the French ones.)

b. √ Either Mary discovered that Jack read the French novels or she discovered that he read the Russian novels.

(This inference presupposes that Jack actually read both the French novels and the Russian novels.)

Extending this idea to modalized questions, we correctly predict the unavailability of mention-some in (197), which involves a negative island.

(197) Who doesn’t have to serve on the committee? (# mention-some)

(w: Neither Andy nor Billy have to serve on the committee.)

a. # [CP BEDOM(who) λx [IP not [have to [x serve on the comm]]]]

b. * [CP BEDOM(who) λπ [IP not [have to [π λx [x serve on the comm]]]]]

c. √ [CP BEDOM(who) λπ [IP π λx [not [have to [x serve on the comm]]]]]

d. √ [CP BEDOM(who) λX [IP EACH(X) λx [not [have to [x serve on the comm]]]]]

The LF (197a) yields an individual reading, which however violates the presupposition of the ANS-operator in the given discourse. The LF (197b) is similar to the proposed LF for mention-some readings of ◇-questions (see the LF for mention-some in (118)); but it is syntactically ill-formed because it involves scope reconstruction across a negative island. The rest two LFs (197c-d) are well-formed but yield mention-all readings.
3.6. Anti-presuppositions of plural questions

A plural ◊-question rejects a mention-some answer that names only one atomic individual. Compare the questions in (198) and (199). If the committee needs one chair but multiple members, mention-some answers of (198) and (199), if they are available, would be based on atomic individuals and groups of individuals, respectively. With this difference, (199) admits both mention-some and mention-all answers, but (198) accepts only the mention-all answer (198b) and requires the non-exhaustive answer (198a) to be ignorance-marked.

(198) Which professors can chair the committee?

\( w: \) the committee can and can only be chaired by either John or Mary.

a. # John.

a’ John...

b. John and/or Mary.

(199) Which professors can form the committee?

\( w: \) the committee can only be formed by any two professors among John, Mary, and Sue.

a. John+Mary.

b. John+Mary, John+Sue, and/or Mary+Sue.

The contrast above is more salient in embedding contexts. Compare the two following indirect questions. (200a) requires John to know the mention-all answer of (198); while (200b) only requires John to know a mention-some answer of of (199).
(200)  a. John knows which professors can chair the committee.

         b. John knows which professors can form the committee.

Sauerland et al. (2005) make use of the principle of *Maximize Presupposition* (Heim 1991) to analyze inferences evoked by plurals.

(201)  **Maximize Presupposition** (Heim 1991)

Out of two sentences which are presuppositional alternatives and which are contextually equivalent, the one with the stronger presuppositions must be used if its presuppositions are met in the context.

Based on this principle, Sauerland et al. (2005) argue that singulars are more presuppositional than plurals, and thus that a plural-morpheme implicates an “anti-presupposition” that *the singular counterpart is undefined*.

Following this idea, I propose that a plural *wh*-phrase implicates an anti-presupposition, namely that **the corresponding singular question is undefined**. Further, in spirit of question-answer congruence, I propose that a proper answer of a plural question needs to entail the anti-presupposition of this question. On this account, the plural question (198) rejects mention-some because a mention-some answer names only one individual and does not entail the anti-presupposition that *the singular question ‘which professor can chair the committee’ is undefined*. In contrast, (199) admits mention-some because its mention-some answers do entail the anti-presupposition that *the singular question ‘which professor can form the committee’ is undefined*. 

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3.7. Summary

This chapter has been centered on the dilemma between uniqueness and mention-some, and more broadly, the conflict between Dayal’s (1996) presupposition and Fox’s (2013) generalization of mention-some. With Dayal’s presupposition, mention-some readings can never be grammatically licensed. Without Dayal’s presupposition, Fox’s generalization predicts undesired mention-some readings for the following questions: (a) questions that are subject to uniqueness requirements (e.g., *which boys came?*); and (b) questions with non-monotonic collective predicates (e.g., *which boys formed a team?).

Fox (2013) offers a solution to this dilemma based on Spector’s (2007, 2008) diagnose of higher-order answers and the idea of innocent exclusion (Fox 2007). This solution, however, fails in predicting individual mention-some readings of $\Diamond$-questions with quantifiers (for instance: *where can everyone get gas?).

I propose that, in search of the strongest true answer, short answers with scopal effects can be interpreted as if they took a wide scope. Technically, I weaken Dayal’s presupposition by allowing the strongest true answer to be obtained based on a type-lifted variant of a short answer.

In the case of a non-scopal item, type-lifting makes no difference. Therefore, if a question takes an individual reading (namely, the short answers are all individuals of type $e$), this repair strategy makes no difference. Therefore my solution preserves the merits of Dayal’s presupposition in interpreting questions with uniqueness requirements and questions with non-monotonic collective predicates.

By contrast, in the case of a generalized quantifier, applying internal lift (Shan &
Barker 2006) yields a wide scope reading of this quantifier. Hence, if a question takes a higher-order reading (namely, the short answers are generalized quantifiers), it can always obtain a strongest true answer based on a generalized conjunction. Mention-some readings are thus preserved in ◊-question admitting higher-order readings. Moreover, since the derivation of a higher-order reading involves scope reconstruction, this account further predicts that the availability of mention-some is subject to weak island constraints.

Following Sauerland et al. (2005), I propose that plural questions implicates an anti-presupposition that *the corresponding singular question is undefined*. This proposal predicts the fact that a plural ◊-question (e.g., *which professors can chair the committee?*) rejects a mention-some answer that names only one atomic individual.
Chapter 4

Variations of exhaustivity and sensitivity to false answers
4.1. Introduction

There have been a plenty of studies on the interpretations of indirect questions, especially on the variations of exhaustivity. Most of the studies take weak exhaustivity as the baseline and generate other forms of exhaustivity using some strengthening operation (such as employing a strong answerhood-operator or strengthening the root denotation). Nevertheless, to unify mention-some and mention-all, we have replaced weak exhaustivity with max-informativity. This move requires to revise the derivational procedures of other forms of exhaustivity accordingly.

The center of this chapter is to characterize the false answer (FA)-sensitivity condition. Previous accounts (Klinedinst & Rothschild 2011; Spector & Egré; Uegaki 2015) consider only the case of indirect mention-all questions and treat it as a result of strengthening weak exhaustivity. George (2011, 2013) observes that, however, FA-sensitivity is also involved in interpreting indirect mention-some questions, which therefore calls for a uniform treatment of FA-sensitivity. Moreover, I observe that the content of FA-sensitivity is richer than what the previous accounts thought: it is concerned with not only possible complete answers, but also the answers that are always partial, such as false disjunctive answers and false denials.

The rest of this chapter is organized as follows. Section 4.2 introduces some basics about question-embedding, including the typology of question-embedding predicates and the forms of exhaustivity involved in interpreting indirect mention-all questions. Section 4.3 and 4.4 discuss and experimentally validate two facts that challenge the traditional view on FA-sensitivity: (i) indirect mention-some questions have readings sensitive
to false answers (George 2011, 2013); (ii) FA-sensitivity is concerned with partial answers. Section 4.5 presents my proposal. This section has the following four goals: (i) characterizing Completeness and FA-sensitivity; (ii) explaining the interactions between FA-sensitivity and factivity, especially the contrast between emotive factives and cognitive facts; (iii) explaining the unavailability of mention-some for questions embedded under agree; and (iv) explaining the asymmetry of FA-sensitivity observed from Exp-MA and Exp-MS. Section 4.6 reviews the exhaustification-based account by Klinedinst & Rothschild (2011). Section 4.7 summarizes the lines of approaches to the distinction between weak/strong exhaustivity and shows how those approaches can be adapted to the proposed framework.

4.2. Background

4.2.1. Interrogative-embedding predicates

There is a rich literature on the interpretations of indirect questions and the semantics of interrogative-embedding predicates.\(^\text{1}\) The following tree illustrates the typology of interrogative-embedding predicates, adapted from Lahiri (2002), Spector & Egré (2015), and Uegaki (2015).

\(^{1}\text{Representative studies are listed the following: Karttunen (1977); Groenendijk & Stokhof (1982, 1984); Heim (1994); Ginzburg (1995); Dayal (1996, in progress); Beck & Rullmann (1999); Lahiri (2002); Beck & Sharvit (2002); Sharvit (2002); Guerzoni & Sharvit (2007); George (2011, 2013); Klinedinst & Rothschild (2011); Nicolae (2013); Spector & Egré (2015); Kríž (2015); Xiang (2015); Uegaki (2015); Cremers & Chemla (2016); Cremers (2016); Theiler et al. (2016).}
Rogative versus responsive  Following Lahiri (2002), we firstly classify interrogative-embedding predicates into two major classes, namely rogative predicates and responsive predicates. Rogative predicates are only compatible with interrogative complements, while responsive predicates are also compatible with declarative complements. We further divide responsive predicates into two groups, based on veridicality with respect to interrogative complements. Compare the following minimal pair:

(202)  a. John knows who left.

\[\rightsquigarrow\text{For some true answer } p \text{ as to who came, John knows } p\]

b. John is certain who left.

\[\rightsquigarrow\text{For some possible answer } p \text{ as to who came, John is certain that } p\]

(202a) implies that John knows a complete true answer as to who left, while (202b) only suggests that John is sure about the truth of a possible answer as to who left. Hence, we say that know is veridical while be certain is non-veridical.
Communication verbs as factives  A few more things need to be clarified for communication verbs like \textit{tell} and \textit{predicate}. Karttunen (1977) claims that \textit{tell} is non-veridical with respect to declarative complements, but that it can be veridical with respect to interrogative complements. For instance, (203a) does not imply that what John told us is the truth (namely, does not imply that Mary indeed left), while (203b) intuitively suggests that John told us the truth as to who left. Based on this contrast, Karttunen concludes that it is the interrogative complement that contributes to the veridicality of \textit{tell} in (203b).

\begin{enumerate}
\item[(203)]
\begin{enumerate}
\item John told us that Mary left.
\[ \not\rightarrow \text{Mary left.} \]
\item John told us who left.
\[ \not\rightarrow \text{For some true answer } p \text{ as to who came, John told us } p. \]
\end{enumerate}
\end{enumerate}

Contrary to Karttunen’s claim, Spector & Egré (2015) argue that declarative-embedding \textit{tell} does admit a factive/veridical reading. Compare the examples in (204): while the indirect question in (204a) by itself does not necessarily imply the truth of the declarative complement, embedding it under negation or in a polar question strongly suggests the truth of the declarative complement. These facts suggest that the declarative-embedding \textit{tell} also has a factive reading, under which it triggers a factive presupposition. Following this idea, I classify communication verbs taking veridical readings as factives.

\begin{enumerate}
\item[(204)]
\begin{enumerate}
\item Sue told Jack that Fred is the culprit.
\[ \not\rightarrow \text{Fred is the culprit.} \]
\item Sue didn’t tell Jack that Fred is the culprit.
\[ \not\rightarrow \text{Fred is the culprit.} \]
\item Did Sue tell Jack that Fred is the culprit?
\[ \not\rightarrow \text{Fred is the culprit.} \]
\end{enumerate}
\end{enumerate}
Not every veridical predicate is factive (Egré 2008; Uegaki 2015). For instance, *prove* is veridical with respect to both interrogative and declarative complements, but they are not factive. The following examples are taken from Uegaki (2015: chapter 4).

(205)  

a. John proved which academic degree he has.

~ ∃ some true answer p as to which academic degree John has, John proved p.

b. John proved that he has a PhD.

~ John has a PhD.

c. John didn’t prove that he has a PhD.

~ John has a PhD

4.2.2. Forms of exhaustivity

Earlier works have noticed two forms of exhaustivity involved in interpreting indirect mention-all questions, namely weak exhaustivity (Karttunen 1977) and strong exhaustivity (Groenendijk & Stokhof 1984). Consider the indirect question (206) for an illustration.2 The weakly exhaustive (WE) reading only requires John to know the mention-all answer as to *who came*, while the strongly exhaustive (SE) reading also requires John to know the mention-all answer as to *who didn’t come*. Recent works (Klinedinst & Rothschild 2011, Spector & Egré 2015, Uegaki 2015, Cremers & Chemla 2016) start to consider an intermediate form of exhaustivity: stronger than WE but weaker than SE, the intermediately exhaustive (IE) reading requires John to know the mention-all answer as to *who came* and

---

2This example is just to illustrate the range of theoretically possible readings. At this point, I am not committed to any empirical claim about the readings of (206).

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have no false belief as to who came. I call the underlined condition “be sensitive to false answers”, and abbreviate it as “the FA-sensitivity condition”.

(206) John knows who came.

(\textit{w: Among the three considered individuals, Andy and Billy came, but Cindy didn’t.})

a. John knows that \textit{a} and \textit{b} came. \hspace{1cm} \textit{WE}

b. John knows that \textit{a} and \textit{b} came; and John knows that \textit{c} did \textbf{not} come. \hspace{1cm} \textit{SE}

c. John knows that \textit{a} and \textit{b} came; and \textbf{not} [John believes that \textit{c} came]. \hspace{1cm} \textit{IE}

Many different empirical claims have been made as to which embedding predicates license which forms of exhaustivity. For now, I only consider veridical responsive predicates, which can be classified into the following four groups.

(207) \textbf{Veridical responsive predicates}

a. Cognitive factives: \textit{know, remember, discover, ...}

b. Emotive factives: \textit{be surprised, be pleased, be annoyed, ...}

c. Communication verbs: \textit{tell, predict, ...}

d. Non-factives: \textit{be clear, prove, ...}

It is generally believed that SE readings are licensed by cognitive factives (Groenendijk & Stokhof 1982, 1984) but are difficult for other veridical responsive predicates (Heim 1994; Beck & Rullmann 1999; Guerzoni & Sharvit 2007; Nicolae 2013; Uegaki 2015). Nevertheless, Cremers & Chemla (2016) recently found experimental evidence that supports the existence of SE readings for the communication verb \textit{predict}.

As for the distribution of WE readings, there are basically two positions, distinct with
respect to whether WE readings can be licensed by cognitive factives: one position (Gronendijk & Stokhof 1984; George 2011; Uegaki 2015) believes that WE readings can be licensed by most veridical responsive predicates except cognitive factives; the other position (Karttunen 1977; Heim 1994; Guerzoni & Sharvit 2007; Klinedinst & Rothschild 2011) believes that WE readings are also available under cognitive factives. For instance, Guerzoni & Sharvit (2007) argue that the consistency of (208) would be left unexplained if know admits only SE readings.

(208)  Jack knows who came, but he does not know who did not come.

Nevertheless, for authors taking either position, the readings that they claim to be WE might be actually IE readings. Lahiri (2002) firstly discusses the possible confusion between WE and IE in the cases of know. He argues that the WE reading is too weak for know, based on the following example due to J. Higginbotham. This sentence cannot be true (on any conceivable reading) if John happens to believe that all numbers between 10 and 20 are prime.

(209)  John knows which numbers between 10 and 20 are prime.

Cremers & Chemla (2016) experimentally validated the existence of IE readings for know and predict. Moreover, they indicated that it is difficult to establish the existence of WE readings for know at least, because what appears to be WE readings might be actually SE or IE readings with covert domain restrictions. The only “seeming” exceptions with respect to the availability of IE, as Uegaki (2015) claims, are emotive factives. For instance, in the given discourse, (210) does not imply the inferences in (210a-b).
John is surprised at who came.

(w: Among the three considered individuals, Andy and Billy came, but Cindy didn’t.)

a.  $\neg \neg$ John isn’t surprised that $c$ came.

b.  $\neg \neg$ If it were the case that $c$ came, John would be surprised that $c$ came.

Contrary to Uegaki’s claim, in section 4.5.3, I will argue that (210a-b) are not appropriate paraphrases of IE readings. Moreover, I will show that the condition that distinguishes IE from WE (viz., the FA-sensitivity condition) would collapse under the factive presupposition, which therefore makes the existence of IE readings undetectable. If all of these claims are right, then there is no independent WE readings for indirect questions.

I summarize my take on the distributional pattern of each exhaustive reading as follows:

(211) a. WE is not an independent reading;

b. IE is widely available;

c. SE is available at least under cognitive factives and communication verbs.

4.3. Two facts on FA-sensitivity

4.3.1. FA-sensitivity under mention-some

George (2011, 2013) observes that indirect mention-some questions also have readings sensitive to false answers, in parallel to the IE readings of indirect mention-all questions. For a concrete example, consider the scenario described in (212): Italian newspapers are available at Newstopia but not PaperWorld; both John and Mary know a true mention-
some answer as to *where one can buy an Italian newspaper* (viz., *at Newstopia*), but Mary also believes a false answer, namely *that one can buy an Italian newspaper at PaperWorld*. Intuitively, there is a prominent reading under which (371a) is true while (371b) is false.

(212) Scenario:

<table>
<thead>
<tr>
<th>Italian newspapers are available at ...</th>
<th>Newstopia?</th>
<th>PaperWorld?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>John’s belief</td>
<td>Yes</td>
<td>?</td>
</tr>
<tr>
<td>Mary’s belief</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

a. John knows where one can buy an Italian newspaper. [Judgment: TRUE]
b. Mary knows where one can buy an Italian newspaper. [Judgment: FALSE]

George takes this fact as an argument against the deductive view of interrogative-embedding *know*. On the deductive view, the meaning of the construction ‘*x knows Q*’ can be paraphrased based on *x*’s knowledge of facts or declaratives relevant to *Q*. The sensitivity to false answers in indirect mention-some questions shows that ‘which answers of *Q x knows*’ does not suffice to resolve ‘whether *x knows Q*’.

It is debatable, however, whether the reading described above for (212a-b) is to any extend exhaustive (see section 4.6.2). To be theory neutral, for both mention-all questions and mention-some questions, I call the readings that are sensitive to false answers “FA-sensitive readings”. I divide the truth conditions of an FA-sensitive reading into two parts, namely *Completeness* and *FA-sensitivity*, roughly described in (213).

(213) John told$_{[+\text{ver}]}$ Mary *Q*.  

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a. John told Mary a complete true answer of Q. \hspace{1cm} \textbf{Completeness}

b. John did not tell Mary any false answer of Q. \hspace{1cm} \textbf{FA-sensitivity}

4.3.2. FA-sensitivity to partial answers

What types of false answers are involved in the condition of FA-sensitivity? Previous studies consider only answers are can be complete and characterize FA-sensitivity accordingly.

(214) A proposition $p$ can be a complete answer of Q if and only if there is a world under which $p$ is a max-informative true answer of Q. Formally:

$$\exists w [p \in \text{ANS}(P)(w)],$$ where $P$ is the topical property of Q.

There are, however, many answers that are involved in FA-sensitivity but can never be complete. For example, (215) and (216) satisfy the Completeness condition but are intuitively false in the given scenarios. These facts suggest that the FA-sensitivity condition is also concerned with disjunctive partial answers of the form `$\phi_c \lor \phi_d$'.

(215) John told us who came. \hspace{1cm} [Judgment: \text{FALSE}]

a. Fact: $a$ and $b$ came; $c$ and $d$ didn’t come.

b. John said to us: “$a$, $b$, and someone else came, who might be either $c$ or $d$.”

(216) John told us where we could get gas. \hspace{1cm} [Judgment: \text{FALSE}]

a. Fact: $a$ and $b$ sold gas; $c$ and $d$ didn’t.

b. John said to us: “$a$, $b$, and somewhere else sell gas, which might be either $c$ or $d$.”

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Moreover, interpretations of indirect mention—some questions show that FA-sensitivity is also concerned with false denials, which are always partial and are even excluded from any Hamblin sets. George (2011, 2013) has discussed false answers that are over-affirming, namely overly affirming a possible answer that is false in the evaluation world: Mary incorrectly believes that Italian newspapers are available at store B. Correspondingly, we should also check false answers that are over-denying, namely denying a possible answer that is true in the evaluation world: Sue incorrectly believes that Italian newspapers are unavailable at store C.

\[ (217) \]

<table>
<thead>
<tr>
<th>Italian newspaper available at ...</th>
<th>A?</th>
<th>B?</th>
<th>C?</th>
<th>FA-type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facts</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>John’s belief</td>
<td>Yes</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Mary’s belief</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
<td>OA</td>
</tr>
<tr>
<td>Sue’s belief</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
<td>OD</td>
</tr>
</tbody>
</table>

a. John knows where one can buy an Italian newspaper. TRUE
b. Mary knows where one can buy an Italian newspaper. FALSE
c. Sue knows where one can buy an Italian newspaper. TRUE/FALSE?

The truth value of (217c) reflects whether FA-sensitivity is concerned with over-denying: if over-denying is involved in FA-sensitivity, then there should be a reading under which (217a) is true while (217c) is false. It is however a bit hard to judge whether (217c) is true or false (see explanation in section 4.5.5). In section 4.4, I provide experimental evidence to show that over-denying is indeed involved in FA-sensitivity: (217c) received significantly less acceptances than (217a).
Note that, from indirect mention-all questions, we cannot tell whether FA-sensitivity is concerned with over-denying. Consider (218) for instance, the requirement of avoiding over-denying can be understood in two different ways.

(218) John knows who came.

a. if \(x\) came, John believes that \(x\) came.

b. if \(x\) didn’t come, not [John believes that \(x\) came] Avoiding OA

c. if \(x\) came, not [John believes that \(x\) didn’t come]. Avoiding OD

One way is to treat this requirement simply as a logical consequence of Completeness, given that (218a) entails (218c). The other way is to treat this requirement as part of FA-sensitivity and group it together with the condition (218b), given that both (218b-c) are concerned with false answers. Previous accounts of FA-sensitivity (Klinedinst & Rothschild 2011; Uegaki 2015; Roelofsen et al. 2014) take the former option; they predict that FA-sensitivity is only concerned with false answers that are possibly complete answers. But given that FA-sensitivity is concerned with over-denying in indirect mention-some questions, we should accordingly take the second option for indirect mention-all questions.

4.4. Experiments

4.4.1. Design

The primary goal of the following experiments is to sort out whether over-denying is involved in the condition of FA-sensitivity. “Exp-MA” stands for reanalyzing Klinedinst
& Rothschild’s (2011) survey on indirect mention-all questions. “Exp-MS” stands for a corresponding experiment on indirect mention-some questions.

4.4.1.1. Exp-MA

Klinedinst & Rothschild (2011) conducted a survey to establish the existence of IE. They stipulated that four individuals *abcd* tried out for the swimming team, and that only *ad* made the team. Four sets of predictions (A1-A4 in Table 4.1) were made as to whether each individual made the team. For instance, A1 means that the agent predicted that *d* but not *a* nor *c* made the swimming team and that the agent was uncertain whether *b* made it.

<table>
<thead>
<tr>
<th>Did <em>x</em> make the swimming team?</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>Answer type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td><strong>No</strong></td>
<td>?</td>
<td>No</td>
<td>Yes</td>
<td>OD</td>
</tr>
<tr>
<td>A2</td>
<td>?</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>MS</td>
</tr>
<tr>
<td>A3</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
<td>Yes</td>
<td>MA</td>
</tr>
<tr>
<td>A4</td>
<td>Yes</td>
<td><strong>Yes</strong></td>
<td>?</td>
<td>Yes</td>
<td>OA</td>
</tr>
</tbody>
</table>

Table 4.1: Design of Exp-MA (Klinedinst & Rothschild 2011)

Next, they asked the participants to judge whether or not each prediction correctly predicted who made the swimming team. Each combination of responses corresponds to a reading of the indirect mention-all question *x* predicted who made the swimming team. For instance, the participants who chose IE would ideally accept A3 and reject the rest responses.
Klinedinst & Rothschild were not particularly interested in over-denying. They removed the participants who accepted A1/A2 (viz., the participants who were tolerant of incompleteness) from their analysis. But this survey is helpful for studying the sensitivity to false answers in indirect questions: A1 and A4 represent answers with over-denying and answers with over-affirming, respectively; A1 incorrectly predicted that \(a\) did not make the team, and A4 incorrectly predicted that \(b\) made the team. A2-A3 have no false predictions, but A2 violates Completeness. I renamed A1-A4 as OD/MS/MA/OA and re-analyzed the raw data.³ To distinguish my data analysis from Klinedinst & Rothschild’s, I will call my re-analysis “Exp-MA”.

4.4.1.2. Exp-MS

I conducted a similar experiment for MS-questions on MTurk:⁴ among the four liquor stores \(abcd\) at Central Square, only \(a\) and \(d\) sold red wine; Susan asked her local friends where she could buy a bottle of red wine at Central Square and received four responses (A1-A4 in Table 4.2). Participants were asked to identify whether each response correctly answered Susan’s question. Note here that A2 satisfies the condition of Completeness, contrary to the case in Exp-MA.

³See here (http://users.ox.ac.uk/~sfop0300/questionsurvey/) for the raw data. This survey has no fillers. Thus I excluded only participants who were (i) non-native speakers, (ii) rejected by Amazon Mechanical Turk (MTurk), or (iii) with missing responses. 107 participants (out of 193) were kept in my analysis.

⁴In Exp-MS, the four target items (A1-A4) and two fillers were randomized into 10 lists. I recruited 100 participants on MTurk. All the participants were required to have completed 90 HITs with the number of HITs approved no less than 50. All IP address were tied to the U.S. Based on the filler accuracy (100%), native language (English), and the completion rate (fully completed exactly one HIT), I kept 88 participants out of 100.
Could Susan buy a bottle of red wine at ...?

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>Answer type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fact</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>No</td>
<td>?</td>
<td>No</td>
<td>Yes</td>
<td>OD</td>
</tr>
<tr>
<td>A2</td>
<td>?</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>MS</td>
</tr>
<tr>
<td>A3</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
<td>Yes</td>
<td>MA</td>
</tr>
<tr>
<td>A4</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
<td>Yes</td>
<td>OA</td>
</tr>
</tbody>
</table>

Table 4.2: Design of Exp-MS

4.4.2. Results and discussions

Figure 4.2 and Figure 4.3 summarize the proportions of acceptances by ANSWER in Exp-MA and Exp-MS, respectively. ‘N’ stands for the sample size.⁵

In Exp-MA, A1 to A4 received 88, 75, 28, and 55 acceptances (out of 107), respectively. Note that the results might be noisy because the subjects/responses could not be removed based on filler accuracy. In Exp-MS, A1 to A4 received 70, 86, 86, and 50 acceptances (out of 88), respectively.

Figure 4.2: Proportion of acceptances by ANSWER in Exp-MA (N = 107)  
Figure 4.3: Proportion of acceptances by ANSWER in Exp-MS (N = 88)
4.4.2.1. FA-sensitivity

For every two answers in each experiment, I fitted a logistic mixed effects model predicting responses by ANSWER. All the models, except the one for MS versus MA in Exp-MS, reported a significant effect. These significant effects, especially the ones for OD versus MS/MA in Exp-MS, show that FA-sensitivity is concerned with both over-affirming and over-denying.

4.4.2.2. Asymmetry of FA-sensitivity

Compared with OD, OA received significantly more acceptances in Exp-MA ($\hat{\beta} = 1.0952$, $p<.001$) but significantly less acceptances in Exp-MS ($\hat{\beta} = -0.7324$, $p<.005$). These results suggest an asymmetry with respect to the sensitivity to over-affirming and over-denying:

\[\text{(219) Asymmetry of FA-sensitivity}\]

Over-affirming is more tolerated than over-denying in mention-all questions, but less tolerated than over-denying in mention-some questions.

What causes these asymmetries? One might suggest that over-denying is less tolerated than over-affirming in mention-all questions because over-denying even does not satisfy the Completeness condition. This suggestion yields the following prediction: if a participant was tolerant of incompleteness, then his or her responses would not show any asymmetry with respect to FA-sensitivity.

---

\[6\] A1 and A4 were coded as $-1$ and $1$, respectively. Formula: glmer(Choice ~ Item + (1|WorkerId), data = mydata, family = binomial (link="logit"), verbose = TRUE)
To assess this prediction, let us consider the participants in Exp-MA who were tolerant of incompleteness (viz., the participants who accepted both MS and MA, N=28). The distribution of each possible combination of responses from these subjects are summarized in Table 4.3.

<table>
<thead>
<tr>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>×</td>
<td>√</td>
<td>√</td>
<td>×</td>
<td>11</td>
</tr>
<tr>
<td>√</td>
<td>√</td>
<td>√</td>
<td>×</td>
<td>1</td>
</tr>
<tr>
<td>×</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>8</td>
</tr>
<tr>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4.3: Responses in Exp-MA (based on subjects accepting partial answers)

Contrary to this prediction, however, these participants also rejected OD significantly more than OA (binomial test: 89%, p<.05). In other words, over-denying is consistently less tolerated than over-affirming in mention-all questions, regardless of whether Completeness is concerned. Therefore, the asymmetry of FA-sensitivity vary by question-type, not result from Completeness. I will present an explanation to this asymmetry of FA-sensitivity in section 4.5.5.

4.5. Proposal

The primary goal of this section is to find a uniform characterization for the truth conditions of FA-sensitivity readings, namely Completeness and FA-sensitivity, as illustrated in the following based on the veridical communication verb *tell*. 
(220) John told [+ver] Mary Q.

a. John told Mary a complete true answer of Q. [Completeness]

b. John did not tell Mary any false answer of Q. [FA-sensitivity]

By “uniform” I mean that this characterization should work for both mention-all and mention-some, and that it can be extended to various types of responsive predicates (non-veridical predicates, cognitive factives, emotive factives, agree, and so on). To extend this characterization to the case of factives and agree, I will also discuss the following two issues: (i) the interactions between FA-sensitivity and factivity, especially the contrast between emotive factives and cognitive facts; (ii) the unavailability of mention-some for questions embedded under agree.

The end of this section proposes a principled explanation to the asymmetry of FA-sensitivity that we observed in Exp-MA and Exp-MS.

4.5.1. Characterizing Completeness

The characterization of Completeness is based on the assumptions of the hybrid approach of question semantics in section 1.4, repeated in the following. First, a root denotation of a question is a topical property, which maps an item in its domain to a possible propositional answer (see section 1.4.1). Second, following Fox (2013), I define completeness as max-informativity: a true answer is considered as a complete true answer if and only if it is not asymmetrically entailed by any of the true answers. Thus the set of complete true answers is derived as the following (see section 1.4.2): the ANS-operator applies to the topical property P and the evaluation world, returning the set of max-informative true
propositions in the range of $P$.

\[
(221) \quad \text{ANS}(P)(w) = \{P(\alpha) : \alpha \in \text{Dom}(P) \land w \in P(\alpha) \land \forall \beta \in \text{Dom}(P)[w \in P(\beta) \rightarrow P(\beta) \notin P(\alpha)]\}
\]

As shown in section 2.6, this definition works for both mention-all and mention-some readings.

Extending this idea to the case of indirect questions, we can schematize the Completeness condition of ‘John told Mary QP’ as in (222a) or (222b). For the sake of simplicity, I write the embedded interrogative as ‘QP’, which indicates that the embedded interrogative has a topical property $P$ and a Hamlin set $Q$.

\[
(222) \quad \text{The Completeness condition of ‘John told Mary QP’}
\]

a. $\lambda w. \exists f [\text{CH}(f) \land \text{told}'_w(j,m,f[\text{ANS}(P)(w)])]
\]

(John told Mary a max-informative true answer of Q.)

b. $\lambda w. \exists \phi \in \text{ANS}(P)(w)[\text{told}'_w(j,m,\phi)]
\]

(there is a max-informative true answer $\phi$ such that John told Mary $\phi$.)

Since $\text{ANS}(P)(w)$ denotes a set of max-informative true answers, we need an operation to get a proposition out of this set. The two options in (222) differ only with respect to how to existentially close this set. In (222a), a choice function which is bound at the matrix clause picks out one member out of $\text{ANS}(P)(w)$. In (222b), the set $\text{ANS}(P)(w)$ is conceived as a domain restriction of an existential closure. The derivation of (222b) involves moving the entire embedded interrogative over the interrogative-embedding predicate, à la quantifier raising a generalized quantifier, as illustrated below:
Both options in (222) allow us to treat the declarative-embedding *tell* and the interrogative-embedding *tell* uniformly as a predicate that selects for a proposition as its direct object. So far, I have not seen any empirical evidence that would strongly favor one option over the other.

Moreover, because the world argument of the Ans-operator is co-indexed with the one of the interrogative-embedding predicate, the predicate receives a veridical reading respect to the interrogative complement. This idea extends to the case of veridical non-factives (e.g., *prove* and *be clear*).

In the case of the non-veridical *tell*, adapting from Uegaki (2015: chapter 4), I assume that the world variable in $\text{Ans}(P)(w)$ is existentially bound at a non-local scopal site, as schematized in the following.

(224) The Completeness condition of ‘John told$_{-\text{ver}}$ Mary $Q_P$’

a. $\lambda w. \exists f [CH(f) \land \exists w'[told''_w(j, m, f[\text{Ans}(P)(w')])]]$

(John told Mary a possible max-informative answer of $Q_P$)

b. $\lambda w. \exists w' \exists \phi \in \text{Ans}(P)(w')[told''_w(j, m, \phi)]$

(there is a possible max-informative answer $\phi$ such that John told Mary $\phi$.)
4.5.2. Characterizing FA-sensitivity

The goal of this section is to capture the following two observations on FA-sensitivity which we saw above (see section 4.3 and 4.4): (i) FA-sensitivity is involved in interpreting both indirect mention-all questions and indirect mention-some questions; and (ii) FA-sensitivity is concerned with both complete answers and partial answers.

Previous accounts (Klinedinst & Rothschild 2011; Uegaki 2015) characterize FA-sensitivity as a logical consequence of strengthening/exhaustifying the weakly exhaustive inference. This line of approaches can be extended to mention-some questions via some extra techniques; but they cannot capture the fact that FA-sensitivity is also concerned with partial answers. A detailed review will be given in section 4.6.

I argue that the condition of FA-sensitivity is simply a matter of “Quality”: only make true contributions. This constraint is traditionally conceived as a conversational maxim due to Grice (1975). But here I treat it as a grammatical condition that is mandatorily involved in interpreting indirect questions with responsive predicates. This treatment also extends to the cases of non-veridical responsive predicates and emotive factives, although some minimal adjustments are needed.

Consider (225) for an illustration. Regardless of whether the embedded question is interpreted as mention-some or mention-all, the FA-sensitivity condition of this indirect question can be uniformly schematized as (225a) based on a Hamlin-set Q, or as (225b) based on the topical property P. Both formalizations can be read as everything that John told Mary about Q_P is true.

(225) The FA-sensitivity condition of ‘John told_{[+ver]} Mary Q_P’:
a. \( \lambda w. \forall \phi \in \text{REL}(Q)[\neg \phi(w) \rightarrow \neg \text{told}''_{w}(j,m,\phi)] \)

b. \( \lambda w. \forall \phi \in \text{REL}([P(\alpha) : \alpha \in \text{Dom}(P)])[\neg \phi(w) \rightarrow \neg \text{told}''_{w}(j,m,\phi)] \)

\text{REL}(Q) \) stands for the set of propositions that are relevant to the embedded interrogative, called “Q-relevant propositions” henceforth. Formally, this set is obtained by closing the Hamblin set \( Q \) under negation and Boolean propositional operations (namely, conjunctions and disjunctions), excluding tautologies and contradictions. For instance, if \( Q = \{ p, q \} \), then \( \text{REL}(Q) = \{ p, q, \neg p, \neg q, p \land q, p \lor q, p \land \neg q, ... \} \). A recursive definition and a set-theoretical definition are given in the following.

(226) **Definition: Q-relevant propositions** (recursive)

a. If \( p \in Q \), then \( p \in \text{REL}(Q) \) and \( \neg p \in \text{REL}(Q) \)

b. If \( p, q \in \text{REL}(Q) \) and \( p \land q \neq \bot \), then \( (p \land q) \in \text{REL}(Q) \)

c. If \( p, q \in \text{REL}(Q) \) and \( p \lor q \neq \top \), then \( (p \lor q) \in \text{REL}(Q) \)

d. Nothing else is in \( \text{REL}(Q) \).

(227) **Definition: Q-relevant propositions** (using set-theoretical notations)

\[
\text{REL}(Q) = \text{MIN}\{X : Q \subseteq X \land \forall p \in X[\neg \neg p \in X] \land \forall X' \subseteq X[\lor X' \in X \land \forall X' \in X]\} - \{\bot, \top\}
\]

The proposed treatment of the FA-sensitivity condition has two major advantages over the previous and other ongoing accounts. First, it works for both mention-all and mention-some, which therefore captures George’s (2011) observation for FA-sensitivity in mention-some questions (see section 4.3.1). Second, it takes all types of false answers into the account of FA-sensitivity, not just those that can be complete. This consequence captures the observation that FA-sensitivity is concerned with disjunctive partial answers.
(see section 4.3.2) as well as the experimental results in Exp-MS that mention-some questions are sensitive to over-denying (see section 4.4).

The FA-sensitivity inference does not arise when the interrogative-embedding tell takes a non-veridical reading. To predict this fact, we do not need to make any stipulation as to the distribution of FA-sensitivity, but instead apply the strategy in (224) for Completeness to FA-sensitivity. To be more concrete, we just need to make the world variable of \( \phi(w) \) existentially bound, as schematized in (228a) based on a Hamblin set or as in (228b) based on a topical property. Both formalizations mean that there is world such that everything John told Mary about \( Q \) is true in this world, or equivalently, that everything John told Mary about \( Q \) is consistent.

(228) The FA-sensitivity condition of ‘John told\(-\text{ver}\) Mary \(Q_P\)’:

a. \( \lambda w . \exists w' \forall \phi \in \text{REL}(Q)[told'_w(j, m, \phi) \rightarrow \phi(w')] \)

b. \( \lambda w . \exists w' \forall \phi \in \text{REL}([P(\alpha) : \alpha \in \text{Dom}(P))][told'_w(j, m, p) \rightarrow \phi(w')] \)

4.5.3. *Know versus surprise*: FA-sensitivity and factivity

In case the interrogative-embedding predicate triggers a factive presupposition, I predict that the FA-sensitivity inference would collapse under the factive presupposition. This prediction explains why questions with emotive factives “seemingly” reject FA-sensitive readings.

For instance in (229), the emotive factive be surprised triggers a factive presupposition. Accomodating this presupposition locally makes no difference to the Completeness condition but turns the FA-sensitivity condition into a tautology.
(229) John is surprised at $Q_p$.

a. $\lambda w. \exists \phi \in \text{ANS}(P)(w)[\text{surprise}'_w(j, \phi) \land \phi(w)]$ \hspace{2cm} \textit{Completeness}

($\lambda w.$ John is surprised$_w$ at a max-informative true answer of $Q_p$ in $w$)

b. $\lambda w. \forall \phi \in \text{REL}(Q)[\phi(w) \rightarrow \neg[\text{surprise}'_w(j, \phi) \land \phi(w)]]$ \hspace{2cm} \textit{FA-sensitivity}

($\lambda w.$ every $Q$-relevant proposition $\phi$ such that $\phi$ surprises$_w$ John and is true in $w$ is true in $w$)

More concretely speaking, (230b) is true as long as the factive presupposition is accommodated under negation. By contrast, (230c) is not implied because global accommodation causes presupposition failure.

(230) John is surprised at who came.

($w$: Among the three considered individuals, Andy and Billy came, but Cindy didn’t.)

a. $\sim \phi$ John is surprised that $ab$ came. \hspace{2cm} \text{surprise}'(j, \phi_a \land \phi_b)$

b. $\sim \phi$ it isn’t the case that John is surprised that $c$ came. \hspace{2cm} $\neg[\text{surprise}'(j, \phi_c) \land \phi_c]$

c. $\neg \phi$ John isn’t surprised that $c$ came. \hspace{2cm} $\neg \text{surprise}'(j, \phi_c)\phi_c$

Puzzles arise in cases of cognitive factives. Spector & Egré (2015) speculate that the FA-sensitive (viz., IE) reading of (231) should be paraphrased as (231c) rather than (231a-b). To be more concrete, in paraphrasing the FA-sensitivity inference, the factive verb $\text{know}$ should be replaced with its non-factive counterpart $\text{believe}$, and the factive presupposition should be ignored.$^7$

$^7$In (231a), ‘$\text{know}'(j, \phi_c)\phi_c$’ stands for an inference that asserts $\text{know}'(j, \phi_c)$ and presupposes $\phi_c$. 
(231) John knows who came.

(w: Among the three considered individuals, Andy and Billy came, but Cindy didn’t.)

a. \( \times \text{know}'(j, \phi_a \land \phi_b) \land \neg \text{know}'(j, \phi_c) \). 

b. \( \times \text{know}'(j, \phi_a \land \phi_b) \land \neg [\text{know}'(j, \phi_c) \land \phi_c] \)

c. \( \sqrt[\text{know}'](j, \phi_a \land \phi_b) \land \neg \text{believe}'(j, \phi_c) \)

We need to explain two puzzles. **First**, why is that (231c) is more preferable than (231a-b)? The answer is simple: (231a) suffers presupposition failure, and (231b) is a tautology; therefore, whenever allowed, it is better to “deactivate” the factive presupposition of know in paraphrasing the FA-sensitivity inference. **Second**, why is that the FA-sensitivity inference of (230) keeps the factive presupposition of be surprised and accommodates it locally, contrary to the case in (231)? This contrast correlates with the general distinction between emotive factives and cognitive factives as presupposition triggers, as exemplified in (406a): the factive presupposition triggered by the cognitive factive discover is defeasible, while that triggered by the emotive factive regret is not.

(232) a. If someone regrets that I was mistaken, I will admit that I was wrong.

\( \to \) The speaker was mistaken.

b. If someone discovers that I was mistaken, I will admit that I was wrong.

\( \to \) The speaker was mistaken.

Earlier works have argued that emotive factives are strong triggers, while cognitive factives are weak triggers (Karttunen 1971; Stalnaker 1977). Recent theoretical and experimental works (Romoli 2012, 2015; Romoli & Schwarz 2015) argue that the presuppositions
of soft triggers are actually scalar implicatures. The contrast between hard and soft triggers is far beyond the scope of this dissertation, but whatever accounting for this contrast can also explain the contrast between (230) and (231) with respect to the FA-sensitivity inferences.

4.5.4. Agree: mention-some collapses under FA-sensitivity and opinionatedness

An indirect questions with a non-veridical responsive predicate agree also exhibits sensitivity to “false answers”. For instance, for any of the following sentences to be true, if Mary believes that Cindy didn’t come, John cannot have the belief that Cindy came.

(233)  a. John agrees with Mary on who came.
       b. John and Mary agree on who came.

It is still controversial what precisely the truth conditions of (233a-b) are. The experimental results in Chemla & George (2016) overall favor Lahiri’s (2002) empirical claim, as summarized in the following:

8Chemla & George’s (2016) experimental results did not find any significant difference between agree with and agree on, which is puzzling for the asymmetric reading that Lahiri assumes for agree with. To be more concrete, Chemla & George predict the following truth condition for both (233a-b):

(1)  a. \( \forall x \) [Mary believes that \( x \) came \( \rightarrow \) John believes that \( x \) came]
       b. \( \forall x \) [\( \neg \) [Mary believes that \( x \) did came] \( \rightarrow \) \( \neg \) [John believes that \( x \) came]]

John and Mary have the same positive belief as to who came. But, as Alexandre Cremers points out (p.c.) to me, we do not need to draw strong interpretations from the lack of difference between agree with and agree on in the results, because it might be due to experimental artifact.
if and only if $A$ and $B$ have the same positive beliefs on $Q$. (See different views in Beck & Rullmann (1999), Egré & Spector (2007, 2015), George (2011), and Uegaki (2015: chapter 4)).

My take on the truth conditions of (1) are as follows. The (a) conditions in (234) and (235) are simply the ones proposed by Lahiri. The (b-c) conditions are concerned with disagreements. For instance, (234b) says that John cannot have any belief that contradicts Mary’s belief as to who came. Mary believes that $c$ didn’t come, and then due to the (b) condition, John cannot have the belief that $c$ came. By contrast, Mary is ignorant as to whether $d$ came, and then it does not matter whether John believes $d$ came. In (235), condition (c) is added due to the symmetric reading of agree on; note that here the conditions (b-c) collapse under the condition (a).

(234)  John agrees with Mary on who came.

a. $\forall x [\text{Mary believes that } x \text{ came} \rightarrow \text{John believes that } x \text{ came}]$

b. $\forall x [[\text{Mary believes that } x \text{ did not came}] \rightarrow \text{not } [\text{John believes that } x \text{ came}]]$

9Beck & Rullmann (1999) assume the conditions in (1a-b); and Spector & Egré (2015) and George (2011) also assume the condition (1c), due to Kratzer (2006). Nevertheless, as the results from Chemla & George’s (2016) experiments show, the conditions in (1b-c) are too strong.

(1) ‘$A$ agrees on $B$ on $Q$’

a. $A$ and $B$ have the same positive beliefs on $Q$

b. $A$ and $B$ have the same negative beliefs on $Q$;

c. $A$ and $B$ are fully opinionated at $Q$.

Uegaki (2015) follows Chemla & George’s (2016) experimental results and assumes the conditions in (1a-b) for both agree with and agree on. He analyzes (1b) as a consequence of exhaustifying (1a).
John and Mary agree on who came.

a. $\forall x \, [\text{Mary believes that } x \text{ came}] \leftrightarrow [\text{John believes that } x \text{ came}]$

b. $\forall x \, [[\text{Mary believes that } x \text{ did not came}] \rightarrow \text{not } [\text{John believes that } x \text{ came}]]$

c. $\forall x \, [[\text{John believes that } x \text{ did not came}] \rightarrow \text{not } [\text{Mary believes that } x \text{ came}]]$

These truth conditions above can be easily characterized by the proposed account. Here I consider only the case of agree with. The conditions in (234a) and (234b) correspond to Completeness and FA-sensitivity, respectively. We firstly find out the max-informative members among the answers that Mary believes, as schematized in (236). The Completeness condition requires John to believe one of these propositions. The FA-sensitivity condition is concerned with all types of disagreements relevant to the embedded interrogative, including positive beliefs, negative beliefs, and partial beliefs.

(236) a. $\mathcal{B}_w(m, P) = \{P(\alpha) : \alpha \in \text{Dom}(P)\} \cap \{\phi : \text{believe}_w'(m, \phi)\}$

b. $\text{MaxI}(\mathcal{B}_w(m, P)) = \{p : p \in \mathcal{B}_w(m, P) \land \forall q \in \mathcal{B}_w(m, P)[q \not\in p]\}$

(237) John agrees with Mary on $Q_P$. 

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a. \(\lambda w. \exists \phi \in \text{MaxI}(B_w(m, P))[\text{believe}_w'(j, \phi)]\)  
Completeness

\((\lambda w. \text{John believes}_w \text{ a max-informative member of } B_w(m, P))\)

b. \(\lambda w. \forall \phi \in \text{Rel}(Q)[\text{believe}_w'(m, -\phi) \rightarrow -\text{believe}_w'(j, \phi)]\)  
FA-sensitivity

(for every \(Q\)-relevant proposition, John’s belief doesn’t contradict Mary’s belief)

What strikes me the most is that a \(\Diamond\)-question embedded under agree does not admit mention-some readings. For example, for (238) being true, John needs to share all the positive beliefs that Mary has as to who can chair.

(238) John and Mary agree on who can chair the committee.

a. \(\sim \forall x [\text{Mary believes that } x \text{ can chair} \leftrightarrow \text{John believes that } x \text{ can chair}]\)

b. \(\sim \forall x [\text{not } \text{Mary believes that } x \text{ can chair} \leftrightarrow \text{not } \text{John believes that } x \text{ can chair}]\)

<table>
<thead>
<tr>
<th>Can ... chair the committee?</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary’s belief</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td>John’s belief can be</td>
<td>Yes</td>
<td>Yes</td>
<td>No/?</td>
<td>Yes/No/?</td>
</tr>
</tbody>
</table>

To be more concrete, compare the scenarios described in the following two tables, (238) is intuitively false in both scenarios. The conditions characterized in (236) correctly predict (238) to be false in Scenario 1 due to the violation to the FA-sensitivity condition: Mary doubts at \(\sim \phi_b\) (viz., \(b\) cannot chair), while John believes \(\phi_b\). Nevertheless, we incorrectly predict (238) to be true in Scenario 2, where John is ignorant as to whether \(b\) can chair: (i) John agrees with Mary that \(a\) can chair, and hence Completeness is satisfied; (ii) John
has no belief that contradicts Mary’s belief as to who can chair, and hence FA-sensitivity is satisfied.

<table>
<thead>
<tr>
<th>Can ... chair the committee?</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary’s belief</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td>John’s belief</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>?</td>
</tr>
</tbody>
</table>

Table 4.4: Scenario 1

<table>
<thead>
<tr>
<th>Can ... chair the committee?</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary’s belief</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>?</td>
</tr>
<tr>
<td>John’s belief</td>
<td>Yes</td>
<td>?</td>
<td>No</td>
<td>?</td>
</tr>
</tbody>
</table>

Table 4.5: Scenario 2

In responding to the unavailability of mention-some, I propose that indirect questions with agree also evoke an Opinionatedness condition.

(239) The Opinionatedness condition of ‘John agrees with Mary on Q_P’

\[ \lambda w. \forall \phi \in \text{MaxI}(\mathcal{B}_w(m, P))[\text{opinionated}_w(j, \phi)] \]

(John is opinionated about every max-informative belief of Mary on Q_P.)

FA-sensitivity and Opinionatedness together entail a mention-all inference:

(240) a. FA-sensitivity ⇒ \( \lambda w. \forall \phi \in \text{MaxI}(\mathcal{B}_w(m, P))[-\text{believe}'_w(j, \neg \phi)] \)

b. Opinionatedness = \( \lambda w. \forall \phi \in \text{MaxI}(\mathcal{B}_w(m, P))[\text{believe}'_w(j, \phi) \lor \text{believe}'_w(j, \neg \phi)] \)

c. a&b ⇒ \( \lambda w. \forall \phi \in \text{MaxI}(\mathcal{B}_w(m, P))[\text{believe}'_w(j, \phi)] \)

In conclusion, (238) cannot take mention-some because its Completeness condition for mention-some collapses under the mention-all inference derived from FA-sensitivity and
Opinionatedness.

4.5.5. **Asymmetries of FA-sensitivity**

Experiments in section 4.4 found an asymmetry with respect to FA-sensitivity (at least for indirect questions with communication verbs): over-affirming is more tolerated than over-denying in mention-all questions, but less tolerated than over-denying in mention-some questions. In other words, mention-all questions are more sensitive to over-denying, while mention-some questions are more sensitive to over-affirming. Moreover, I have shown that this asymmetry holds even if the Completeness condition is ignored.

Why is that false answers are not equally bad? I propose that a false answer is tolerated if it is not misleading. Each response brings an update to the answer space, such as removing the incompatible answers or adding the entailed answers. If the questioner accepts this response, he would take any max-informative answer of the new answer space as a resolution and make decisions accordingly. If none of these max-informative answers leads to an improper decision (such as making the questioner go somewhere for gas where however has no gas), this response could be tolerated, even if it contains false information.

For instance, in Exp-MS, red wine is only available in store A and store D. If someone told Susan that she could get red wine from A but not from store D, she would still go to a right place for red wine (viz., store A). For this reason, overly denying the possibility of getting red wine from store D is tolerated. In contrast, if someone told Susan that she could get red wine from both Store A and store B, she might end up going to a wrong place for red wine (viz., store B). For this reason, overly affirming the possibility of getting
red wine from store B is not tolerated.

<table>
<thead>
<tr>
<th><strong>Could Susan buy a bottle of red wine at ...?</strong></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>Answer type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>No</td>
<td>?</td>
<td>No</td>
<td>Yes</td>
<td>OD</td>
</tr>
<tr>
<td>A4</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
<td>Yes</td>
<td>OA</td>
</tr>
</tbody>
</table>

Table 4.6: Scenario of Exp-MS

More generally speaking, for a max-informative answer not leading to an improper decision, it has to provide enough information that a good answer would do. Whether an answer is considered as a “good answer” is determined by both linguistic factors (namely, whether this answer is a max-informative true answer) and non-linguistic factors (namely, whether this answer is sufficient for the conversational goal). In a context-neutral case, a max-informative true answer counts as a good answer.

Hence formally, I propose that an answer is tolerated if and only if it satisfies the **Principle of Tolerance**. This principle relates FA-sensitivity to max-informativity.

**(241)** **Principle of Tolerance**

An answer $p$ is tolerated iff accepting $p$ yields an answer space such that every max-informative member of this answer space entails a complete true answer.

In the following, I elaborate how this principle captures the asymmetry of FA-sensitivity.

### 4.5.5.1. Asymmetry of FA-sensitivity in mention-all questions

Figure 4.4 illustrates the asymmetry of FA-sensitivity in mention-all questions. The letter $f$ stands for the predicate *made the swimming team* and $a/b/c$ for relevant individuals
(e.g., $f(a) = \lambda w. \text{a made}_w \text{ the swimming team}$). Arrows indicate entailments. The shaded answers are the ones that entail the bottom-left answer $f(a)$. Underlining marks the max-informative answers of each answer space.

**Figure 4.4: OA and OD in “who made the swimming team?”**

**Over-affirming is tolerated.** Assume that only the unshaded answers are true, then the question has a unique max-informative true answer $f(b \oplus c)$. Due to the entailment relation among the answers, overly affirming $f(a)$ brings in all the shaded answers. The unique max-informative member of the updated answer space, namely $f(a \oplus b \oplus c)$, entails the unique max-informative true answer $f(b \oplus c)$. In contrast, **over-denying is not tolerated.** Assume that all the present answers are true, then the question has a unique max-informative true answer $f(a \oplus b \oplus c)$. Due to the entailment relation among the answers, overly denying $f(a)$ subsequently excludes all the shaded answers. The max-informative member of the updated answer space, namely $f(b \oplus c)$, does not entail the unique max-informative true answer $f(a \oplus b \oplus c)$.

This idea also applies to the case of non-monotonic collective predicates. As we saw in Chapter 3, due to the involvement of higher-order conjunctive answers, the answer space of (242) can and must be closed under conjunction. Hence, the answers of (242) exhibit the same entailment relations as in Figure 4.4.

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(242) which boys formed a team?

4.5.5.2. Asymmetry of FA-sensitivity in mention-some questions

Figure 4.5 illustrates the asymmetry of FA-sensitivity in questions taking mention-some readings. For the sake of simplicity, here I only consider individual answers.\(^{10}\) The letter \(f\) stands for the predicate \(\text{serve on the committee}\) and \(a/b/c\) for relevant individuals. Due to the non-monotonicity of the local \(O\)-operator (see section 2.6.1), all the present answers are semantically independent; hence, the bottom-left answer is only entailed by itself (shaded).

![Diagram showing OA and OD in “who can serve on the committee?”](image)

**Over-affirming is not tolerated.** Assume that only the unshaded answers are true, then all of the unshaded answers are max-informative true answers. Overly affirming \(\Diamond Of(a)\) only adds \(\Diamond Of(a)\) itself to the answer space. \(\Diamond Of(a)\) is a max-informative member in the updated answer space, but it does not entail any max-informative true answers. In contrast, **over-denying is tolerated.** Assume that all the present answers are true, then all of them are max-informative true answers. Overly denying \(\Diamond Of(a)\) only removes \(\Diamond Of(a)\) itself from the answer space. All the remaining answers are max-informative members.

\(^{10}\)As we saw in Figure 2.1, if a question takes a mention-some reading, its answer space consists of individual answers, disjunctive answers, and conjunctive answers. But only individual answers can be max-informative answers.
of the updated answer space, and each of them entails a max-informative true answer, namely itself.

4.6. Comparison with the exhaustification-based account

4.6.1. The exhaustification-based account

Klinedinst & Rothschild (2011) account for IE readings using exhaustifications. The core idea of their account is the following: exhaustifying the Completeness condition (243a) yields an inference entailing the FA-sensitivity condition (243b).

\[(243)\quad \text{John told}_{\text{[+ver]}} \text{Mary who came.}\]

\[
\begin{align*}
\text{a. If } x \text{ came, John told Mary that } x \text{ came.} & \quad \text{Completeness} \\
\text{b. If } x \text{ didn’t come, John didn’t say to Mary that } x \text{ came.} & \quad \text{FA-sensitivity}
\end{align*}
\]

They assume that the ordinary value of (243) is its WE inference, and that the IE reading is derived by exhaustifying this WE inference at the matrix level. The LFs for WE and IE are thus as follows, where \(O\) stands for a covert exhaustivity operator.

\[(244)\quad \begin{align*}
\text{a. John told Mary [who came]} & \quad \text{WE} \\
\text{b. } O [\text{John told Mary [who came]}] & \quad \text{IE}
\end{align*}\]

The \(O\)-operator comes from the grammatical view of exhaustifications (Chierchia 2006, 2013; Fox 2007; Chierchia et al. 2013; Fox & Spector to appear; among the others). Adapting Rooth’s (1985, 1992, 1996) system for focus and the canonical semantic treatment of
only (see section 7.4.1), the grammatical view defines the $O$-operator as in (245): it affirms the prejacent proposition $p$ and negates all the alternatives that are not entailed by $p$.

\[(245) \quad O(p) = \lambda w. p(w) \land \forall q \in \text{Alt}(p)[p \not\in q \rightarrow \neg q(w)]\]

Here $p$ and $\text{Alt}(p)$ correspond to what Rooth calls “the ordinary value of $p$” and “the focus value of $p$” (or “the alternative semantic value of $p$”), respectively. See section 7.4.1 for more discussions as to how the alternatives are evoked and composed.

In (244b), the embedded interrogative who came denotes a set of possible mention-all answers, as schematized in (246a), and the WE inference in (244b) says that John told Mary the true mention-all answer as to who came. Employing exhaustification affirms the WE inference and negates all the propositions of the form “John told Mary $\phi$” where $\phi$ is a possible mention-all answer of who came and is not entailed by the true mention-all answer of who came, yielding an inference that John only told Mary the TRUE mention-all answer as to who came.

\[(246) \quad \text{John told}_\text{[+ver]} \text{ Mary who came.}\]

a.  
\[
\llbracket \text{who came} \rrbracket = \lambda w. \lambda w'. \forall x[\text{came}'_w(x) \rightarrow \text{came}'_{w'}(x)]
\]

b.  
\[
p = \lambda w. \text{told}'_w(j, m, \lambda w'. \forall x[\text{came}'_w(x) \rightarrow \text{came}'_{w'}(x)]) \quad \text{WE}
\]

(John told Mary the true mention-all answer as to who came)

c.  
\[
\text{Alt}(p) = \{ q | \exists w''[q = \lambda w. \text{told}'_w(j, m, \lambda \forall x[\text{came}'_w(x) \rightarrow \text{came}'_{w'}(x)])] \}
\]

((q | \exists w''[q = \text{John told Mary the mention-all answer of who came}_{w''}]))

d.  
\[
O(p) = \lambda w. p(w) \land \forall q \in \text{Alt}(p)[p \not\in q \rightarrow \neg q(w)] \quad \text{IE}
\]

(John only told Mary the TRUE$_F$ mention-all answer as to who came)
A more concrete description for the derivations above is given in the following. ‘\( \phi_x \)’ is abbreviated for the proposition that \( x \) came.


(w: Among the three considered individuals, Andy and Billy came, but Cindy didn’t.)

a.  \[[\text{who came}] = \{\phi_a, \phi_b, \phi_c, \phi_a \land \phi_b, \phi_a \land \phi_c, \phi_b \land \phi_c, \phi_a \land \phi_b \land \phi_c\}\]

b.  \( p = \lambda w.\text{told}_w(j, m, \phi_a \land \phi_b) \) \hspace{1cm} \text{WE}

(John told Mary that Andy and Billy came.)

c.  \( \text{Alt}(p) = \{\lambda w.\text{told}_w(j, m, \phi) : \phi \in \{\phi_a, \phi_b, \phi_c, \phi_a \land \phi_b, \phi_a \land \phi_c, \phi_b \land \phi_c, \phi_a \land \phi_b \land \phi_c\}\}\]

d.  \( O(p) = \lambda w[\text{told}_w(j, m, \phi_a \land \phi_b) \land \neg \text{told}_w(j, m, \phi_c)] \) \hspace{1cm} \text{IE}

(John told Mary that Andy and Billy came, and John didn’t tell Mary that Cindy came.)

Moreover, Klinedinst & Rothschild derive the SE reading by placing the \( O \)-operator immediately above the embedded interrogative, as in (248). This implementation requires additional assumptions, because here the \( O \)-operator operates on a set of propositions. I will not get into the details.

(248)  John told Mary \( O \) [who came] \hspace{1cm} \text{SE}

As (246) shows, Klinedinst & Rothschild (2011) do not assume \( \text{ANS} \) in their structure of interrogative complements. In an analysis with \( \text{ANS} \), the \( \text{WE} \) reading can be obtained via the employment of an \( \text{ANS} \)-operator. In particular, using the proposed hybrid semantics, we can re-formulate Klinedinst & Rothschild’s idea as follows. On this account, the root denotation of the embedded interrogative is a topical property, as in (249a); employing
the ANS-operator returns a singleton set consisting of only the true mention-all answer, as in (249b); and the derivation of the WE reading involves picking out the mention-all answer via a choice function \( f_{ch} \), as in (249c).

(249)  John told\([_{+ver}]\) Mary who came.

a. \( [\text{who came}] = \lambda x. \lambda w. \text{came}^\prime_w(x) \)  \( P \)

b. \( \text{ANS}(P)(w) = \{ \text{came}^\prime(x) : \text{came}^\prime_w(x) \land \forall y[\text{came}^\prime_w(y) \rightarrow \text{came}^\prime(y) \notin \text{came}^\prime(x)] \} \)

c. \( [p] = \lambda w. \exists \phi \in \text{ANS}(P)(w)[\text{told}^\prime_w(j,m,\phi)] \)  \( \text{WE} \)

d. \( \text{Alt}(p) = \{ \lambda w. \exists \phi \in \alpha[\text{told}^\prime_w(j,m,\phi)] | \exists w'[\alpha = \text{ANS}(P)(w')] \} \)

\( = \{ \lambda w. \exists \phi \in \text{ANS}(P)(w')[\text{told}^\prime_w(j,m,\phi)] | w' \in W \} \)

e. \( [O(p)] = \lambda w. p(w) \land \forall q \in \text{Alt}(p)[p \notin q \rightarrow \neg q(w)] \)  \( \text{IE} \)

4.6.2. Extending the exhaustification-based account to mention-some

In an indirect mention-some question like (250), there are two possible positions to place the \( O \)-operator: one position is immediately above the scope part of the existential closure, called “local exhaustification”; the other is above the existential closure, called “global exhaustification”. In the following, I show that neither of the options derives the desired the FA-sensitivity inference.

(250)  John told us \([Q \text{ where we could get gas}]\).

a. Local exhaustification

\( \exists \phi[\phi \text{ is a true mention-some answer of } Q] [O [\text{John told us } \phi]] \)

b. Global exhaustification
Local exhaustification is apparently infeasible. This operation yields the following truth conditions: first, John told us an mention-some answer as to where we could get gas; second, John didn’t give us any answer that is not entailed by this mention-some answer. The second condition is too strong. For instance, if what John said was we could get gas at place a and somewhere else, which is strictly stronger than any mention-some answer, the sentence (250) would be predicted to be false, contra the fact. One might suggest to stipulate that the local exhaustifier negates only false inferences. This option is however conceptually circular.

The option of global exhaustification seems to have a better chance of yielding the desired FA-sensitivity inference. As Danny Fox and Alexandre Cremers point out (p.c.) to me independently, innocently exclusive exhaustification (Fox 2007) yields an inference that is very close to the FA-sensitivity condition. As we saw in section 3.4, while the regular exhaustifier \( O \) negates all the excludable alternatives (i.e., the alternatives that are not entailed by the prejacent of the exhaustifier, as in (251a)), the innocently exclusive exhaustifier IE-Exh negates only innocently excludable alternatives. For a proposition \( p \), an alternative \( q \) is innocently excludable iff \( p \land \neg q \) is consistent with negating any excludable alternative(s) of \( p \).

(251)  

\[
\begin{align*}
a. \text{Excl}(p) &= \{q : q \in \text{Alt}(p) \land p \not\in q\} \\
b. \text{IExcl}(p) &= \{q : q \in \text{Alt}(p) \land \exists q' \in \text{Excl}(p)[[p \land \neg q] \rightarrow q']\} \\
c. \text{IE-Exh}(p) &= p \land \forall q \in \text{IExcl}(p)[\neg q]
\end{align*}
\]

Using innocent exclusion avoids negating propositions of the form “John told us \( \phi \)”
where $\phi$ is a true mention-some answer or a disjunction involving at least one true mention-some answer as a disjunct. Consider (252) for instance. Using innocent exclusion, global exhaustification proceeds as follows. The prejacent of IE-Exh is a disjunction that coordinates all the true mention-some answers, as schematized in (252b). $\phi_a$ is short for the proposition we could get gas at place $a$. Alternatives are propositions of the form “John told us a member of $\alpha$” where $\alpha$ is a possible set of complete answers, as list in (252c). Among these alternatives, only $\text{told}'(j,\phi_c)$ is innocently excludable. Hence, employing an IE-Exh-operator yields a very appealing inference as in (252d): John told us a true mention-some answer of $Q$, and didn’t give us any false mention-some answer of $Q$.

(252) John told us $[Q$ where we could get gas].

$$(w: \text{among the considered places } abc, \text{ only } ab \text{ sold gas})$$

a. IE-Exh $[S \exists \phi [\phi \text{ is a true mention-some answer of } Q] [\text{John told us } \phi]]$

b. $[S] = \lambda w. \exists \phi \in \text{ANS}(P)(w)[\text{told}'_w(j, \phi)] = \text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b)$

c. $\text{Alt}(S) = \{\lambda w. \exists \phi \in \alpha[\text{told}'_w(j, \phi)] \mid \exists \phi'(\alpha = \text{ANS}(P)(w'))\}$

$$= \begin{cases} 
\text{told}'(j, \phi_a), & \text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b), & \text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b) \lor \text{told}'(j, \phi_c) \\
\text{told}'(j, \phi_b), & \text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_c), \\
\text{told}'(j, \phi_c), & \text{told}'(j, \phi_b) \lor \text{told}'(j, \phi_c), 
\end{cases}$$

d. $[\text{IE-Exh}(S)] = [\text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b)] \land \neg \text{told}'(j, \phi_c)$

\footnote{For instance, $\text{told}'(j, \phi_a)$ is not innocently excludable, because $[\text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b)] \land \neg \text{told}'(j, \phi_a)$ entails $\text{told}'(j, \phi_b)$. In contrast, $\text{told}'(j, \phi_c)$ is innocently excludable, because $[\text{told}'(j, \phi_a) \lor \text{told}'(j, \phi_b)] \land \neg \text{told}'(j, \phi_c)$ does not entail any of the excludable alternatives.}
4.6.3. Problems with the exhaustification-based account

4.6.3.1. FA-sensitivity is concerned with partial answers

So far, the alternative set used by the exhaustification-based account includes only propositions that are possible complete answers. Hence, exhaustifying the Completeness condition only yields the requirement of avoiding false answers that are possible complete answers, which is however insufficient.

One might suggest to enlarge the alternative set based on the condition of Relevance, as the proposed treatment does: a proposition $p$ is relevant to a question $Q$ iff $p$ is equivalent to the union of some cells of the partition yielded by $Q$ (Heim 2011). This move, however, does not work for the exhaustification-based approach; it yields bad consequence in interpreting indirect mention-some questions. For instance in (253), it rules in not only inferences as to telling a false answer, like those in (253a-c), but also inferences as to telling a true answer that is strictly stronger than an mention-some answer, such as (253d). Once answers of the form (253d) are added into the alternative set, an exhaustification-based account would predict (253) to be false in a discourse where John told us multiple accessible gas stations, contra the fact.

(253) John told us where we could get gas.

(w : $a$ and $b$ sell gas; $c$ and $d$ do not.)

a. Over-affirming: $told'(j, \phi_c), told'(j, \phi_d)$

b. Over-denying: $told'(j, \neg \phi_a), told'(j, \neg \phi_b)$

c. Disjunctive partial: $told'(j, \phi_c \lor \phi_d)$
4.6.3.2. FA-sensitivity is not a scalar implicature

Treating FA-sensitivity as a logical consequence of exhaustifying Completeness amounts to saying that FA-sensitivity is a scalar implicature of Completeness. Nevertheless, FA-sensitivity inferences do not behave like scalar implicatures.

First, contrary to the case of scalar implicatures, FA-sensitivity inferences are easily generated even in downward-entailing contexts. In (254), appearing within the antecedent of a conditional, the scalar item some, unless focus-marked, does not evoke a scalar implicature.

(254) a. If [Mary invited some of the speakers to the dinner], I will buy her a coffee.
    \[\not\exists \text{ If Mary invited some but not all speakers to the dinner, I will buy } \ldots.\]

b. If [Mary invited SOME of the speakers to the dinner], I will buy her a coffee; but if she invited all of the speakers to the dinner, we would run out of budget.
    \[\not\to \text{ If Mary invited some but not all speakers to the dinner, I will buy } \ldots.\]

This is so because strengthening the antecedent weakens the entire conditional and violates the Strongest Meaning Hypothesis (Chierchia et al. 2013; Fox & Spector to appear) for exhaustifications: the use of an exhaustifier is marked if it gives rise to a reading that is equivalent to or weaker than what would have resulted in its absence. In other words, it is marked to use an exhaustification in a downward-entailing or a non-monotonic environment.
Let $S$ be a sentence of the form $[S ..O(X)...]$. Let $S_0$ be the sentence of the form $[S_0 ...X...]$, i.e., the one that is derived from $S$ by replacing $O(X)$ with $X$, i.e., by eliminating this particular occurrence of $O$. Then, everything else being equal, $S_0$ is preferred to $S$ if $S_0$ is logically stronger than $S$.

In (256), however, while uttered as the antecedent of a conditional, the indirect question *Mary knows which speakers went to the dinner* still evokes an FA-sensitivity inference.

(256)  
(w: *Barbara and Irene went to the dinner, but Uli didn’t.*)

If Mary knows which speakers went to the dinner, I will buy her a coffee.

$\neg$ If [Mary knows that Barbara and Irene went to the dinner] $\land$

not [Mary believes that Uli went to the dinner], I will buy her a coffee.

Second, FA-sensitivity inferences are not cancelable. Compare the conversations in (257) and (258). In (257), the scalar implicature *that Mary did not invite all of the speakers to the dinner* can be easily cancelled, while in (258) the FA-sensitivity inference *it is not the case that Mary believes that Uli went to the dinner* cannot be cancelled.

(257)  
A: “Did Mary invite some of the speakers to the dinner?”

B: “Yes. Actually she invited all of them.”

(258)  
(w: *Barbara and Irene went to the dinner, but Uli didn’t.*)

A: “Does Mary know which speakers went to the dinner?”

B: “Yes. #Actually also she believes that Uli went to the dinner.”

One might suggest that FA-sensitivity inferences are special species of scalar implica-
tures which are mandatorily evoked and exceptionally robust. To assess this assumption, let us compare FA-sensitivity inferences with scalar implicatures that are mandatorily evoked in presence of the overt exhaustifier only. In (259) and (260) for instance, since the scalar item some is associated with only, its scalar implicature patterns like FA-sensitivity inferences: this scalar implicature can be generated within the antecedent of a conditional and cannot be cancelled.

(259) If [Mary invited only SOME\(_F\) of the speakers to the dinner], I will buy her a coffee.

\[\sim\sim \text{If Mary invited some but not all speakers to the dinner, I will buy her a coffee.}\]

(260) A: “Did Mary invite only SOME\(_F\) of the speakers to the dinner?”

B: “Yes. # Actually she invited all of them.”

Nevertheless, a difference arises in negative sentences. In (261b), associating only with the focused item over negation evokes a positive implicature, namely an indirect scalar implicature: only negates the negative alternative \(\neg \phi_{\text{male}}\), yielding an indirect scalar implicature \(\phi_{\text{male}}\), as schematized in (261c).

(261) a. Mary only invited some [female]\(_F\) speakers to the dinner.

\[\sim\sim \text{Mary did not invite any male speakers to the dinner.} \quad \neg \phi_{\text{male}}\]

b. Mary only did not invite any [female]\(_F\) speakers to the dinner.

\[\sim\sim \text{Mary did invite some male speaker(s) to the dinner.} \quad \phi_{\text{male}}\]

c. \(O\neg \phi_{\text{female}} \rightarrow \neg \phi_{\text{female}} \land \neg \phi_{\text{male}} = \neg \phi_{\text{female}} \land \phi_{\text{male}}\)

If the FA-sensitivity inference were a mandatory scalar implicature, we would analo-
gously predict that a negated indirect question like (262b) takes the LF (262c) and evokes an indirect scalar implicature $told'(m, \phi_{uli})$, namely the negation of the FA-sensitivity inference, contra the fact. Note that here the exhaustifier cannot be placed below negation, due to the Strongest Meaning Hypothesis.

(262)  ($w$: *Barbara and Irene went to the dinner, but Uli didn’t.*)

a. Mary told us which speakers went to the dinner.

$\sim$ Mary did not tell us that Uli went to the dinner.  $\neg told'(m, \phi_{uli})$

b. Mary did not tell us which speakers went to the dinner.

$\not \sim$ Mary told us that Uli went to the dinner.  $told'(m, \phi_{uli})$

c. *O not* [Mary told us [Q which speakers went to the dinner ]]

4.7. **Lines of approaches to the WE/SE distinction**

There are, quite generally, three lines of approaches to the WE/SE distinction, which I call “the ANS-based approaches”, “the strengthener-based approaches” and “the neg-raising-based approach”. This section does not attempt to take a position from the three lines, but just to show how each line of approaches can be adapted or extended to the proposed account of Completeness and FA-sensitivity.

4.7.1. **The ANS-based approaches**

The WE/SE distinction is a result of employing different answerhood-operators (Heim 1994; Dayal 1996; Beck & Rullmann 1999). The root denotation of a question unambiguously denotes a Hamlin set, but it can enter into different answerhood operations. In
particular, employing $\text{ANS}_{\text{WE}}$ and $\text{ANS}_{\text{SE}}$ yield WE and SE readings, respectively.

We have seen several $\text{ANS}_{\text{WE}}$-operators, as collected in (263). On Heim’s and Dayal’s accounts, employing the $\text{ANS}_{\text{WE}}$-operator returns strongest true answer, which is therefore the WE answer. On Fox’s account, employing the $\text{ANS}_{\text{WE}}$-operator returns a set of max-informative true answers; if the underlying question takes a mention-all reading, this set is a singleton set and it consists of only the WE answer.

\begin{equation}
\text{(263)}
\begin{align*}
a. \quad \text{ANS}_{\text{Heim,WE}}(Q)(w) &= \cap\{p : w \in p \in Q\} \quad \text{(Heim 1994)} \\
&= \forall p[w \in p \Leftrightarrow \forall q[w \in q \Rightarrow p \subseteq q]] \\
&\quad \text{ifa.}[\text{predicted}](j, \phi) \\
&\quad \text{Completeness for WE}
\end{align*}
\end{equation}

Based on whichever $\text{ANS}_{\text{WE}}$-operator in (263), we can obtain an $\text{ANS}_{\text{SE}}$-operator via the rule in (264): $\text{ANS}_{\text{SE}}(Q)(w)$ returns the set of worlds $w'$ such that the complete true answer(s) of the underlying question in $w$ and $w'$ are the same.

\begin{equation}
\text{(264)} \quad \text{ANS}_{\text{SE}}(Q)(w) = \lambda w'[\text{ANS}_{\text{WE}}(Q)(w) = \text{ANS}_{\text{WE}}(Q)(w')] \quad \text{(Heim 1994)}
\end{equation}

Adapting this line of approaches to the proposed account of Completeness and FA-sensitivity, we can treat the WE/SE distinction as a variation with respect to the Completeness condition, as shown in (265a-b). Note that $\text{ANS}_{\text{WE}}(P)(w)$ denotes a set of propositions and needs to be existentially bound, while $\text{ANS}_{\text{SE}}(P)(w)$ denotes a proposition.

\begin{equation}
\text{(265)} \quad \text{John predicted}_{[\text{+ver}]} Q_p
\begin{align*}
a. \quad \lambda w. \exists \phi \in \text{ANS}_{\text{WE}}(P)(w)[\text{predicted}'(j, \phi)]
\end{align*}
\text{(there is a max-informative true answer } \phi \text{ such that John predicted } \phi.)
\end{equation}
b. \( \lambda w. \text{predicted}'_w(j, \text{ANS}_{SE}(P)(w)) \) \hspace{1cm} \text{Completeness for SE}

(John predicted the SE inference of \( Q_p \).)

c. \( \lambda w. \forall \phi \in \text{REL}(Q)[\text{predicted}'_w(j, \phi) \rightarrow \phi(w)] \) \hspace{1cm} \text{FA-sensitivity}

(Everything that John predicted relevant to \( Q \) is true.)

Moreover, the FA-sensitivity condition is asymmetrically entailed by the Completeness condition for SE; hence, FA-sensitivity collapses under strong exhaustivity.

4.7.2. The strengthener-based approaches

A more recent line of approaches attributes the WE/SE distinction to the absence/presence of a strengthening operator. The strengthening operator, depending on the actual approach, can be applied to the question root (George 2011; Klinedinst & Rothschild 2011) or used within the question nucleus (Nicolae 2013). The following summarizes the basic idea of each representative analysis.

**George (2011: chapter 2)** assumes an \( X \)-operator which can be present between the lambda abstract \( Abs \) and the question-formation operator \( Q \). An answerhood-operator unambiguously takes an existential quantification force. Primarily, \( Q(Abs) \) returns a Hamlin set, yielding mention-some\(^{12} \); when the \( X \)-operator is present, \( Q[X(Abs)] \) returns a set of exhaustified propositions, yielding SE. (See more details in section 2.4.2.)

\(^{12}\text{George (2011) does not take WE as an independent reading, but a special case of mention-some.}\)
Klinedinst & Rothschild (2011) assume that a question primarily denotes a set of possible WE answers, and hence the ordinary value of an indirect question is its WE reading. The SE reading arises when a generalized exhaustivity-operator is applied to the embedded question. Note here that the exhaustivity-operator is not used in sense of the grammatical view of exhaustifications, because it does not operate on a proposition but instead a set of propositions. (See more details in section 4.6.1.)

Nicolae (2013) takes insights from the negative polarity item (NPI)-licensing effects in wh-questions, and correlates these effects with the distributional pattern of SE readings. Compare the sentences in (266) for instance. An emotive factive like surprise does not license SE, and the weak NPI any cannot be licensed when appearing in a wh-question embedded under surprise. In contrast, a cognitive factive like know licenses SE, and the weak NPI any can be licensed when appearing in a wh-question embedded under know.

(266)  
a. *It surprised Angela which boys brought her any gifts.

b. Angela wants to know which boys brought her any gifts.

Given the similar distributional patterns of SE and weak NPIs, Nicolae proposes that the SE reading arises when a covert only\(^{13}\) appears within the question nucleus and is

\(^{13}\)This covert only assumed by Nicolae (2013) is slightly different from the covert O-operator assumed by the grammatical view. The overt exclusive particle only licenses an NPI in its scope, while a covert exhaustification does not.

(1)  
a. Only JOHN\(_F\) read any books.

b. *O [JOHN\(_F\) read any books].

Gajewski (2011) proposes that the licensing of a weak NPI is only concerned with the asserted component of the embedding environment, not the presupposed or the implicated components. This proposal easily captures the contrast in (1): only asserts an exhaustivity inference and presupposes the truth of the prejacent (Horn 1969), while O asserts both; therefore the asserted component of only is downward-entailing with
associated with the wh-trace. For instance, under the WE reading, the root denotation of (267) is a set of propositions of the form ‘x came’, and under the SE reading, it is a set of propositions of the form ‘only x came’.

(267) Who came?

\[ \ldots \quad \text{IP} \quad \text{(only)} \quad \text{VP} \quad x_F \text{came} \]

(268) \[ [\text{only}] (p) = \lambda w [p(w) = 1 \cdot \forall q \in \text{Alt}(p)[q(w) = 1 \rightarrow p \subseteq q]] \]

The presence of a covert only has two consequences. First, it makes all the answers exhausted and mutually exclusive, which therefore yields SE. Second, it creates an NPI-licensing environment, just like the overt only would do.

On the strengthen-based line of approaches, the WE/SE distinction is an ambiguity within the root denotation of the embedded question. Hence, this distinction is independent from how we characterize the Completeness condition and the FA-sensitivity condition.

For my interests in mention-some questions, another advantage with Nicolae’s approach is that it predicts the difficulty for mention-some questions to take SE readings when the mention-some readings are not contextually blocked. On this account, SE readings cannot be derived directly from mention-some readings. Consider (269) for a con-

respect to the weak NPI any, while that of the covert O-operator is non-monotonic with respect to the weak NPI any. For Nicolae to make use of the NPI-licensing effect of only, she needs an exhaustifier that asserts only the exhaustivity inference.
crete example. Each square represents an answer space, and the shaded answers are the true answers. (269a) illustrates the answer space for the mention-some reading; when each of the answers is exhaustified as in (269a’), the answer space would have no true answer, which violates the presupposition of the ANS-operator. By contrast, SE readings can be derived from mention-all readings via exhaustifications: in (269b’)/(269c’), the conjunctive/disjunctive mention-all answer is the unique true answer and therefore the SE answer.

(269) Who can chair the committee?

(w: only Andy and Billy can chair the committee; single-chair only.)

a. mention-some

\[\Diamond [Of(a) \land Of(b)]\]

\[\Diamond Of(a) \lor \Diamond Of(b)\]

\[\Diamond [Of(a) \lor Of(b)]\]

a’. adding only to a

\[\text{only} \Diamond [Of(a) \land Of(b)]\]

\[\text{only} \Diamond Of(a) \land \text{only} \Diamond Of(b)\]

\[\text{only} \Diamond [Of(a) \lor Of(b)]\]

b. mention-all

\[\Diamond Of(a) \land \Diamond Of(b)\]

\[\Diamond Of(a) \lor \Diamond Of(b)\]

\[\Diamond [Of(a) \lor Of(b)]\]

b’. adding only to b

\[\text{only} [\Diamond Of(a) \land \Diamond Of(b)]\]

\[\text{only} \Diamond Of(a) \land \text{only} \Diamond Of(b)\]

\[\text{only} [\Diamond Of(a) \lor \Diamond Of(b)]\]

c. disjunctive mention-all

\[O_{dou} \Diamond [Of(a) \land Of(b)]\]

\[O_{dou} \Diamond Of(a) \land O_{dou} \Diamond Of(b)\]

\[O_{dou} \Diamond [Of(a) \lor Of(b)]\]

c’. adding only to c

\[\text{only} O_{dou} \Diamond [Of(a) \land Of(b)]\]

\[\text{only} O_{dou} \Diamond Of(a) \land \text{only} O_{dou} \Diamond Of(b)\]

\[\text{only} O_{dou} \Diamond [Of(a) \lor Of(b)]\]
4.7.3. The neg-raising based approach

Uegaki (2015: chapter 3) makes use of a matrix exhaustification to derive IE readings (à la Klinedinst & Rothschild 2011) and further derives SE from IE based on neg-raising.

Consider (270) for a concrete example. **First**, an exhaustivity-operator \( X \) mandatorily presents in the matrix clause; it affirms the prejacent and negates all the alternatives that are strictly stronger than the prejacent clause, yielding an IE reading, as in (270b). **Second**, \( \text{know} \) evokes an excluded middle inference (270c), namely that \( \text{John is opinionated at whether abc all came and whether ab both came} \). Last, (270b-c) together entail the SE reading, as in (270d).

(270) John knows who came.

\((w: \text{Among the three considered individuals, Andy and Billy came, but Cindy didn’t.})\)

a. \([\text{John knows who came}] = \text{know}'(j, \phi_a \land \phi_b)\)

b. \([X[\text{John knows who came}]] = \text{know}'(j, \phi_a \land \phi_b) \land \neg \text{believe}'(j, \phi_a \land \phi_b \land \phi_c)\) \hspace{1cm} \text{IE}

c. \([\text{believe}'(j, \phi_a \land \phi_b) \lor \text{believe}'(j, \neg[\phi_a \land \phi_b])] \land \text{Excluded middle} \ \ \ \ [\text{believe}'(j, \phi_a \land \phi_b \land \phi_c) \lor \text{believe}'(j, \neg[\phi_a \land \phi_b \land \phi_c])]\)

d. \(b \& c = \text{know}'(j, \phi_a \land \phi_b) \land \text{believe}'(j, \phi_a \land \neg[\phi_a \land \phi_b \land \phi_c])\) \hspace{1cm} \text{SE}

\[\begin{align*}
&= \text{know}'(j, \phi_a \land \phi_b) \land \text{believe}'(j, \neg \phi_c)\
\end{align*}\]

Adapting this idea to the proposed account, we can derive SE by strengthening the FA-sensitivity condition with an excluded middle inference: the inferences in (271b-c) together yield a neg-raised FA-sensitivity condition (271d); the neg-raised FA-sensitivity condition together with the Completeness condition yields SE.
(271) John knows Q_p

a. $\lambda w. \exists \phi \in \text{ANS}_{\text{we}}(P)(w)[\text{believe}'_w(j, \phi)]$  
Completeness

(there is a max-informative true answer $\phi$ such that John predicted $\phi$.)

b. $\lambda w. \forall \phi \in \text{REL}(Q)[\neg \phi(w) \rightarrow \neg \text{believe}'_w(j, \phi)]$  
FA-sensitivity

(Every Q-relevant proposition that John predicted is true.)

c. $\lambda w. \forall \phi \in \text{REL}(Q)[\neg \phi(w) \rightarrow \text{believe}'_w(j, \phi) \lor \text{believe}'_w(j, \neg \phi)]$  
Excluded middle

(John is opinionated at every Q-relevant proposition.)

d. $b \& c = \lambda w. \forall \phi \in \text{REL}(Q)[\neg \phi(w) \rightarrow \text{believe}'_w(j, \neg \phi)]$

(John doubts at every false Q-relevant proposition.)

4.8. Summary

This chapter has presented a uniform characterization for the truth conditions of FA-sensitive readings. I defined Completeness based on max-informativity, and analyzed FA-sensitivity as a matter of “Quality”. This account works for both mention-some and mention-all questions, and can be extended to various types of responsive predicates. Moreover, observing that the FA-sensitivity inference is concerned with all types of false answers and that it does not behave like a scalar implicature, I argued against the exhaustification-based approach by Klinedinst & Rothschild (2011).

I have also explained some seemingly exceptional behaviors of emotive factives and the non-veridical predicate agree. In the case of an emotive factive, the FA-sensitivity condition collapses under the indefeasible factive presupposition and is therefore not detectable. In the case of agree, FA-sensitivity and Opinionatedness together entail a WE
inference, and hence a ◇-questions embedded under agree cannot take a mention-some reading.

Experimental results from Exp-MA and Exp-MS suggested an asymmetry with respect to FA-sensitivity: over-affirming is more tolerated than over-denying in mention-all questions, but less tolerated than over-denying in mention-some questions. I proposed a Principle of Tolerance to explain this asymmetry. This principle relates FA-sensitivity to Completeness/max-informativity.
Chapter 5

Pair-list readings of multi-$wh$ questions
5.1. **Introduction**

This chapter will be centered on the pair-list readings of multiple-*wh* questions. Under a pair-list reading, the multi-*wh* question (272) expects the addressee to list out all the boy-kissing-girl pairs.

(272) Which boy kissed which girl?

a. Andy kissed Mary. (single-pair)

b. Andy kissed Mary, Billy kissed Jenny. (pair-list)

Two lines of approaches have been proposed in the literature. One line assumes that the pair-list reading of a multiple-*wh* question inquires the functional dependency between the sets denoted by the *wh*-items (Engdahl 1980, 1986; Dayal 1996, in progress); while the other line treats questions of this sort as families of questions (Hagstrom 1998; Fox 2012; Nicolae 2013; Kotek 2014). This chapter will explore both lines.

The rest of this chapter is organized as follows. Section 5.2 discusses the so-called “domain exhaustivity” and “point-wise uniqueness” presuppositions, and I argue that pair-list readings of multi-*wh* questions are actually not subject to domain exhaustivity. Section 5.3 reviews two lines of approaches, including the function-based line and the higher-order question line. Section 5.4 presents my proposal. This proposal takes insights from previous function-based analyses, and also overcomes many of their conceptual and empirical problems. Section 5.5 shows how to adapt Fox’s (2012) higher-order question approach to the proposed hybrid semantics of questions.
5.2. The phenomenon

Questions with multiple *wh*-items are ambiguous between a *single-pair* reading and a *pair-list* reading. Consider the question (273) for instance, the single-pair reading asks about the unique boy-kissing-girl event, while the pair-list reading asks about a list of boy-kissing-girl events.

(273) Which boy kissed which girl?

a. Andy kissed Mary.  
   (single-pair)

b. Andy kissed Mary, Billy kissed Jenny.  
   (pair-list)

I have discussed the single-pair reading in section 1.4 (see (39) and (46) for the derivations of the topical property and the answers, respectively). This section will be centered on the pair-list reading, and will be exclusive to questions containing only singular *wh*-items.

5.2.1. A prominent view

A prominent view, due to Dayal (2002), says that the pair-list readings of multi-*wh* questions evoke two presuppositions, namely *domain exhaustivity* (also called “domain cover” in Dayal (in progress)) and *point-wise uniqueness*, as defined below. For the question in (273) for instance, the former presupposition requires that every boy kissed some girl, and the latter requires that each boy kissed exactly one girl.

(274) The presuppositions of a multiple singular *wh*-question (Dayal 2002):

a. Domain exhaustivity:
Every member of the set quantified over by the overtly moved wh is paired with a member of the set quantified over by the in-situ wh.

b. **Point-wise uniqueness:**

Every member of the set quantified over by the overtly moved wh is paired with no more than one member of the set quantified over by the in-situ wh.

The point-wise uniqueness effect is easy to detect. It is hard to see, however, whether the multi-wh question in (273) triggers domain exhaustivity. In the following examples taken from Fox (2012), which have explicitly restricted the domain of each wh-phrase, we can see clearer domain exhaustivity inferences.

(275)  

a. Guess which one of these 3 kids will sit on which of these 4 chairs.  

(\text{OK single-pair, OK pair-list})

b. Guess which one of these 4 kids will sit on which of these 3 chairs.  

(\text{OK single-pair, # pair-list})

Fox’s argument proceeds as follows: when the embedded multi-wh question in (275b) takes a pair-list reading, it presupposes that each of the four kids will sit on one of the three chairs; but since the number of chairs is fewer than the number of kids, there will be at least two kids sitting on the same chair, which makes the sentence infelicitous.

5.2.2. **Domain exhaustivity?**

I doubt that multi-wh questions are subject to domain exhaustivity inference. First, let us re-consider Fox’s example in (275b) and imagine that the four kids are playing the game
of Musical Chairs\textsuperscript{1} and are competing for three chairs. The sentence (275b) would be fully acceptable in such a scenario, and it clearly does not imply the domain exhaustivity inference that \textit{each of the four kids will sit on one of the three chairs}. Hence, it is plausible to say that the domain exhaustivity inference in (275b) comes from a contextual expectation, rather than the multi-\textit{wh} question itself.

Moreover, consider the following minimal pair, where a multi-\textit{wh} question and a \textit{\forall}-question are preceded by an indirect question that presupposes the negation of the domain exhaustivity inference: \textit{some of the boys didn’t kiss any of the girls}.

(276) a. I know that some of the boys didn’t kiss any of the girls, and I also know which boy kissed which girl.

b. I know that some of the boys didn’t kiss any of the girls, \# and I also know which girl every boy kissed.

Intuitively, (276b) is more deviant than (276a). This contrast suggests that multi-\textit{wh} questions are not subject to domain exhaustivity, or at least that the domain exhaustivity inferences in multi-\textit{wh} questions are less robust than those in \textit{\forall}-questions. Hence, it is more precise to treat the pair-list reading of a multi-\textit{wh} question as a universal pair-list reading with respect to a sub-domain of the subject-\textit{wh}:

(277) \textit{Which girl did which boy kiss?}

\textsuperscript{1}“Musical Chairs is a game where a number of chairs, one fewer than the number of players, are arranged facing outward with the players standing in a circle just outside the chairs. Usually music is played while the players in the circle walk in unison around the chairs. When the music stops each player attempts to sit down in one of the chairs. The player who is left without a chair is eliminated from the game.” (Wikipedia)
a. ≠ Which girl did each boy kiss?

b. ≈ Among the boys who kissed a girl, which girl did each of the boys kiss?

5.3. Previous studies

5.3.1. Function-based approaches

The line of function-based approaches was firstly designed to deal with the pair-list readings of questions with universal quantifiers, called “∀-questions” henceforth (Engdahl 1980, 1986; Groenendijk & Stokhof 1984; Chierchia 2013; Dayal 1996, in progress; among the others).

(278) a. Which girl did every boy kiss?

   b. Which boy kissed which girl?

Claiming that the two questions (278a-b) have the very same pair-list readings, Engdahl (1980, 1986) and Dayal (1996) use similar structures to derive the pair-list readings of multi-wh questions and the pair-list readings of ∀-questions. Contra this view, I argue that the pair-list readings of these two types of questions are derived differently. Moreover, in Chapter 6, I will show that the derivational procedure of the pair-list readings of ∀-questions resembles that of the choice readings of ∃-questions like (279).

(279) Which girl did one of the boys kiss?

The rest of this section will discuss only Dayal’s (1996) account on multi-wh questions, because it is the only function-based account of multi-wh questions that has considered
the effect of point-wise uniqueness. See a literature review for the other accounts in Dayal (in progress: chapter 4).

Dayal argues that pair-list answers to multi-wh questions involve a functional dependency between the quantificational domains of the two wh-items. For instance, the pair-list reading of (280) asks about a function $f$ from atomic boys to atomic girls such that each boy $x$ kissed a girl $f(x)$, as illustrated in (281). To specify this function, one needs to list out all the boy-kissing-girl events, which is therefore the pair list answer.

(280) Which boy kissed which girl?

\[ \text{\sim For which function } f \in \{ \text{boy} \rightarrow \text{girl} \} \text{ is such that } x \text{ kissed } f(x)?\]

(281) (w: Andy kissed Mary, Billy kissed Jenny; no other boy kissed any girl.)

\[ f = \begin{cases} 
    a & \rightarrow \ m \\
    b & \rightarrow \ j
\end{cases} \]

Formally, Dayal (1996, in progress) defines a functional $C^0$ that contributes three semantic features: an existential quantification over functions ($\exists f$), restrictions on the domain and range of the function ($f \in [D \rightarrow R]$), and the creation of graphs for each such function. The graph of a function is a conjunction over a set of propositions obtained by quantifying over the function domain $D$.

(282) \[ [C^0_{\text{FUNC}}] = \lambda q_{(ee,ext)} \lambda D \lambda R \lambda p. \exists f \in [D \rightarrow R] [p = \bigcap \lambda p'. \exists x \in D [p' = q(x)(f)]] \]

where $f \in [D \rightarrow R]$ if and only if $\text{Dom}(f) = D$ and $\forall x [f(x) \in R]$

A full LF for the pair-list reading of (280) is given in the following.

(283) Which boy kissed which girl?
The denotation of IP saturates the first argument of $C_{\text{FUNC}}^0$. It denotes a function (of type $\langle ee, est \rangle$) that maps a function ($f_2$) to a property over individuals ($\lambda x_1.\text{like}(x_1, f_2(x_1))$).

(284)   a. $[[\text{IP}]] = \lambda f_{(e,e)} \lambda x_e [\text{kiss}'(x, f(x))]$

b. $[[C_{\text{FUNC}}^0]] = \lambda q_{(ee,est)} \lambda D \lambda \lambda p. \exists f \in [D \to R][p = \bigcap \lambda p'. \exists x \in D[p' = q(x)(f)]]$

c. $[[C']] = \lambda D \lambda \lambda p. \exists f \in [D \to R][p = \bigcap \lambda p'. \exists x \in D[p' = \text{kiss}'(x, f(x))]$

The domain and range arguments of the functional $C^0$ are saturated by the quantificational domains of which boy and which girl, respectively. Dayal (in progress) discusses two ways to obtain the quantificational domains. One way is to employ Partee’s (1987) BE-shifter. This BE-shifter can extract the quantificational domain of an existential generalized quantifier (but not that of a universal generalized quantifier).2 Alternatively,

---

2 The following illustrates how the BE-shifter works, repeated from (33).

(1)   a. $[[\text{which boy}]_@] = \lambda f_{(e,e)} . \exists x \in \text{boy}_@ [f(x)]$

b. $BE = \lambda P . \lambda x . [P(\lambda y. y = x)]$

c. $BE([[[\text{which boy}]_@]]) = \lambda x ([\lambda f_{(e,e)} . \exists x \in \text{boy}_@ [f(x)])(\lambda y. y = x)]$

\[
= \lambda x [\exists x \in \text{boy}_@ [x = x]]
\]

\[
= \{ x : x \in \text{boy}_@ \}
\]

\[
= \text{boy}_@
following Bittner (1994), one can treat the root denotations of *wh*-items as terms and derive their quantificational meanings via Partee’s $\exists$-shifter. Finally, we get the proposition set (285a) as the root denotation, and Dayal’s answerhood-operator can be applied in the normal way: it returns the unique strongest true proposition in Q, as in (285b).

\[(285) \quad a. \quad Q = \lambda p. \exists f \in [boya@ \to girol][p = \bigcap \lambda p'. \exists x \in boya@[p' = kiss'(x, f(x))]]
\]
\[= [\bigcap \{kiss'(x, f(x)) : x \in boya@ \} : f \in [boya@ \to girol}}]
\]

\[b. \quad ANSDayal(Q)(w) = kiss'(a, m) \land kiss'(b, j)
\]

While Fox (2012) uses a point-wise answerhood-operator to obtain the domain exhaustivity effect of pair-list readings, Dayal (1996, in progress) assigns this responsibility to the functional $C^0$, which restricts the domain of the function and contains a $\bigcap$-closure. Thus, Dayal maintains a lower semantic type for double-*wh* questions: under a pair-list reading, a dual-*wh* question denotes a set of propositions, just like what a single-*wh* question denotes.

Nevertheless, as Dayal (p.c.) pointed out to me very recently, Utpal Lahiri pointed out to her that the $\bigcap$-closure has unwelcome consequences in predicting the *quantification variability effects* (QVEs) in interpreting indirect questions (Lahiri 2002). The QVE effect is exemplified in (286): with a quantificational adverb *mostly* in the matrix clause, this sentence infers that John knows most true propositions of the form ‘boy $x$ kissed girl $y$’.

To allow for this QVE effect, we need to keep these propositions alive and hence should not mash them under conjunctions.
John mostly knows which boy kissed which girl.

\[ \sim \text{For most } p \text{ s.t. } p \text{ is a true proposition of the form ‘boy } x \text{ kissed girl } y', \text{ John knows } p. \]

Thus Dayal (in progress) is trying to get rid of the \( \cap \)-closure in the functional \( C^0 \) and analyzing the root denotation of a multi-\( wh \) question as a family of proposition sets. For the most recent revisions, see the handout Dayal (2016).

There are, however, quite a few problems with the technical details in Dayal’s treatment. Recall that Dayal’s account is designed for both multi-\( wh \) and \( \forall \)-questions. This section only discusses its problems that apply to the case of multi-\( wh \) questions, some of the problems also apply to the case of \( \forall \)-questions. First, the denotation of IP has an abnormal semantic type, namely \( \langle ee, est \rangle \). Second, the lambda operators are kept in IP and are isolated from the moved \( wh \)-phrases. Third, the functional \( C^0 \) is structure specific and has a lot of distinct semantic features, and hence Dayal herself calls this approach “crazy \( C^0 \) approach”.

5.3.2. Higher-order question approaches

The higher-order question approaches (Hagstrom 1998; Fox 2012; Nicolae 2013; Kotek 2014) regards multiple-\( wh \) questions with pair-list readings as families of questions. Answering a family of questions amounts to answering all of the questions. For instance, in interpreting (287), one first creates a question as to for a specific boy which girl he kissed, and then asks this question for each boy in the considered domain, as in (288a). If this domain consists of only two atomic boys, Andy and Billy, the root denotation of (287) is the question set (288b).
(287) Which boy kissed which girl?

(288) a. \{ \text{which girl did } x \text{ kiss? : } x \in \text{boy}' \} \\
    b. \{ \text{Which girl did Andy kiss?} \} \\
    \{ \text{Which girl did Billy kiss?} \}

Using the Hamblin-Karttunen semantics, (288) denotes a set of proposition sets:

(289) a. \{ \text{kiss}'(x,y) : y \in \text{girl}' : x \in \text{boy}' \} \\
    b. \{ \text{kiss}'(a,y) : y \in \text{girl}' \} \\
    \{ \text{kiss}'(b,y) : y \in \text{girl}' \}

To deal with question denotations of higher-order types, Fox (2012) defines a polymorphic answerhood-operator that can be applied point-wise and recursively.

\[
\text{ANS}_{\text{PW-Fox}}(\text{Q})(w) = \begin{cases} 
\text{Q is of type } \langle st, t \rangle \\
\text{ANS}_{\text{Dayal}}(\text{Q})(w) \\
\bigcap \{ \text{ANS}_{\text{PW-Fox}}(\alpha)(w) : \alpha \in \text{Q} \} \text{ otherwise}
\end{cases}
\]

Applying \text{ANS}_{\text{PW-Fox}} to (289), we get a conjunction that coordinates the unique true answer of each sub-question, as schematized in (291). The domain exhaustivity is achieved by the conjunctive closure, and the point-wise uniqueness effect is captured by point-wise applying Dayal’s (1996) presuppositional answerhood-operator.

(291) Which boy kissed which girl?

\[ (w: \text{Andy kissed Mary, Billy kissed Jenny; no other boy kissed any girl.}) \]

\[
\text{ANS}_{\text{PW-Fox}}\left( \{ \text{kiss}'(x,y) : y \in \text{girl}' : x \in \text{boy}' \} \right)(w) = \bigcap \{ \text{ANS}_{\text{Dayal}}(\text{kiss}'(x,y) : y \in \text{girl}' : x \in \text{boy}') : x \in \text{boy}' \}
\]
A full derivation for the question denotation is given in the following. The internal structure for CP1 is the same as what we saw in (13) in section 1.3.2. The identity function ID is defined type-flexible. Following Nicolae (2013: chapter 6), we can consider the abstraction of Q as a type-driven movement of the answerhood-operator.

(292) Which boy kissed which girl?

\[
\begin{align*}
\text{ANS}_{\text{Dayal}}(\text{kiss}'(a, y) : y \in \text{girl}'_@)(w) \\
\text{ANS}_{\text{Dayal}}(\text{kiss}'(b, y) : y \in \text{girl}'_@)(w)
\end{align*}
\]

\[= \text{kiss}'(a, m) \land \text{kiss}'(b, j)\]

A full derivation for the question denotation is given in the following. The internal structure for CP1 is the same as what we saw in (13) in section 1.3.2. The identity function ID is defined type-flexible. Following Nicolae (2013: chapter 6), we can consider the abstraction of Q as a type-driven movement of the answerhood-operator.

(292) Which boy kissed which girl?

\[
\begin{array}{c}
\text{ANS}_{\text{Dayal}}(w) \\
\text{Q : } \langle \text{stt}, t \rangle \\
\lambda \text{Q} \\
\text{CP2} \\
\text{DP} \\
\text{which boy@} \\
\lambda x \\
\text{C}_2' \\
\text{ID} \\
\text{Q}_{(\text{st}, t)} \\
\text{CP1} : \langle \text{st}, t \rangle \\
\text{x kissed which girl}
\end{array}
\]

a. \[[\text{CP}_1] = \{\text{kiss}'(x, y) : y \in \text{girl}'_@\}\]

b. \[[\text{ID}] = \lambda \alpha. \lambda \beta. \alpha = \beta\]

c. \[[\text{ID}(Q)] = \lambda Q'. Q = Q'\]

d. \[[\text{C}_2'] = \text{Q} = \{\text{kiss}'(x, y) : y \in \text{girl}'_@\}\]

e. \[[\text{CP}_2] = \exists x \in \text{boy}'_@[Q = \{\text{kiss}'(x, y) : y \in \text{girl}'_@\}]\]

f. \[Q = \{\text{kiss}'(x, y) : y \in \text{girl}'_@ : x \in \text{boy}'_@\}\]

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5.4. **My proposal: a function-based approach**

This section presents a new function-based approach for the pair-list readings of multi-
*wh* questions. This approach inherits the advantage of Dayal’s (1996) treatment and over-
comes many of its conceptual problems. Moreover, it does not overly generate domain
exhaustivity requirements and is free from Lahiri’s concern with the QVE effects.

5.4.1. **Live-on sets including functions**

I assume that the live-on set of a *wh*-phrase ‘wh-*A*’ includes also functions ranging over
*A*. The domain of each such function is unrestricted.

(293) **Previous definition: lexical entries of *wh*-items** (see section 1.5.4)

a. $[[\text{which } A]] = \lambda B. \exists x \in [\dagger A \cap B]$

b. $\text{BE}([[\text{which } A]]) = \dagger A$

c. $\text{BE}([[\text{which girl}_@]]) = \dagger \text{girl}'_@ = \text{girl}'_@$

(294) **New definition: lexical entries of *wh*-items**

a. $[[\text{which } A]] = \lambda B. \exists x \in ([\dagger A \cup \{f : \text{Range}(f) \subseteq \dagger A\}] \cap B)$

b. $\text{BE}([[\text{which } A]]) = \dagger A \cup \{f : \text{Range}(f) \subseteq \dagger A\}$

c. $\text{BE}([[\text{which girl}_@]]) = \dagger \text{girl}'_@ \cup \{f : \text{Range}(f) \subseteq \dagger \text{girl}'_@\}$

\[= \text{girl}'_@ \cup \{f : \text{Range}(f) \subseteq \text{girl}'_@\}\]

(295) $\text{Range}(f) \subseteq A$ if and only if $\forall x \in \text{Dom}(f)[f(x) \in A]$

Items of which type are involved in the formation of the topical property is determined
by the highest \textit{wh}-trace. Hence, if the movement of a \textit{wh}-item leaves a functional trace, the obtained topical property is a property over functions, as exemplified below.

(296) ‘Which girl did Andy kiss?’ ‘Mary.’/‘His girlfriend.’

a. \textbf{Individual reading:}

\[
P : \langle e, \text{st} \rangle
\]
\[
\lambda x [x \in \text{girl}' \cdot \text{`kiss'}(a, x)]
\]

b. \textbf{Functional reading:}

\[
P : \langle ee, \text{st} \rangle
\]
\[
\lambda f [\text{Range}(f) \subseteq \text{girl}' \cdot \text{`kiss'}(a, f(a))]
\]

What about generalized functional answers? In (297), the elided disjunction should take scope below the necessity modal and be interpreted as a function from an individual to a generalized quantifier (of type \langle e, \langle est, st \rangle \rangle). To be more concrete, if Andy’s girlfriend and mother are Mary and Kate, respectively, then \textit{his girlfriend or his mother} is a function \textbf{F} such that \textbf{F}(a) = m \lor k. Based on the definition (294), such generalized functions are included in the live-on set of \textit{who}: \text{BE(\langle who \rangle)} = \dagger \text{people}'_\oplus \cup \{ f : \text{Range}(f) \subseteq \dagger \text{people}'_\oplus \}.

(297) ‘Who is Andy required to invite?’
‘His girlfriend or his mother. (The choice is up to him.)’

Following the treatment of □-questions in section 1.5.4, we expect such generalized functional answers to be derived through the following LF: BeDOM(who) takes an IP-internal QR (namely, from f to F) before moving to the spec of CP, leaving a higher-order trace F below the necessity modal.

\[(298) \quad \lbrack \text{CP BeDOM(who)} \lambda F \lbrack \text{IP require F} \lambda f \lbrack \text{VP Andy invited f(Andy)} \rbrack \rbrack \rbrack \]

Nevertheless, here arises a type-mismatch: the highest wh-trace F is of type \(\langle ee, st \rangle, st \rangle\); while the generalized functional answer his girlfriend or his mother is of type \(\langle e, \langle est, st \rangle \rangle\). This type mismatch can be resolved using George’s (2011: Appendix A) idea of tuple types, which I have adopted for deriving the single-pair answers of multi-wh questions (see section 1.4.2). George writes an n-ary sequence as \((x_1; x_2; \ldots; x_n)\) which takes a tuple type \((\tau_1; \tau_2; \ldots; \tau_n)\), and then equivocates between the type \(\langle \tau_1 \langle \tau_2 \langle \ldots \langle \tau_n, \sigma \rangle, \ldots \rangle \rangle, \sigma \rangle\), and with the type \(\langle \langle \tau_1; \tau_2; \ldots; \tau_n \rangle, \sigma \rangle\). For instance, \(\langle e, \langle e, st \rangle \rangle\) equals to \(\langle \langle e; e \rangle, st \rangle\). Following this idea, we can consider \(\langle \langle ee, st \rangle, st \rangle\) (the type of trace F) to be equivalent to \(\langle e, \langle est, st \rangle \rangle\), and further equivalent to \(\langle e, \langle est, st \rangle \rangle\) (the type of the generalized functional answer his girlfriend or his mother). The derivation of the topical property is re-illustrated in the following LF.

\[(299) \quad \text{Who is Andy required to invite?} \]
5.4.2. Deriving pair-list

Return to the pair-list reading of the multi-wh question *which boy kissed which girl*. It root denotation is derived as follows.

(300) Which boy kissed which girl?
The lower CP denotes a set of propositions, compositionally derived based on the regular LF for Karttunen Semantics (see section 1.3.2), as schematized in (301a). This set is immediately closed by the $\cap$-closure, returning a conjunctive proposition. We can consider this $\cap$-closure as a function graph creator, and hence the abstraction of the argument $p$ as a type-driven movement of this graph creator. Moving ‘$\text{BE DOM}(\text{which girl})$’ to the spec of the upper CP leaves a functional trace within IP and forms a topical property of functions, just like what we saw with the basic functional reading in (296b). This topical property, as schematized in (301b), is defined for functions ranging over atomic girls, and it maps each such function to a conjunctive proposition that spells out the graph of this function.

\[ (301) \]
\[
\begin{align*}
\text{a.} & \quad [\text{CP}_1] = \lambda p. \exists x [\text{boy}_@'(x) \land p = \text{kiss}_"'(x, f(x))] \\
& \quad = \{ \text{kiss}'(x, f(x)) : x \in \text{boy}_@' \}
\end{align*}
\[
\begin{align*}
\text{b.} & \quad P = tP[\text{Dom}(P) = \{ f : \text{Range}(f) \subseteq \text{girl}_@' \}] \\
& \quad \land
\end{align*}
\]
\( \forall \alpha \in \text{Dom}(P)[P(\alpha) = \bigcap \{ \text{kiss}'(x, \alpha(x)) : x \in \text{boy}'@\}] \)

\[ = \lambda f[\text{Range}(f) \subseteq \text{girl}'@. \bigcap \{ \text{"kiss}'(x, f(x)) : x \in \text{boy}'@\}] \]

Note here that the \( P \) restricts the range of \( f \), but not its domain. Hence, for a function \( f \) being considered as a possible short answer of (300), its domain could be equivalent to, smaller than, or larger than the domain of the subject-wh (viz. \( \text{boy}'@\)). To be more concrete, with two boys Andy and Billy taken into considerations, \( P \) is still defined for not only \( f_3 \) but also \( f_1 \) and \( f_2 \), although the domains of \( f_1 \) and \( f_2 \) are just subsets of atomic boys.

\[
\begin{align*}
\text{(302)} \\
& \text{a. } f_1 = \{ a \rightarrow m \} \\
& \text{b. } f_2 = \{ b \rightarrow j \} \\
& \text{c. } f_3 = \begin{cases} 
  a & \rightarrow m \\
  b & \rightarrow j 
\end{cases}
\end{align*}
\]

The topical property \( P \) in (301b) yields the possible answers in (303a).\(^3\) Applying the \( \text{ANS} \)-operator returns a singleton set that consists of only the pair-list answer.

\[ \text{(303) Which boy kissed which girl?} \]

\( (w: \text{Andy kissed Mary, Billy kissed Jenny; no other boy kissed any girl.}) \)

\[ \text{a. } \{ \text{P}(f) : f \in \text{Dom}(P) \} \]

\[ = \left\{ \bigcap \{ \text{"kiss}'(x, f(x)) : x \in \text{boy}'@\} : \text{Range}(f) \subseteq \text{girl}'@ \right\} \]

\(^3\text{Since } f \text{ is a function (not just a relation), namely, for any } x, f \text{ maps } x \text{ to one and only one girl, there is no possible answer of the form } \text{kiss}'(a, m) \land \text{kiss}'(a, j). \)
\[
\begin{align*}
\{ k'_{\text{a,m}}, & \; k'_{\text{b,m}}, \; k'_{\text{a,m}} \land k'_{\text{b,m}} \\
\{ k'_{\text{a,j}}, & \; k'_{\text{b,j}}, \; k'_{\text{a,m}} \land k'_{\text{b,j}} \\
& \; k'_{\text{a,j}} \land k'_{\text{b,m}} \\
& \; k'_{\text{a,j}} \land k'_{\text{b,j}} \}
\end{align*}
\]

b. True answers from \( P \) in \( w \): \{ \text{kiss}(a,m), \text{kiss}(b,j), \text{kiss}(a,m) \land \text{kiss}(b,j) \}

c. \( \text{ANS}(P)(w) = \{ \text{kiss}(a,m) \land \text{kiss}(b,j) \} \)

Compared with Dayal’s (1996) account and the higher-order question approaches, the proposed function-based approach successfully predicts that multi-\( \text{wh} \) questions are not subject to domain exhaustivity. On the proposed account, the object-\( \text{wh} \) restricts the ranges of the functions, while the domains of the functions are unrestricted. For instance in (303), in a world that only Andy kissed any girl and that he kissed Mary, \( \text{ANS}(P)(w) \) would still be defined and denote the answer set \{ \text{kiss}(a,m) \}.

5.4.3. Quantificational variability effects

Recall that Dayal (1996) has difficulties in predicting QVE effects, and hence that she has to pursue a higher-order function-based approach. This move, however, would sacrifice her advantage of keeping the semantic type low.

The proposed approach, in contrast, leaves space for deriving QVE effects, even though the function graph is closed under a \( \cap \)-closure. Unlike Dayal (1996) which is built upon the Hamblin Karttunen Semantics and treats the root dentation of a multi-\( \text{wh} \) question as a set of propositions, the present account treats the root denotation as a topical property of functions. For this reason, under the proposed account, we are able to retrieve
the quantificational domain of mostly from the short answers: given one max-informative true answer based on a function f, the quantificational domain of mostly is the power set of f (excluding the empty set).

(304) John mostly knows [Q which boy kissed which girl].

Let P be the topical property of Q, then for some f such that P(f) ∈ ANS(P)(w), most singleton f′ ⊆ f is such that John knows P(f').

5.4.4. Mention-some with functional answers

Due to the presupposition of the ANS-operator, mention-some readings are licensed only when the underlying question admits generalized quantifiers as possible answers (see section 3.5.2). For the same reason, to get functional mention-some answers, we need a topical property that is defined for generalized quantifiers over functions.

Let us start with the regular functional mention-some reading of a basic ◇-question, as exemplified in (305). Note the following two points, both of which are related to the derivation of higher-order functions. First, just like what we assumed in section 2.6.1, the LF involves an IP-internal QR of the wh-item (from f to π), which is to rule in higher-order functional answers (e.g., f₁ ∨ f₂, f₁ ∧ f₂). Second, like the case in (297), based on George’ s (2011: Appendix) idea of tuple types, the higher-order trace F can freely denote (i) a generalized quantifier over functions (of type ⟨⟨ee, st⟩, st⟩), so that it provides generalized short answers like f₁ ∨ f₂⁴, or (ii) a function from an individual to a generalized quantifier

---

⁴ I assume the following definition for generalized disjunction over functions.

(1) F = f₁ ∨ f₂ if and only if
(of type \((e,\langle est, st\rangle)\)), so that it ranges over \(\dagger^\ast place_@\) and is defined for \(P\). Applying the ANS-operator returns a set consisting of two mention-some answers, based on \(f_1\) and \(f_2\), respectively.

(305) ‘Where can John get gas?’ ‘The cheapest place near his apt.’

\(w: John\ can\ get\ gas\ at\ the\ cheapest\ place\ near\ his\ apt\ (f_1),\ and\ he\ can\ get\ gas\ from\ the\ biggest\ place\ near\ his\ apt\ (f_2);\ he\ cannot\ get\ gas\ from\ anywhere\ else.\)

\[\begin{align*}
&... \\
&IP \\
&\text{can} \\
&\mathcal{F} \\
&\langle\langle ee, st\rangle, st\rangle = \langle e, \langle est, st\rangle\rangle \\
&\lambda f_{(e,e)} \\
&\text{VP} \\
&O[John\ get\ f(John)]
\end{align*}\]

a. \(P = \lambda F[\text{Range}(F) \subseteq \dagger^\ast place_@. \Diamond F(\lambda f. O[get'(j, f(j))])]

b. True short answers in \(w\): \(\{f_1, f_2, f_1 \lor f_1\}

c. True propositional answers in \(w\): \(\{\Diamond O[get'(j, f_1(j))], \Diamond O[get'(j, f_2(j))]|\Diamond [O[get'(j, f_1(j))] \lor O[get'(j, f_2(j))]]\}

d. \(\text{ANS}(P)(w) = \{\Diamond O[get'(j, f_1(j))], \Diamond O[get'(j, f_2(j))]|\Diamond [O[get'(j, f_1(j))] \lor O[get'(j, f_2(j))]]\}

Extending the derivation of functional mention-some to the pair-list readings of multi-
\(wh\) questions, we obtain generalized functions ranging over generalized quantifiers over

\[\begin{align*}
a. \text{Dom}(F) &= \text{Dom}(f_1) = \text{Dom}(f_2) \\
b. \forall x \in \text{Dom}(F)[F(x) = f_1(x) \lor f_2(x)]
\]
places, as list in (306b). Based on \(f_4\) and \(f_5\), we get two max-informative true answers, which are therefore the pair-list mention-some answers.

(306) Which boy can get coffee from where?

\[w: J.P. Licks is accessible to Andy and Billy, while McDonald’s is only accessible to Billy; no other coffee place is accessible to any of the boys.\]
5.5. Adapting the higher-order question approach

To adapt the higher-order question approach to the proposed hybrid semantics, we simply need to change the denotation of the embedded CP from a set of propositions into a topical property. In other words, under a pair-list reading, *which boy kissed which girl* denotes a set of topical properties.

(307) Which boy kissed which girl?

a. \[\{\lambda y.\lambda w. [\text{girl}_y(y) \land \text{kiss}_w(x, y)] : x \in \text{boy}_y\}\]

b. \[\begin{align*}
\lambda y.\lambda w. [\text{girl}_y(y) \land \text{kiss}_w(a, y)] \\
\lambda y.\lambda w. [\text{girl}_y(y) \land \text{kiss}_w(b, y)]
\end{align*}\]

The point-wise answerhood operator is defined as follows. Note that here the conjunctive closure needs to be applied point-wise, because applying ANS to each sub-question returns a set of max-informative true answers.

(308) Basic answerhood-operator:

\[\text{ANS}(\mathbf{P})(w) = \exists \alpha \in \text{Dom}(\mathbf{P}) \exists \mathbf{P} \in \{\mathbf{P}, \mathbf{P}^\downarrow\} \{\mathbf{w} \in \mathbf{P}(\alpha) \land \forall \beta \in \text{Dom}(\mathbf{P})[\mathbf{w} \in \mathbf{P}(\beta) \rightarrow \mathbf{P}(\alpha) \subseteq \mathbf{P}(\beta)]\}.\]

\[\{\mathbf{P}(\alpha) : \alpha \in \text{Dom}(\mathbf{P}) \land \mathbf{w} \in \mathbf{P}(\alpha) \land \forall \beta \in \text{Dom}(\mathbf{P})[\mathbf{w} \in \mathbf{P}(\beta) \rightarrow \mathbf{P}(\beta) \notin \mathbf{P}(\alpha)]\}\]

(309) Point-wise answerhood-operator:

\[\text{ANS}_{\text{PW}} = \lambda \mathbf{P}.\lambda w. \begin{cases} 
\text{ANS}(\mathbf{P})(w) & \mathbf{P} \text{ is of type } \langle \tau, \text{st} \rangle \\
\bigcap_{\text{PW}} \{\text{ANS}_{\text{PW}}(\alpha)(w) : \alpha \in \mathbf{P}\} & \text{otherwise}
\end{cases}\]

(310) Point-wise conjunction:

\[\bigcap_{\text{PW}} \{A, B\} = \{a \land b : a \in A, b \in B\}\]
Applying ANS\(_{pw}\) to the root denotation in (307), we get a set of conjunctive propositions. Each conjunctive proposition coordinates one max-informative true answer of each sub-question. Since here each sub-question has only one max-informative true answer, the output of employing ANS\(_{pw}\) is a singleton set.

(311) Which boy kissed which girl?

\[ (w: Andy\ kissed\ Mary,\ Billy\ kissed\ Jenny;\ no\ other\ boy\ kissed\ any\ girl.) \]

\[
\text{ANS}_{pw}(\lambda y.\lambda w[\text{girl'}(y) \land \text{kiss}'_w(a, y)]) (w)
\]

\[
= \bigcap_{pw} \text{ANS}((\text{kiss}'(x, y) : y \in \text{girl'}) (w) : x \in \text{boy'})
\]

\[
= \bigcap_{pw} \left\{ \text{ANS}(\lambda y.\lambda w[\text{girl'}(y) \land \text{kiss}'_w(a, y)]) (w) \right\}
\]

\[
= \{\text{kiss}'(a, m) \land \text{kiss}'(b, j)\}
\]

The adapted analysis can also derive pair-list mention-some readings, as exemplified below. The output set of employing ANS is a non-singleton set, each member of which counts as a complete true answer of the multi-\(wh\) question.

(312) Which boy can get coffee from where?

\[ (w: J.P. Licks\ is\ accessible\ to\ Andy\ and\ Billy,\ while\ McDonald’s\ is\ only\ accessible\ to Billy;\ no\ other\ coffee\ place\ is\ accessible\ to\ any\ of\ the\ boys.) \]

a. \[\llbracket x\ can\ get\ coffee\ from\ where\rrbracket = \lambda x.\lambda w[\uparrow^{*}\text{place'}@(\pi) \land \Diamond_w\pi(\lambda y.\text{O}[\text{get}'(x, y)])] \]

b. \[\text{ANS}(\llbracket a\ can\ get\ coffee\ from\ where\rrbracket)(w) = \{\Diamond\text{O}[\text{get}'(a, j)]\} \]

c. \[\text{ANS}(\llbracket b\ can\ get\ coffee\ from\ where\rrbracket)(w) = \{,\Diamond\text{O}[\text{get}'(b, j)],\Diamond\text{O}[\text{get}'(b, m)]\} \]

d. \[\text{ANS}_{pw}(\llbracket\text{which\ boy\ can\ get\ coffee\ from\ where}\rrbracket)(w) \]

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The presupposition of the basic ANS-operator has the same consequence as Dayal’s presupposition in singular questions, and hence it captures the point-wise uniqueness effects just like $\text{ANS}_{\text{Dayal}}$ does.

A full derivation for the root denotation is given in the following. The embedded CP_1 denotes the topical property of $x$ kissed which girl, derived by moving BEDOM(which girl) to the spec of CP_1. The abstraction of $P$ is a type-driven movement of the $\text{ANS}_{\text{PW}}$-operator.
(313) Which boy kissed which girl?

\[
\begin{align*}
\text{Ans}_{PW} & \quad \text{P: } \langle est, t \rangle \\
\lambda P & \quad \text{CP}_2: t \\
\text{DP: } \langle et, t \rangle & \quad \langle e, t \rangle \\
\lambda x & \quad \text{C}_2': t \\
\langle \tau, t \rangle & \quad \text{ID } P_\tau \\
\text{BeDOM} & \quad \text{DP } \lambda y \\
\text{which girl@} & \quad \text{kiss}(x, y) \\
\end{align*}
\]

a. \([\text{CP}_1] = \lambda y \lambda w [\text{girl}_@'(y) \land \text{kiss}_w'(x, y)]\)

b. \([\text{ID}(P)] = \lambda P'. P = P'\)

c. \([\text{C}_2'] = P = \lambda y \lambda w [\text{girl}_@'(y) \land \text{kiss}_w'(x, y)]\)

d. \([\text{CP}_2] = \exists x [\text{boy}_@'(x) \land P = \lambda y \lambda w [\text{girl}_@'(y) \land \text{kiss}_w'(x, y)]]\)

e. \(P = \lambda P. \exists x [x \in \text{boy}_@' \land P = \lambda y \lambda w [\text{girl}_@'(y) \land \text{kiss}_w'(x, y)]]\)

\[= \{ \lambda y \lambda w [\text{girl}_@'(y) \land \text{kiss}_w'(x, y)] : x \in \text{boy}_@' \}\]

f. \(\text{ANS}_{PW}(P)(w) = \cap_{PW} [\text{ANS}(P)(w) : P \in P]\)
Chapter 6

Quantifying into questions
6.1. **Introduction**

Questions with universal quantifiers, called “\(\forall\)-questions” henceforth, have three types of readings (Engdahl 1980), namely individual readings\(^1\), functional readings, and pair-list readings, as exemplified in the following.

(314) Which girl did every/each boy kiss?

a. **Individual reading** \((\iota > \forall)\)

For which unique girl \(y\) is such that every boy kissed \(y\)?

‘Mary.’

b. **Functional reading** \((\iota > \forall)\)

For which unique function \(f\) to a girl is such that every boy \(x\) kissed \(f(x)\)?

‘His girlfriend.’

c. **Pair-list reading** \((\forall > \iota)\)

For every boy \(x\), which unique girl did \(x\) kiss?

‘Andy kissed Mary, Billy kissed Jenny.’

This chapter will be focused on the pair-list readings, and will only consider \(\forall\)-questions with a singular *wh*-item, henceforth called “singular \(\forall\)-questions”. The pair-list readings of singular \(\forall\)-questions exhibit clear domain exhaustivity and point-wise uniqueness effects: under the pair-list reading, (314) presupposes that every boy kissed one and only one girl, and it requests the addressee to list out all the boy-kissing-girl events.

\(^1\)Note to distinguish these “individual readings” from the ones in Chapter 2-4, which were named as oppose to “higher-order readings”.

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In parallel to the pair-list readings of \( \forall \)-questions, questions with existential quantifiers (called “\( \exists \)-questions” henceforth) admit choice readings.\(^2\) Due to the singular \( wh \)-object *which girl*, the \( \exists \)-question (315) presupposes that at least one of the boys kissed exactly one girl. To answer this question, the addressee needs to utter one true proposition of the form ‘\( x \) kissed \( y \)’ where \( x \) is a boy and \( y \) is a girl, such that \( x \) kissed exactly one girl. For instance, since Clark kissed two girls, (315c-d) are not proper answers.\(^3\)

(315) Which girl did one of the boys kiss?

**Choice reading:** For one of the boys \( x \), which girl did \( x \) kiss? \((\exists > i)\)

\((w: Andy \ only \ kissed \ Mary, \ Billy \ only \ kissed \ Jenny, \ Clark \ kissed \ Mary \ and \ Jenny.)\)

a. Andy kissed Mary.

b. Billy kissed Jenny.

c. # Clark kissed Mary.

d. # Clark kissed Mary and Jenny.

Pair-list reading and choice readings in \( \forall \)-questions and \( \exists \)-questions are usually described as “quantifying into questions”. The phenomenon casts doubts to the Hamblin-Karttunen Semantics. In (316) for instance, if a question denotes a set of propositions, [...]

\(^2\)It is unclear to me whether (315) admits individual and functional readings. If these readings are available, we expect the possibilities of interpreting uniqueness below the \( \exists \)-quantifier.

\(^3\) Note to distinguish the choice reading of the \( \exists \)-question (??) from the single pair reading of the multi-\( wh \) question (1). Under a single pair reading, (1) presupposes that there is only one boy-kissing-girl event (namely, that only one of the boys kissed a girl and that this boy kissed exactly one girl). In the discourse described in (315), the single-pair reading of (1) is undefined.

(1) which boy kissed which girl?
moving a quantifier out of a question root causes type-mismatch: the scope of every boy should be of type \( (e, st) \), while here the scope is of type \( (e, stt) \).

(316) Which girl did every boy kiss?

* [[every boy] \( \lambda x \) \( Q \) which girl did \( x \) kiss]]

We now have three types of question readings, as list below. Which and which readings should be treated uniformly?

A. Pair-list readings of multi-wh questions

B. Pair-list readings of \( \forall \)-questions

C. Choice readings of \( \exists \)-questions.

One prominent view is to treat A and B uniformly (Engdahl 1980, 1986; Dayal 1996, in progress), since they both are pair-list readings and seemingly both exhibit functionality effects. The other view, which I will pursue, is to treat B and C uniformly (Chierchia 1993). In the following, I provide empirical arguments for the second view.

First, the pair-list reading of a multi-wh question and that of a \( \forall \)-question are semantically different: the former is not subject to domain exhaustivity (contra Dayal 1996, Fox 2012, among the many others), while the latter is. This difference is illustrated by the following minimal pair:

(317) (Scenario: Four kids are playing the game of Musical Chairs and competing for three chairs.)

a. \( \sqrt{ \text{Which kid} } \) will sit on which chair? \hspace{1cm} \text{multi-wh question}

b. \# \text{Which chair will every/each kid sit on?} \hspace{1cm} \forall \text{-question}
The game rule of Musical Chair suggests the following conditions: (i) that one of the four kids will not sit on a chair, and (ii) the rest three kids will each sit on a chair. Condition (ii) ensures the two questions to take pair-list readings (as oppose to individual readings and single-pair readings), and condition (i) contradicts a domain exhaustivity inference that each kid will sit on a chair, if it exists. Observing that only (317b) is infelicitous, we can conclude that only (317b) is subject to domain exhaustivity. Hence, we should treat the pair-list readings of (317a-b) differently. In section 5.4, I have presented a function-based analysis for the pair-list readings of multi-\emph{wh} questions that does not predict a domain exhaustivity effect.

Second, the pair-list readings of \emph{\forall}-questions and the choice readings of \emph{\exists}-questions have similar distributional patterns: they both exhibit a subject-object/adjunct asymmetry (Chierchia 1991, 1993). To be more specific, both readings are available when the non-interrogative quantifier serves as the subject and the \emph{wh}-item serves as the object or an adjunct; otherwise they are unavailable (examples repeated from section 2.3.2).

(318) **Pair-list readings of \emph{\forall}-questions**

a. Subject-Object

   i. Which candidate did everyone vote for? \checkmark pair-list

   ii. Which voter voted for every candidate? \times pair-list

b. Subject-Adjunct

   i. At which station did every guest get gas? \checkmark pair-list

   ii. Which guest got gas from every gas station? \times pair-list

(319) **Choice readings of \emph{\exists}-questions**
a. Subject-Object

   i. Which candidate did [one of the students] vote for? √ choice
   
   ii. Which person voted for [one of the students]? ?choice

b. Subject-Adjunct

   i. At which station did [one of the guests] get gas? √ choice
   
   ii. Which guest got gas at [one of the nearby stations]? ?choice

Given their similar surface structure and the very same subject-object/adjunct asymmetry, we can conjecture that the pair-list readings of ∀-questions and the choice readings of ∃-questions are derived via similar procedures.

This chapter will present two uniform accounts for questions with quantifiers. One account follows the line of higher-order question approaches, and the other follows the line of function-based approaches. Both accounts treat the quantifiers are regular quantifications.

6.2. Previous accounts


Groenendijk & Stokhof (1984) provide two accounts, one based on partitions, and the other based on witness sets.
6.2.1.1. The partition-based account

Groenendijk & Stokhof (1984) firstly analyze a \( \forall \)-question like (320) as a partition that can identify which boy kissed which girl. From the derivation in (321), it can be nicely observed that the quantifier is moved out of a proposition, and hence that quantifying-into a question does not cause type mismatch.

(320) Which girl did every boy kiss?

\[
\{ \langle i, j \rangle : \forall x[\text{boy}'(x) \rightarrow \{ y : \text{girl}'(y) \land \text{kiss}'(x,y) \} = \{ y : \text{girl}'(y) \land \text{kiss}'(x,y) \}] \}
\]

\((i\text{ and } j\text{ are in the same cell if and only if every boy }x\text{ is such that }x\text{ kissed the same girl in }i\text{ and in }j.)\)

(321)

\[
\begin{align*}
\lambda i & \langle s, st \rangle \\
\lambda j : \forall x[\text{boy}'(x) \rightarrow [\lambda y[\text{girl}'(y) \land \text{kiss}'(x,y)]] = \\
& [\lambda y[\text{girl}'(y) \land \text{kiss}'(x,y)]] \\
\langle e, st \rangle & \text{every boy} \\
\lambda P : \forall x[\text{boy}'(x) \rightarrow [\lambda x[P(x)]] = \\
& [\lambda x[P(x)]] \\
\lambda j & \langle s, t \rangle \\
& \text{which girl }x\text{ kissed} \\
\end{align*}
\]

This analysis, however, cannot extend to the case of non-universal quantifiers. Consider the corresponding \( \exists \)-question (322) for instance, extending the analysis above to (322) yields a set of world cells: two worlds are in the same cell as long as one of the boys kissed the same girl in these two worlds.
Which girl did one of the boys kiss?

\[
\langle i, j \rangle : \exists x [\text{boy}^\prime (x) \land y : \text{girl}^\prime (y) \land \text{kiss}^\prime (x, y)] = \{y : \text{girl}^\prime (y) \land \text{kiss}^\prime (x, y]\} \]

\(i\) and \(j\) are in the same cell as long as for some boy \(x\) is such that \(x\) kissed the same girl in \(i\) and in \(j\).

To be more concrete, in (323a), the three worlds \(w_1w_2w_3\) are in the same cell \(C_1\): Andy kissed the same girl in \(w_1\) and \(w_2\), and Billy kissed the same girl in \(w_1\) and \(w_3\); likewise in (323b), the three worlds \(w_2w_3w_4\) are in the same cell \(C_2\): Billy kissed the same girl in \(w_2\) and \(w_4\). Note that \(C_1\) and \(C_2\) are different cells because none of the boys kissed the same girl in \(w_1\) and \(w_4\).

\[
\begin{align*}
C_1 &= \left\{ \begin{array}{l}
  w_1 : [a \to m, b \to j] \\
  w_2 : [a \to m, b \to m] \\
  w_3 : [a \to j, b \to j]
\end{array} \right\} & \\
C_2 &= \left\{ \begin{array}{l}
  w_2 : [a \to m, b \to m] \\
  w_3 : [a \to m, b \to j] \\
  w_4 : [a \to j, b \to m]
\end{array} \right\}
\end{align*}
\]

This setting yields two problems. First, there is no boy such that we can identify which girl he kissed. Assume that \(w_1\) is the actual world, for instance, we are not able to decide whether Andy kissed Mary or Jenny, because \(w_3\) is also in \(C_1\). Second, as Krifka (2001) indicates, it does not give a partition, because some cells overlap: \(C_1\) and \(C_2\) are different cells but they both include \(w_2\) and \(w_3\).

6.2.1.2. A witness sets-based account

To account for the phenomena of quantifying-into question uniformly, Groenendijk & Stokhof (1984) provide an alternative account and propose that quantifiers in questions supply \textit{minimal witness sets} (Barwise & Cooper 1981), and that questions are quan-
tified internally over each element of a minimal witness set. This account has great influences on the subsequent accounts proposed by Chierchia (1993), Dayal (1996), Nicolaie (2013), and so on.

(324) **Definition: witness sets** (Barwise & Cooper 1981)

For a quantifier \( \mathcal{P} \) that lives on the set \( B \), \( A \) is a witness set of \( \mathcal{P} \) if and only if

a. \( A \subseteq B \);

b. \( A \in \mathcal{P} \);

c. \( \neg \exists A' \subseteq A[A \in \mathcal{P}] \)

A universal quantifier like *every boy* has only one witness set, namely its quantificational domain *boy*’, while an existential quantifier like *two boys* has multiple witness sets, each of which consists of exactly two boys. Moreover, downward monotone quantifiers like *no boy* has a unique minimal witness set, namely the emptyset.

See (325) for a concrete example of choice readings of \( \exists \)-questions. This question denotes a set of sub-questions, each sub-question denotes a partition with respect to ‘which member of \( A \) kissed who’ where \( A \) is a minimal witness set of *two of the boys* (i.e., a set consisting of only two boys). Answering this question amounts to answering one of these sub-questions. Since the existential quantifier *two of the boys* has multiple minimal witness sets, we obtain a choice reading.

(325) Who did two of the boys kiss?

\[ \lambda Q. \lambda A[MWS(two-boys', A) \wedge ] \]

\[ Q = \lambda w.\lambda w'[\lambda x.\lambda y[x \in A \land kiss'(x,y)] = \lambda x.\lambda y[x \in A \land kiss'(x,y)] \]

\[ = \{\lambda w.\lambda w'[\lambda x.\lambda y[x \in A \land kiss'(x,y)] = \lambda x.\lambda y[x \in A \land kiss'(x,y)] : MWS(two-boys', A)] \]
More generally, under this account, the meaning of a question of the form “who did \( P \) kiss?” is paraphrased as the following: for some \( A \) such that \( A \) is a minimal witness set of \( P \), what is the pair-list answer of ‘who did which member of \( A \) kiss’? Accordingly, the choice answer of an \( \exists \)-question amounts to the pair-list answer of one of the sub-questions, and the pair-list answer of a \( \forall \)-question amounts to the pair-list answer of the unique sub-question.

This analysis yields two nice predictions. First, it predicts the contrast between \( \forall \)-quantification and \( \exists \)-quantification: a \( \forall \)-quantifier has only one minimal witness set; while an \( \exists \)-quantifier has multiple minimal witness sets. Second, it explains why questions with a downward monotone quantifier does not admit pair-list readings: downward monotone quantifiers has a unique minimal witness set, i.e. the emptyset.

(326)  a. Who does at most two of the students love?

    # Andy loves Mary, Billy loves Jenny.

b. Who does no student love?

    # [silence]

Nevertheless, this analysis overly predicts pair-list readings. The seeming pair-list answer with respect to some two boys in (325) is actually an individual answer with an atomic or generalized distributive reading (Srivastav 1992; Krifka 1992; Dayal 1996; Moltman & Szabolcsi 1994; Szabolcsi 1997; Beghelli 1997; among the others).

(327)   Who did two of the boys kiss?

Andy and Billy voted for Mary and Jenny. In particular, Andy kissed Mary and Billy kissed Jenny.
To avoid the confounds from distributive individual answers, we need to check the availability of pair-list readings in questions with singular wh-items. In the following, pair-list readings are only licensed by distributive universal quantificational phrases (e.g., *every boy, each student*). This limited distribution is not predicted under the witness sets-based account.

(328) I know that every student voted for a different candidate, please tell me ...  
   a. Which candidate did every student vote for? \((\forall > \iota)\)  
   b. Which candidate did each of the students vote for? \((\text{EACH} > \iota)\)  
   c. # Which candidate did two of the students vote for? \((\exists 2 > \text{EACH} > \iota)\)  
   d. # Which candidate did most of the students vote for? \((\text{MOST} > \text{EACH} > \iota)\)

6.2.2. Chierchia (1993)

Chierchia (1993) argues that list readings of questions with quantifiers are functional readings of a special kind. He observes that, in a \(\forall\)-question, both pair list and functional answers become unavailable when the universal quantifier is in object rather than subject position. This is what we called “subject-object asymmetry” in section 6.

(329) Which girl did every boy kiss?  
   a. Mary. Individual  
   b. Every boy kissed his girlfriend. Functional  
   c. Andy kissed Mary, Billy kissed Jenny. Pair-list

(330) Which boy kissed every girl?
a. Andy (kissed every girl). Individual

b. # Her boyfriend (kissed every girl). # Functional

c. # Andy kissed Mary, Billy kissed Jenny. # Pair-list

Chierchia subsumes this syntactic asymmetry under **weak cross-over (WCO)**. He proposes that a *wh*-item is associated with two things: a function and an argument. The function is bound by the existential quantifier within the *wh*-determiner, and the argument is locally bound by some suitable nominal expression. The movement of a *wh*-item thus leaves a complex trace. For instance in (331), the trace of *which girl* has a functional (f)-index $i$ bound by *which girl*, and an argument (a)-index $j$ bound by the c-commanding quantificational expression *every boy*.

(331) Which girl did every boy kiss?

In case *every boy* serves as the object, it must be raised to a position that c-commands the *wh*-trace so as to bind the a-index, as shown below. This movement, however, results in a weak cross over violation: *every boy* is co-indexed with the a-trace, which is a pronominal element.

(332) which girl$_i$ [ every boy$_j$ [ t$_i^j$ likes t$_j$ ]]
Formally, Chierchia adopts Groenendijk & Stokhof’s (1984) witness sets-based account and analyzes questions of the form (333) as denoting a family of sub-questions, each sub-question quantifies over a minimal witness set of \( P \). Moreover, the picked minimal witness set restricts the function domain.\(^4\)

\[ (333) \quad \text{which girl} \oplus P_j + \text{kiss}(t_j, t_i^j) \]

\[ \Rightarrow \lambda Q. \exists A [\text{WMS}(P, A) \land Q = \lambda p. \exists f \in [A \rightarrow \text{girl}_@] \exists x \in A[p = \text{kiss}'(x, f(x))]] \]

\[ = \left\{ \{\text{kiss}'(x, f(x)) : x \in A \land f \in [A \rightarrow \text{girl}_@] : \text{MWS}(P, A) \right\} \]

Consider only two boys Andy and Billy, we get the following denotations. The \( \forall \)-question denotes a singleton set of a proposition set, while the \( \exists \)-question denotes a set consisting of two proposition sets. To answer these questions, the addressee needs to name all the true propositions in one of the proposition sets.

\[ (334) \quad \text{Which girl did every boy kiss?} \]

\[ \{Q : \exists A [\text{WMS(\text{every boy}, A)} \land Q = \{p : \exists f[A \rightarrow \text{girl}_@] \exists x \in A[p = \text{kiss}'(x, f(x))]]\} \]

\[ = \left\{ \{\text{kiss}'(x, f(x)) : x \in A \land f \in [A \rightarrow \text{girl}_@] : \text{MWS(\text{every boy}, A)} \right\} \]

\[ = \left\{ \{\text{kiss}'(x, f(x)) : x \in A \land f \in [A \rightarrow \text{girl}_@] : A \in \{\{a, b\}\} \right\} \]

\[ = \left\{ \text{kiss}'(a, m), \text{kiss}'(b, m), \text{kiss}'(a, j), \text{kiss}'(b, j) \right\} \]

\[ (335) \quad \text{Which girl did one of the boys kiss?} \]

\[ \{Q : \exists A [\text{WMS(\text{one boy}, A)} \land Q = \{p : \exists f[A \rightarrow \text{girl}_@] \exists x \in A[p = \text{kiss}'(x, f(x))]]\} \]

\[ = \left\{ \{\text{kiss}'(x, f(x)) : x \in A \land f \in [A \rightarrow \text{girl}_@] : \text{MWS(\text{one boy}, A)} \right\} \]

\(^4\)Note that the quantifier \( P \) is interpreted within the question nucleus (viz. within IP), but to be used as the function domain it has to take scope outside the interrogative \( C^0 \). Chierchia salvages this problem via a restructuring operation called \text{ABSORPTION}.\]
Due to the use of minimal witness sets, Chierchia’s account inherits the advantages and shortcomings of Groenendijk & Stokhof’s (1984) witness sets-based account. A more serious problem, as indicated by Dayal (1996), is that it cannot account for the domain exhaustivity and point-wise uniqueness requirements in interpreting ∃-questions. On Chierchia’s account, answering a ∃-question amounts to specifying all the true propositions in its unique sub-question. Thus (334) is predicted to be utterable in a scenario that only Andy kissed any girls or a scenario that Andy kissed both Mary and Jenny, contra the fact.

6.2.3. Dayal (1996, in progress)

Dayal (1996, in progress) proposes a uniform FUNCTION-BASED ACCOUNT to derive pair-list readings of multi-wh questions and ∃-questions. I have discussed the consequences of this account in multi-wh questions in section 5.3.1 and argued in section 6.1 that the pair-list readings of these two types of questions should be treated differently. This section will only consider its consequences in questions with quantifiers.

The semantic compositions of the following structure is exactly the same as what we saw from (283) to (285) for which boy kissed which girl?: IP contributes the first argument of the functional $C^0$; the subject and object quantificational phrases restrict the domain and the range of the function; the obtained denotation is a set of propositions, each of which names a function from atomic boys to atomic girls; applying the $\text{ANS}_{Dayal}$-operator
returns the strongest true answer.

(336) Which girl did every boy kiss?

which girl\(\_\_\_\_\)every boy\(\_\_\_\_\)C'

a. \([\text{IP}] = \lambda f(x) . x \in \text{kiss}'(x, f(x))\)

b. \([C^0_{\text{func}}] = \lambda q(x, y) . D \land R \land p . \exists f \in [D \rightarrow R] \forall x \in D[p = p' = q(x)(f)]\)

c. \([C'] = \lambda D \land R \land p . \exists f \in [D \rightarrow R][p = \land p'. \exists x \in D[p' = \text{kiss}'(x, f(x))]\)

d. \(Q = \lambda p . \exists f \in [\text{boy}' \rightarrow \text{girl}'] \forall x \in \text{boy}'[p = \land p'. \exists x \in \text{boy}'[p' = \text{kiss}'(x, f(x)))]\)

\[= \{ \exists x \in \text{boy}' . f \in [\text{boy}' \rightarrow \text{girl}'] \land \text{kiss}'(x, f(x)) \} \]

e. \(\text{ANS}_{\text{Dayal}}(Q)(w) = \text{kiss}'(a, m) \land \text{kiss}'(b, j)\)

But here the function domain boy\(\_\_\_\_\)is extracted from a universal quantifier every boy (as oppose to the existential indefinite which boy). Hence, this function domain cannot be obtained in the same way as we saw in the case of the multi-wh question (283). Dayal assumes that here the set boy\(\_\_\_\_\)is extracted as the minimal witness set of every boy. Moreover, to avoid overly generating pair-list readings in questions like (337), she stipulates that such an extraction operation is only available to a quantifier that has a unique minimal witness set, and hence that only \(\forall\)-questions admit pair-list answers.
(337) Which girl did two of the boys kiss?

    # Andy kissed Mary, and Billy kissed Jenny.

Compared with earlier accounts, Dayal’s account has two major advantages. First, it captures the functionality effects in pair-list readings of ∀-questions, namely domain exhaustivity and point-wise uniqueness. Second, it maintains a low semantic type for ∀-questions: a ∀-question taking a pair-list reading still denotes a set of propositions.

Nevertheless, this account faces many problems. All the problems raised for the case of multi-wh questions also apply here: the denotation of IP has an abnormal semantic type; the lambda operators are isolated from the moved phrases; the functional C^0 is structure specific and has a lot of “crazy” features. In the case of questions with quantifiers, this account faces more problems. First, it is syntactically impermissible to move a non-interrogative phrase every boy to the spec of an interrogative CP (Heim 2012). Second, this account incorrectly predicts universal pair-list readings for ∃-questions. On Dayal’s account, the LF (338) is available to all the three questions in (339). Dayal has shown that this LF yields universal pair-list readings in the case of (339a-b), but she has not discussed the case of (339c). But, since which boy and some boy are lexically identical, this account would predict the ∃-question (339c) to take a universal pair-list reading under the LF (338), which is however unavailable.

(338) \[
[CP [DP which girl]_i \, [[DP every/which/some boy]_j \, [C^0_{func} \, [IP t_j \, kissed \, t_i^i]]]]
\]

(339)  a. ‘Which girl did every boy kiss?’     √ ‘Andy kissed Mary, Billy kissed Jenny.’
       b. ‘Which boy kissed which girl?’     √ ‘Andy kissed Mary, Billy kissed Jenny.’
       c. ‘Which girl did some boy kiss?’    # ‘Andy kissed Mary, Billy kissed Jenny.’
Third, this account cannot capture the choice readings of $\exists$-questions. Recall that, in the traditional witness sets-based accounts (Groenendijk & Stokhof 1984; Chierchia 1993), the choice readings of $\exists$-questions are captured based on the idea that an existential quantifier has multiple minimal witness sets. To avoid predicting pair-list readings in cases like (337), however, Dayal has to stipulate that a non-universal quantifier cannot supply witness sets for the restriction of the function domain. This stipulation makes her account unable to generate choice readings of $\exists$-questions based on witness sets. Instead, as we just saw, Dayal predicts that, with a functional $C^0$ in the LF, an $\exists$-question takes only a universal pair-list reading.

6.2.4. Fox (2012)

Fox (2012) proposes a higher-order question approach to the pair-list readings of $\forall$-questions. On this approach, a $\forall$-question with a pair-list reading first generates a set of sets that contain all the sub-questions and then back down to the set of sub-questions (of type $\langle stt, t \rangle$) with the application of a minimization operator (Pafel 1999; Preuss 2001).

(340) Minimization operator (Pafel 1999)

$$\text{MIN}(\alpha) = \exists K [K \in \alpha \land \forall K' \in \alpha [K' \subseteq K]]$$

A concrete example for the derivation of the root denotation is given in (341). This LF has three novel pieces: the movement of a null operator $K$, the QR of the $\forall$-quantifier over CP, and the application of a minimization operator MIN.\footnote{The internal structure of CP is omitted; it is the basic GB-style structure for Karttunen Semantics, as what we saw in (13) in section 1.3.2.} The meaning of (341) proceeds
as follows. The bracketed parts are the paraphrases.

- (‘which girl did x kiss’)
  The CP denotes the Hamblin set of *which girl did x kiss*, as in (341a).

- (‘which girl did x kiss’ is in K)
  The insertion of the null operator K yields a membership relation that the
  Hamblin set of *which girl did x kiss* is a member of K, as in (341b).

- (EVERY x is such that ‘which girl did x kiss’ is in K.)
  *Every boy* moves over CP and quantifies into the membership relation,
  yielding a universal membership relation, as in (341c-d).

- (K: every boy x is such that ‘which girl did x kiss’ is in K])
  At node 3, as in (341e), abstracting the null operator K yields a family
  of “K sets”, namely the sets that contain all the subquestions. Here the
  ★-sign stands for an arbitrary object that is not a subquestion.

- (MIN(K: every boy x is such that ‘which girl did x kiss’ is in K))
  Employing the MIN-operator returns the minimal K set, which is simply
  the set of all the sub-questions, as in (341f).
(341) Which girl did every boy kiss?

\[ Q : \langle st, t \rangle \]

\[ \text{MIN} \]

\[ 3 : \langle stt, t \rangle \]

\[ \lambda K \]

\[ 2 : t \]

DP: \( \langle et, t \rangle \)

\[ \lambda x \]

\[ 1 : t \]

K

CP: \( \langle st, t \rangle \)

which girl did \( x \) kiss

a. \([\text{CP}_1]\) = \{kiss'(x, y) : y \in \text{girl}'@\}

b. \([1]\) = K\{kiss'(x, y) : y \in \text{girl}'@\}

\[ = \{kiss'(x, y) : y \in \text{girl}'@\} \in K \]

c. \([\text{every boy}@]\) = \(\lambda f. \forall x \in \text{boy}'_@[f(x)]\)

d. \([2]\) = \(\forall x \in \text{boy}'_@[\{kiss'(x, y) : y \in \text{girl}'@\} \in K]\)

e. \([3]\) = \(\lambda K. \forall x \in \text{boy}'_@[\{kiss'(x, y) : y \in \text{girl}'@\} \in K]\)

\[ = \left\{ \begin{array}{l}
\{kiss'(a, y) : y \in \text{girl}'@\} \\
\{kiss'(b, y) : y \in \text{girl}'@\}
\end{array} \right\} \]

\[ \text{MIN}([3]) = \left\{ \begin{array}{l}
\{kiss'(a, y) : y \in \text{girl}'@\} \\
\{kiss'(b, y) : y \in \text{girl}'@\}
\end{array} \right\} \]

The obtained root denotation \( Q \) is identical to what Fox (2012) proposes for the pair-list
reading of the multi-wh question *which boy kissed which girl?* (see section 5.3.2). Employing
the point-wise answerhood-operator returns the conjunction of the strongest true answers
of the sub-questions, namely the pair-list answer. Just like what we saw in the case of
multi-wh questions, the conjunctive closure within the point-wise answerhood-operator
yields domain exhaustivity, and the point-wise application of $\text{ANS}_\text{Dayal}$ predicts point-
wise uniqueness.

(342) **Point-wise answerhood operator** (Fox 2012)

$$\text{ANS}_{\text{PW}-\text{Fox}} = \lambda Q \{ w. \begin{cases} \text{ANS}_{\text{Dayal}}(Q)(w) & \text{Q is of type } \langle st, t \rangle \\ \bigcap \{ \text{ANS}_{\text{PW}-\text{Fox}}(\alpha)(w) : \alpha \in Q \} & \text{otherwise} \end{cases} \}$$

(343) (w: consider only two boys Andy and Billy; Andy only kissed Mary, and Billy only kissed Jenny.)

$$\text{ANS}_{\text{PW}-\text{Fox}}(Q)(w) = \bigcap \begin{cases} \text{ANS}_{\text{Dayal}}((\text{kiss}'(a, y) : y \in \text{girl}'_0))(w) \\ \text{ANS}_{\text{Dayal}}((\text{kiss}'(b, y) : y \in \text{girl}'_0))(w) \end{cases}$$

$$= \bigcap \begin{cases} \text{kiss}'(a, m) \\ \text{kiss}'(b, j) \end{cases}$$

$$= \text{kiss}'(a, m) \land \text{kiss}'(b, j)$$

Fox’s account has two advantages. **First**, it manages to analyze the semantic contribu-
tion of the generalized quantifier *every boy* as a regular universal quantification (as oppose
to supplying witness sets, which are artificial): due to the insertion of the null operator
K, the scope of *every boy* is of type $\langle e, t \rangle$, and hence quantification does not suffer type-
mismatch. **Second**, it captures the limited distribution of pair-list readings: with any
quantifier other than a universal, the MIN-operator is undefined. Compare the following sets of K sets for instance. Observe that (344a) has a minimal K, while that (344b-c) do not; hence the MIN-operator is defined in (344a) but not in (344b-c).

(344)  
a. \{K: EVERY x is such that ‘which girl did x kiss’ is in K\}

b. \{K: MOST x are such that ‘which girl did x kiss’ is in K\}

c. \{K: TWO x are such that ‘which girl did x kiss’ is in K\}

Nevertheless, Fox’s account cannot capture the choice readings of \(\exists\)-questions: (345) does not have a minimal K set; hence Pafel’s MIN-operator would be undefined.

(345)  \{K: SOME boy x is such that ‘which girl did x kiss’ is in K\}

6.3. **Proposal I: a higher-order question approach**

This and the next sections present two proposals, both of which work uniformly for the pair-list readings of \(\forall\)-questions and the choice readings of \(\exists\)-questions. These two proposals are distinct from each other mainly with respect to whether (under a pair-list/choice reading) a \(\forall/\exists\)-question denotes a family of sub-questions (\(\text{à la} \) Fox 2012) or a basic question taking a special functional reading (\(\text{à la} \) Chierchia 1993; Dayal 1996).

The semantic compositions in these two sections will follow my hybrid semantics. But the basic tricks also work under other frameworks of question semantics, such as Hamblin-Karttunen Semantics, Categorical semantics, and so on.
6.3.1. Overview

This section presents a higher-order question approach. The most crucial pieces of this approach are the following.

(i) A complex non-interrogative $C^0$[[-\text{WH}]], which has the same semantic contribution as Fox’s (2012) null operator $K$.

\[(346) \text{Definition: non-interrogative } C^0\]

\begin{enumerate}
  \item \[\text{IN} = \lambda K.\lambda \alpha.\alpha \in K\]
  \item \[C^0\text{[-WH]} = \lambda \alpha.\alpha \in K\]
\end{enumerate}

(ii) A cross-categorical max-informativity operator MaxI and a choice function $f_{ch}$, which together replace the role of Pafel’s MIN-operator.\(^6\) Given a set $A$, MaxI($A$) returns the set of max-informative members of $A$, and $f_{ch}[\text{MaxI}(A)]$ returns one of these max-informative members.\(^7\)

\[(347) \text{Definition: Max-informativity operator}\]

\[
\text{MaxI}(A) = \{\alpha : \alpha \in A \land \forall \beta \in A[\beta \notin \alpha]\}
\]

(the set of members in $A$ that are not proper supersets of any members in $A$)

\(^6\)It does not matter whether we consider $f_{ch}$ and MaxI as a single operator or two separate operators.

\(^7\)The definition of MaxI is consistent with what Fox (2013) assumes for max-informative true answers. Let $A$ be the set of true propositional answers, since a proposition denotes a set of worlds, the max-informative true answers are the ones that are not asymmetrically entailed by any of the true answers.
(iii) A point-wise answerhood-operator. Definition repeated from (308):

\[
\text{ANS}_{PW} = \{ \text{P}_{\lambda w}. \begin{cases} \text{ANS}(\text{P})(w) & \text{P is of type } \langle \tau, st \rangle \\ \bigcap_{\alpha \in \text{P}} \{ \text{ANS}_{PW}(\alpha)(w) : \alpha \in \text{P} \} & \text{otherwise} \end{cases} \}
\]

where \( \bigcap_{P}[A, B] = \{ a \wedge b : a \in A, b \in B \} \)

Compared with Fox’s (2012) LF in (341), the main difference in following LF is that the minimization operator is replaced with a max-informativity operator MaxI and a choice function \( f_{ch} \). This revision makes the proposed analysis feasible to \( \exists \)-questions.

(349) which girl did \( \mathcal{P} \) kiss?

\[
\mathcal{P} : \langle e, st \rangle
\]

\[
f_{ch} \quad \langle \text{est}, t \rangle
\]

\[
\text{MaxI} \quad 4 : \langle \text{est}, t \rangle
\]

\[
\lambda K \quad 3 : t
\]

\[
\text{DP} : \langle \text{et}, t \rangle
\]

\[
\mathcal{P} \in \{ \text{every boy, some boy, no boy, ...} \}
\]

\[
\lambda x \quad 2 : t
\]

\[
\mathcal{C}_{[\text{WH}]}^0 \quad \text{IN} \quad \mathcal{K} \quad \text{which girl did } x \text{ kiss}
\]

\[\lambda x \quad \mathcal{C}_{[+\text{WH}]}^0 : \langle e, st \rangle\]
6.3.2. \( \forall \)-questions

Take the \( \forall \)-question *which girl did every boy kiss* for a full illustration, the LF (349) yields its \( \forall \)-pair-list answer as follows. A step-by-step explanation is provided after the schematization.

\[
(350) \text{Which girl did every boy kiss?}
\]

(w: consider only two boys Andy and Billy; Andy only kissed Mary, and Billy only kissed Jenny.)

\[
[4 \ f_{ch} [\maxi \ \lambda K [3 \ [\text{every boy}] \ \lambda x [2 \ [c_{\text{WH}}^0] \ \text{IN K} \ [\text{CP}_{\text{WH}}] \ \text{which girl did x kiss}]]]]
\]

a. \[
[\text{CP}_{\text{WH}}] = \lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(x, y)]
\]

b. \[2 = [\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(x, y)]] \in K\]

c. \[3 = \forall x[\text{boy}_w(x) \rightarrow [\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(x, y)]] \in K]\]

d. \[4 = [\lambda K : \forall x[\text{boy}_w(x) \rightarrow [\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(x, y)]] \in K]]
\]

\[
= \left\{ \begin{array}{l}
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(a, y)] \\
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(b, y)]
\end{array} \right\} \quad \left\{ \begin{array}{l}
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(a, y)] \\
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(b, y)]
\end{array} \right\} \quad \ldots
\]

\[
= \left\{ K : K \supset \left\{ \begin{array}{l}
\text{kiss}(a, y) : y \in \text{girl}_w\\
\text{kiss}(b, y) : y \in \text{girl}_w
\end{array} \right\} \right\}
\]

e. \[P = f_{ch}[\maxi([4])] = \left\{ \begin{array}{l}
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(a, y)] \\
\lambda y. w[\text{girl}_w(y) \land \text{kiss}_w(b, y)]
\end{array} \right\}
\]

f. \[\text{ANS}_{P_W}(P)(w) = \cap_{P_W}(\text{ANS}(P)(w) : P \in P)\]
Step 1:  (‘which girl did x kiss’)

The embedded interrogative CP\(_{+[WH]}\) denotes the topical property of which girl did x kiss, as in (350a). The internal structure of CP\(_{+[WH]}\) is as follows (see relevant definitions and assumptions in section 1.4.1). For the purpose of this chapter, it is also fine to analyze the denotation of CP\(_{+[WH]}\) as a Hamblin set, a partition, etc.

\[
= \bigcap_{P_W} \left\{ \{kiss'(a,m)\}, \{kiss'(b,j)\} \right\} = \{kiss'(a,m) \land kiss'(b,j)\}
\]

Step 2:  (‘which girl did x kiss’ is in K)

The I\(N\)-function in the non-interrogative C\(_{0-[WH]}\) yields a membership relation that the topical property of which girl did x kiss is in K, as in (350b).

Step 3:  (every boy x is such that ‘which girl did x kiss’ is in K)

Every boy moves to the spec of the non-interrogative CP and quantifies into the membership relation, as in (350c).

Step 4:  (\{K: every boy x is such that ‘which girl did x kiss’ is in K\})

At node 3, abstracting K yields a family of “K sets”, namely the super sets of \{which girl
Step 5: \((f_{ch} \text{MaxI} \{K: \text{every boy } x \text{ is such that ‘which girl did } x \text{ kiss’ is in } K\})\)

Employing the MaxI-operator and the choice function \(f_{ch}\) returns one of the max-informative K sets, which is therefore a possible root denotation \(P\). In the case of a \(\forall\)-question, there is only one max-informative K set (namely the set consists of exactly all the sub-questions) and therefore only one possible \(P\), as in (350e).

Step 6: Employing the point-wise \(\text{ANS}\)-operator (see definition in (308) in section 5.5) returns a set of conjunctive propositions. Each conjunctive proposition conjoins a max-informative true answer of each sub-question in \(P\).

In the considered question, the obtained answer is a universal pair-list mention-all answer. Here I explain the features one by one: (i) the \(P\) consists of multiple sub-questions, and hence the obtained answer is a pair-list answer; (ii) the unique \(P\) consists of all the sub-questions, and hence the obtained answer is a universal answer; (iii) since each sub-question has only one max-informative true answer, \(\text{ANS}_{\text{PW}}(P)(w)\) is a singleton set consisting of only one such conjunctive proposition, which is therefore a mention-all answer.

In comparison, the following \(\Diamond \forall\)-question admits mention-some answers. In this question, the sub-questions can have multiple max-informative true answers. Therefore, the set \(\text{ANS}_{\text{PW}}(P)(w)\) can be made up of multiple conjunctive propositions, each of which represents a universal pair-list mention-some answer.

(351) Where can every guest get gas?

\[\text{ANS}_{\text{PW}}(P)(w)\]

\(^8\)The \(\star\)-sign stands for an arbitrary object that is not a subquestion.
(w: John can get gas from A or B, Mary can get gas from B or C, ...)

John can get gas from station A, Mary can get gas from station B, ...

e. \( P = \left\{ \text{[where can John get gas]}_{e, st} \right\} \)

f. \( \text{ANS}_{\text{PW}}(P)(w) \)

\[
= \bigcap_{P \in \text{P}} \{ \text{ANS}(P)(w) : P \in \text{P} \}
\]

\[
= \bigcap_{P \in \text{P}} \left\{ \{ \diamond f(j, a), \diamond f(j, b) \}, \{ \diamond f(m, b), \diamond f(m, c) \} \right\}
\]

\[
= \left\{ \diamond f(j, a) \land \diamond f(m, b), \diamond f(j, b) \land \diamond f(m, b), \Diamond f(j, a) \land \diamond f(m, c), \diamond f(j, b) \land \diamond f(m, c) \right\}
\]

\[\forall \text{-PL-MS}\]

6.3.3. \( \exists \)-questions

6.3.3.1. Why choice?

Now let us move to the case of the \( \exists \)-question \textit{which girl did one of the boys kiss}. The LF in (349) derives its choice reading as follows.

(352) Which girl did one of the boys kiss?

\[
[4 \_f_{ch} [\text{MaxI } \lambda K \_3 [\text{one of the boys} \_x [\_l N K [\text{which girl did } x \text{ kiss}]]]]])
\]

c. \[
[3] = \exists [\text{boy}^{\_o}_{r}(x) \land [\_l y \_l w[\text{girl}^{\_o}_{r}(y) \land \text{kiss}^{\_o}_{r}(x, y)]]] \in K]
\]

d. \[
[4] = \{ K : \exists [\text{boy}^{\_o}_{r}(x) \land [\_l y \_l w[\text{girl}^{\_o}_{r}(y) \land \text{kiss}^{\_o}_{r}(x, y)]]] \in K] \}
\]

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Crucially, at Step 5, as schematized in (352e), unlike the case of the ∀-question which has only one max-informative K set (namely the set consists of exactly all sub-questions), here we obtain multiple max-informative K-sets (namely the sets that consist of exactly one sub-question). Each such K set counts as a possible root denotation P. Accordingly, the reason why a ∃-question admits a choice reading is that it has multiple possible P.

For each possible P, employing the ANS_{pw}-operator returns a set of max-informative true answers of the sub-question contained in P. Here since each sub-question has at most one max-informative true answer, each ANS_{pw}(P)(w) denotes a singleton set, yielding a mention-all reading. In comparison, the sub-questions of the ◊-∃-question (353) can have multiple max-informative true answers. Hence we get a mention-some reading.
Where can one of the guests get gas?

(w: Consider only two individuals John and Mary, John can get gas from A or B, Mary can get gas from B or C.)

John can get gas from station A.

a. \( P = \{ \text{[where can John get gas]} \} \) or \( \{ \text{[where can Mary get gas]} \} \)

f. \( \text{ANS}_{PW}(P)(w) \)

\[ = \bigcap_{P \in \text{PW}} \{ \text{ANS}(P)(w) : P \in P \} \]

\[ = \bigcap_{P \in \text{PW}} \{ \{ \Diamond f(j,a), \Diamond f(j,b) \} \} \) or \( \{ \Diamond f(m,b), \Diamond f(m,c) \} \}

\[ = \{ \Diamond f(j,a), \Diamond f(j,b) \} \) or \( \{ \Diamond f(m,b), \Diamond f(m,c) \} \}

6.3.3.2. Why not pair-list?

The proposed account can easily explain the unavailability of existential pair-list readings in the following \( \exists \)-question.

(354) Which girl did two of the boys kiss?

\[ \left[ f_{ch} [\text{MaxI } \lambda K [ \text{[two of the boys]} \lambda x [ \text{[IN K][which girl did } x \text{ kiss}]))) \right] \]

(355) Which girl did two of the boys each kiss?

\[ \left[ f_{ch} [\text{MaxI } \lambda K [ \text{[two of the boys]} \lambda x [ \text{[IN K][which girl did } x \text{ each kiss}]))) \right] \]

The quantifier \textit{two of the boys} is an existential generalized quantifier living on a set of sums of two boys.

(356) \( [\varnothing \exists \text{ two of the boys} @ ] \)

\[ = \lambda f_{(c,t)}. \exists x [x \leq \nu y[^*\text{boy}_@ (y)] \land x = 2 \land f(x)] \]
Hence, each possible $P$ of (354) consists of exactly one sub-question of the form “which girl did $x$ kiss” where $x$ is the sum of two boys.\(^9\) To obtain a pair-list reading, however, there must be some possible $P$ that consists of multiple sub-questions. Therefore, (354) cannot take a pair-list reading. In (355), the distributor each makes not difference: this each is a VP-operator and is interpreted within the embedded interrogative CP.

### 6.3.3.3. \(\exists\)-questions versus multi-wh questions

The proposed analysis can easily account for the difference between \(\exists\)-questions and multi-wh questions: a wh-item must be moved to the spec of an interrogative CP, where $C^0$ contains an identify function $I_D$, while a non-interrogative existential quantifier can only be moved to the spec of the non-interrogative CP, where $C^0$ contains a membership function $I_N$.

(357) a. Which girl did one of the boys kiss?

$$\ldots [[\text{one boy}]_f [\{C^0_{-\text{wh}} I_N K\} [CP \text{ which girl did } t_f \text{ kiss}]]]$$

b. Which girl did which boy kiss?

$$\ldots [[\text{which boy}]_f [\{C^0_{+\text{wh}} I_D P\} [CP \text{ which girl did } t_f \text{ kiss}]]]$$

\(^9\)For instance, with only three boys $abc$ taken into considerations, the possible $P$s are the following: $[[\text{which girl did } a \oplus b \text{ kiss}]], [[\text{which girl did } b \oplus c \text{ kiss}]], [[\text{which girl did } a \oplus c \text{ kiss}]]$.\hfill 243
6.3.4.  Other cases

6.3.4.1.  Questions with N-quantifiers

A question with an N-quantifier (e.g., nobody, no boy) has only one max-informative K set, namely the empty set.

(358)  Which girl did no boy kiss? # [Silence ...]

\[
[ f_{ch} \text{ MaxI } \lambda K \text{ [no boy] } \lambda x \text{ [IN K} \text{ which girl did } x \text{ kiss}]]]
\]

I assume the following presupposition for the point-wise answerhood-operator. Accordingly, \( \text{ANS}_{pw}(\varnothing)(w) \) suffers a presupposition failure and is therefore deviant.

(359)  \( \text{ANS}_{pw}(P_{(\tau_{st,t)})(w) \text{ presupposes that } P \text{ has a member } P_{(\tau_{st,t)} \text{ such that } \text{ANS}(P)(w) \text{ is defined.}}\]

6.3.4.2.  Questions with numeral-modified quantifiers

One might suggest to use the idea for questions with N-quantifiers to explain the unavailability of pair-list readings in (360a-b), each of which contains a downward monotone quantifier (viz., at most three boys and less than three boys). Such a way of thought, however, cannot uniformly explain the unavailability of pair-list readings in the (361a-b). The quantifiers at least two boys and more than two boys are upward monotone. More generally speaking, pair-list readings cannot be licensed by any numeral-modified quantifiers. This fact should be explained uniformly.

(360)  a. Which girl did at most two boys kiss?
# Andy kissed Mary, Billy kissed Jenny.

b. Which girl did less than three boys kiss?

# Andy kissed Mary, Billy kissed Jenny.

(361) a. Which girl did at least two boys kiss?

# Andy kissed Mary, Billy kissed Jenny.

b. Which girl did more than two boys kiss?

# Andy kissed Mary, Billy kissed Jenny, Clark kissed Helen.

A simple way of thought would be to treat numeral-modified quantifiers as existentials with numeral-modified restrictions. For instance, for at least two boys, the closure is a null existential closure $\emptyset_3$ (Link 1987).¹⁰

(362) a. $[\emptyset_3\text{ at least two boys}] = \lambda f. \exists x[\text{*boy}(x) \land x \geq 2 \land f(x)]$

b. $[\emptyset_3\text{ more than two boys}] = \lambda f. \exists x[\text{*boy}(x) \land x > 2 \land f(x)]$

Accordingly, each possible $P$ of (361a) consists of exactly one sub-question of the form “which girl did $x$ kiss” where $x$ is a sum of two or more boys. Such a $P$ does not yield a pair-list reading, just like what we saw in (354).

### 6.3.5. Summary

The proposed higher-order question account yields the following predictions:

¹⁰The definitions for downward monotone quantifiers involve more issues. See Buccola & Spector (2016) for discussions and solutions.
(363) For a question of the form ‘wh-\text{-}A \, P \, f?’ (where \textit{wh}-\text{A} is a \textit{wh}-phrase, \textit{P} is a non-interrogative quantifier, and \textit{f} is the predicate), the obtained reading under the LF (349) is ...

a. a \textsc{pair-list} reading, if and only if it has a possible \textit{P} that consists of multiple sub-questions.

b. a \textsc{universal} reading, if and only if it has a unique \textit{P} which includes all the sub-questions.

c. a \textsc{choice} reading, if and only if it has multiple possible \textit{P}, or equivalently, multiple max-informative K sets such that \( P(λx[λy.λw[y ∈ A ∧ f_w(x,y)] ∈ K]) \).

d. subject to \textsc{domain exhaustivity}, if and only if it has a unique possible \textit{P} and this \textit{P} consists of all the sub-questions.

e. a \textsc{mention-some} reading, if and only if ‘\textit{wh}-\text{A} \, x \, f’ admits a mention-some reading; otherwise \textsc{mention-all}.

f. subject to \textsc{uniqueness}, if and only if ‘\textit{wh}-\text{A} \, x \, f’ is subject to uniqueness.

g. \textsc{undefined}, if it does not have a possible \textit{P} or if \( \text{ANS}_{pw}(P)(w) \) is undefined for every possible \textit{P}.

6.4. Proposal II: a function-based approach

6.4.1. Overview

This section presents a function-based approach. The basic trick is similar to what I used in the higher-order question approach: a quantifier quantifies into a membership rela-
tion, each max-informative K set that satisfies such a quantificational membership relation counts as a possible topical property.

I assume the following LF. None of the ingredients of this LF is new for this dissertation. Some of them were firstly proposed in my function-based approach for multi-wh questions (see section 5.4), and the others were adapted from my high-order question approach for questions with quantifiers (see section 6.3). Despite using similar tricks, this approach differs from the higher-order question approach in both syntax and semantics. **In syntax**, the QR of the quantifier leaves a functional trace $f$ and its landing position is still within IP (or say, within the question nucleus); the membership function $IN$ which was ascribed to a non-interrogative $C^0$ is now ascribed to an $I^0$. **In semantics**, a question with a quantifier is treated as a basic question taking a special functional reading (à la Chierchia 1993; Dayal 1996); in particular, under the proposed hybrid semantics, the root denotation is a property of functions.

(364) which girl did $P$ kiss?
The rest of this section will only discuss how this LF yields pair-list readings of \( \forall \)-questions and choice readings of \( \exists \)-questions. Other issues, such as the unavailability of pair-list readings in \( \exists \)-questions, can be explained along the same line as what I proposed for the higher-order question approach.

### 6.4.2. \( \forall \)-questions

Take the \( \forall \)-question *which girl did every boy kiss* for a full illustration, the LF (364) yields its universal pair-list answer as follows. A step-by-step explanation is provided after the schematization.

\( \text{(365)} \quad \text{Which girl did every boy kiss?} \)
Step 1:  
('x kissed f(x)' is in K)

The membership function IN in the complex I^0 yields a membership relation that 'x kissed f(x)' is in K, as in (365a).

Step 2:  
(every boy x is such that 'x kissed f(x)' is in K)
Every boy takes QR to the spec of IP and quantifies into the membership relation, as in (365b). Note that for (365b) being defined, the function \( f \) has to be defined for every boy. In syntax, following Chierchia (1993), I assume that this quantifier binds two argument indexes, namely the index of its own trace and the argument index of the wh-trace. Accordingly, due to the WCO constraint, such a movement is not available if every boy serves as the object.

a. Which girl did every boy kiss?  
b. Which girl kissed every boy?

\[
\begin{align*}
\text{Step 3:} & \quad \{K: \text{every boy } x \text{ is such that } 'x \text{ kissed } f(x)' \text{ is in } K\} \\
\text{Step 4:} & \quad (f_{ch} \text{ MaxI } K: \text{every boy } x \text{ is such that } 'x \text{ kissed } f(x)' \text{ is in } K) \\
\text{Step 5:} & \quad (\bigcap f_{ch} \text{ MaxI } K: \text{every boy } x \text{ is such that } 'x \text{ kissed } f(x)' \text{ is in } K)
\end{align*}
\]

At node 2, abstracting \( K \) yields a family of “K sets”, namely the sets consist of at least all the propositions of the form ’\( x \) kissed \( f(x) \)’ where \( x \) is an atomic boy, as in (365c). The ★-sign stands for an arbitrary object that is not a subquestion.

Employing the MaxI-operator and the choice function \( f_{ch} \) returns one of the max-informative K sets, which is therefore a possible root denotation \( P \). In the case of a ∃-question, there is only one max-informative K set (namely the set consists of exactly all the propositions of the form ’\( x \) kissed \( f(x) \)’ where \( x \) is an atomic boy) and therefore only one possible \( P \), as in (365d).
Closing the obtained max-informative K set under conjunction, as in (365e). Since here f is defined for every atomic boy, the obtained conjunctive proposition is a universal pair-list statement.

**Step 6:** The *wh*-movement of ‘BE DOM(which girl)’ leaves a functional trace and creates a topical property of functions, as (365f-h). This topical property maps a function ranging over atomic girls to a universal pair-list answer. Due to the following definition, the live-on set of *which girl* consists of not only atomic girls (see section 1.5.4) but also functions ranging over atomic girls (see section 5.4).

(366) **Definition: lexical entries of wh-items** (repeated from (294))

a. \[
\lambda [\text{which } A] = \lambda B \exists x \in ([\uparrow A \cup \{f : \text{Range}(f) \subseteq \uparrow A]\} \cap B)
\]

b. \[
\text{BE}([\text{which } A]) = \uparrow A \cup \{f : \text{Range}(f) \subseteq \uparrow A}\}
\]

c. \[
\text{BE}([\text{which girl}]) = \uparrow \text{girl}_0 \cup \{f : \text{Range}(f) \subseteq \uparrow \text{girl}_0\}
\]

When the movement of *which girl* leaves a functional trace, the obtained topical property is a property of functions. This idea inherits Chierchia’s (1993) insight that pair-list readings are special kinds of functional readings and are subject to similar syntactic constraints.

**Step 7:** Employing the ANS-operator returns a set of universal pair-list answers. In the considered question, \(\text{ANS}_{PW}(P)(w)\) is a singleton set consisting of only one such universal pair-list answer, which is therefore a mention-all answer.
6.4.3. A note on domain exhaustivity

Strictly speaking, the following two formulas are not equivalent. (367a) requires \( f \) to be defined for every atomic boy. If the domain of \( f \) is a proper subset of atomic boys, (367a) will be undefined, while (367b) will still be defined and will denote a set smaller than \( \text{boy}' \).

\[(367)\]
\[
a. \quad f_{ch}[\text{MaxI}[K : \forall x[x \in \text{boy}' \rightarrow \text{kiss'}(x, f(x)) \in K]]]
\]
\[
b. \quad \{\text{kiss'}(x, f(x)) : x \in \text{boy}'\}
\]

Therefore, the topical properties for the pair-list readings of the following two questions are different: the one for the multi-\( \text{wh} \) question (368a) is defined for any function ranging over atomic girls, while the one for the \( \forall \)-question (368b) also requires the functions to be defined for every atomic boy.

\[(368)\]
\[
a. \quad \text{Which girl did which boy kiss?}
\]
\[P = \lambda f[\text{Range}(f) \subseteq \text{girl}' \cap \{\text{kiss'}(x, f(x)) : x \in \text{boy}'\}]\]
\[
b. \quad \text{Which girl did every boy kiss?}
\]
\[P = \lambda f[\text{Range}(f) \subseteq \text{girl}' \wedge f_{ch}[\text{MaxI}[K : \forall x[x \in \text{boy}' \rightarrow \text{kiss'}(x, f(x)) \in K]]])
\]
\[= \lambda f[\text{Range}(f) \subseteq \text{girl}' \wedge \text{Dom}(f) \supseteq \text{boy}' \cap \{\text{kiss'}(x, f(x)) : x \in \text{boy}'\}]\]

This contrast explains why \( \forall \)-questions are subject to domain exhaustivity, while multi-\( \text{wh} \) questions are not.
6.4.4. ∃-questions

Now let us move to the case of the ∃-question *which girl did one of the boys kiss*. The LF in (347) derives its choice reading as follows. At Step 4 (namely Node 3), we get multiple max-informative K, each of which contributes a range to a possible topical property, as in (369c-d). Hence, a ∃-question takes a choice reading because it has multiple possible topical properties.

(369) Which girl did one of the boys kiss?

(w: consider only two boys Andy and Billy; Andy only kissed Mary, and Billy only kissed Jenny.)

P: (ee, st)

\[
\begin{align*}
\text{BEDOM} & \quad \text{DP} \\
\text{which girl_@} & \quad \langle ee, st \rangle \\
\lambda f & \quad \cap \\
3: \langle st, t \rangle & \quad f_{ch} \\
\text{MaxI} & \quad 2 \\
\lambda K & \quad 1 \\
\end{align*}
\]

\[ [1] = \exists x [x \in \text{boy}_@ \land \text{kiss}'(x, f(x)) \in K] \]

\[ [2] = \{ K : \exists x [x \in \text{boy}_@ \land \text{kiss}'(x, f(x)) \in K] \]
\[
\begin{align*}
&= \left\{ \begin{array}{l}
\{ \text{kiss}'(a, f(a)) \}, \\
\{ \text{kiss}'(b, f(b)) \}
\end{array} \right. \\
&\quad \left\{ \begin{array}{l}
\{ \text{kiss}'(a, f(a)) \}, \\
\{ \text{kiss}'(a, f(a)) \}
\end{array} \right.
\end{align*}
\]

\(= \{ K : K \supseteq \{ \text{kiss}'(a, f(a)) \} \lor K \supseteq \{ \text{kiss}'(b, f(b)) \} \}\)

c. \( \llbracket 3 \rrbracket = \left\{ \begin{array}{l}
\{ \text{kiss}'(a, f(a)) \}\end{array} \right. \text{ or } \left\{ \begin{array}{l}
\{ \text{kiss}'(b, f(b)) \}\end{array} \right. \)

d. \( P = \lambda f[ \text{Range}(f) \subseteq \text{girl}'_{a}, \text{kiss}'(a, f(a))] \text{ or } \lambda f[ \text{Range}(f) \subseteq \text{girl}'_{b}, \text{kiss}'(b, f(b))] \)

e. \( \text{ANS}(P(w) = \{ \text{kiss}'(a, m) \} \text{ or } \{ \text{kiss}'(b, j) \} \)
Chapter 7

The Mandarin particle *dou*
7.1. Introduction

The Mandarin particle *dou* has been famous for its function diversity. As a rough classification, *dou* can be used as a distributor, a universal free choice item (FCI)-licenser, and a scalar marker. This chapter presents a uniform semantics of *dou* to capture its seemingly diverse functions. I argue that *dou* is an exhaustifier with the following three features: it triggers an additive presupposition, just like any other overt exhaustifier (e.g., *only*); it operates on only sub-alternatives; and it has a pre-exhaustification effect.

The additive presupposition is responsible for the distributivity and plurality requirements of *dou* in basic declaratives, as well as for the *even*-like interpretations in scalar sentences. The asserted component of *dou* triggers a maximality effect, and it yields a free choice inference when *dou* is associated with a disjunction.

For this dissertation, this chapter provides theoretical preparations for my analyses on the mention-some/mention-all ambiguity in ♦-questions (see Chapter 2), especially the exhaustivity-marker use of *dou* and the derivation of disjunctive mention-all (see section 2.6.3). A formal comparison for the exhaustifiers that have been employed for deriving free choice is given in section 2.7.

The rest of this chapter is organized as follows. Section 7.2 provides a description as to the functions of *dou*. Section 7.3 discusses the advantages and shortcomings of two representative approaches to the semantics of *dou*, namely the distributor approach (Lin 1998) and the maximality operator approach (Giannakidou & Cheng 2006; Xiang 2008). Section 7.4 starts with the prominent exclusive particle *only* so as to introduce the theory of exhaustifications, and then it outlines a preliminary treatment of *dou*. A simple revision
on the definition of sub-alternatives is made in section 7.6.2. Section 7.5 to 7.7 show in formal detail how the proposed semantics of *dou* captures the distributor use, the universal FCI-licenser use, and the scalar marker use, respectively.

### 7.2. Describing the functions of *dou*

The Mandarin particle *dou* has caught a lot of attentions in the literature for its function diversity. Descriptively speaking, *dou* can be used as a universal quantifier-distributor, a free choice item (FCI)-licenser, and a scalar marker.

First, in a basic declarative sentence, the particle *dou*, similar to English *all*, is associated with a preceding nominal expression and universally quantifies over the subparts of this expression, as exemplified in (370). Here and throughout this chapter, I use a [square bracket] to mark the item associated with *dou*.

(370)  

a. [Tamen] **dou** dao -le.  
   they DOU arrive -ASP  
   ‘They all arrived.’

b. [Tamen] **dou** ba naxie wenti da dui -le.  
   they DOU BA those question answer correct -ASP  
   ‘They all correctly answered these questions.’

   they BA those question DOU answer correct -ASP  
   ‘They correctly answered all of these questions.’

Moreover, under the quantifier use, *dou* brings up three more semantic consequences in addition to universal quantification, namely a “maximality requirement”, a “distributivity requirement”, and a “plurality requirement”. The “maximality requirement” means
that *dou* forces the predicate denoted by the remnant VP to predicate on the maximal element in the extension of the associated item (Xiang 2008). For instance, imagine a discourse that a large group of children, with one or two exceptions, went to the park. Then (371) can be judged as true only when *dou* is absent.

(371)  

`[Haizimen] (#dou) qu-le gongyuan.
children DOU go -PERF park`

‘The children (#all) went to the park.’

The “distributivity requirement” says that if a sentence admits both collective and (non-)atomic distributive readings, applying *dou* to this sentence blocks the collective reading (Lin 1998). For instance, (372a) is infelicitous if John and Mary married each other, and (372b) is infelicitous if all the considered individuals only participated in one house-buying event.

(372)  

a.  

`[Yuehan he Mali] dou jiehun -le.
John and Mary DOU get-married -ASP`

‘John and Mary each got married.’

b.  

`[Tamen] dou mai -le fangzi.
they DOU buy -PERF house`

‘They all bought houses.’ (# collective)

The “plurality requirement” says that the item associated with *dou* must take a non-atomic interpretation. If the prejacent sentence of *dou* has no overt non-atomic term, *dou* needs to be associated with a covert non-atomic item. For example in (373), since the spelled-out part of prejacent sentence has no non-singular term, *dou* is associated with a covert term such as *zhe-ji-ci* ‘these times’.

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Second, as a well-known fact, *dou* can license a pre-verbal *wh*-item as a universal FCI, as exemplified in (374). Moreover, I observe that *dou*, in company with an existential modal, can license the universal FCI use of a pre-verbal disjunction, as shown in (375). In particular, if the possibility modal *keyi* ‘can’ is dropped or replaced with a universal modal *bixu* ‘must’, the use of *dou* makes the sentence ungrammatical.

(374) a. [Shui] (*dou*) he -guo jiu.  
    who DOU drink -EXP alcohol  
    ‘Anyone/everyone has had alcohol.’

b. [Na-ge nanhai] *(dou)* he -guo hejiu.  
    which-CL boy DOU drink -EXP alcohol  
    ‘Any/Every boy has had alcohol.’

(375) a. [Yuehan huozhe Mali] (*dou*) keyi jiao hanyu.  
    John or Mary DOU can teach Chinese  
    Without *dou*: ‘Either John or Mary can teach Chinese.’

    With *dou*: ‘Both John and Mary can teach Chinese.’

b. [Yuehan huozhe Mali] (*dou) jiao hanyu.  
   John or Mary DOU teach Chinese

c. [Yuehan huozhe Mali] (*dou) bixu jiao hanyu.  
   John or Mary DOU must teach Chinese

Third, when associated with a scalar item, *dou* implies that the prejacent proposition ranks relatively high in the considered scale. When *dou* takes this use, its associated item can stay in-situ but must be focus-marked. Like in (376a), *dou* is associated with the numeral phrase *wu dian* ‘five o’clock’, and the alternatives are ranked in chronological
order.

(376)  a. **Dou** [WU$_F$-dian] -le.
DOU five-o’clock -ASP
‘It is five o’clock.’ \textasciitilde\textit{Being five o’clock is a bit late.}

b. Ta **dou** lai -guo zher [LIANG$_F$-ci] -le.
he DOU come -EXP here two-time -ASP.
‘He has been here twice.’ \textasciitilde\textit{Being here twice is a lot for him.}

The [\textit{lian} Foc \textit{dou} ...] construction is a special case where \textit{dou} functions as a scalar marker. A sentence taking a [\textit{lian} Foc \textit{dou} ...] construction has an \textit{even}-like interpretation; it implicates that the prejacent proposition is less likely to be true than (some of) the contextually relevant alternatives.

(377)  (Lian) [duizhang]$_F$ **dou** chi dao -le.
LIAN team-leader DOU late arrive -ASP
‘Even [the team leader]$_F$ arrived late.’
\textasciitilde\textit{It is less likely for the team leader to be late.}

In particular, ‘one-CL-NP’ can be licensed as a minimizer at the focus position of the [\textit{lian} Foc \textit{dou} \textit{NEG} ...] construction, as shown in (378a). Interestingly, as James Huang (p.c.) points out, the post-\textit{dou} negation is not always needed, as exemplified in (378b).

(378)  a. Yuehan (lian) [YI$_F$-ge ren] *(dou) *(mei) qing.
John LIAN one-CL person DOU NEG invite
‘John didn’t invite even one person.’

b. Yuehan (lian) [YI$_F$-fen qian] *(dou) (mei) yao.
John LIAN one-cent money DOU NEG request
Without negation: ‘John doesn’t want any money.’
With negation: ‘Even if it is just one cent, John wants it.’
In case a sentence has multiple items that are eligible to be associated with *dou*, the function of *dou* and the association relation can be disambiguated by stress. Compare the following three sentences. In (379a), the prejacent of *dou* has no stressed item, *dou* functions as a quantifier and is associated with the preceding plural term *tamen* ‘they’; while in (379b) and (379c), *dou* functions as a scalar marker and is associated with the stressed item.

(379) a. [Tamen] **DOU/*dou* lai guo liang-ci le.  
they **DOU/DOU** come -EXP two-time -ASP  
‘They ALL have been here twice.’

b. Tamen **dou** lai guo [LIANGF-ci] le. 
they **DOU** come -EXP two-time -ASP  
‘They’ve been here for even twice.’

c. (Lian) [TAMEN] **dou** lai guo liang-ci le. 
LIAN they **DOU** come -EXP two-time -ASP  
‘Even THEY have been here twice.’

The goal of this chapter is to provide a uniform semantics of *dou* to account for its seemingly diverse functions. I propose that *dou* is a special exhaustifier that operates on sub-alternatives and has a *pre-exhaustification effect*. The basic idea can be roughly described as follows. Assume that a *dou*-sentence is of the form “*dou*(x,P)” where x and P correspond to the associated item and the predicate denoted by the remnant VP, respectively. The basic meaning of *dou*(x,P) is P(x) and *not only* P(x’), where x’ can be a proper subpart of x, a weaker scale-mate of x, and so on. For example, “[A and B] dou came” means that A and B came, *not only* A came, *and not only* B came; “it’s dou [five] o’clock” means that it’s 5 o’clock, *not just* 4 o’clock, *not just* 3 o’clock, ....
7.3. Previous studies

There are numerous studies on the syntax and semantics of *dou*. Earlier works treat *dou* as an adverb with universal quantification power (Lee 1986; Cheng 1995; among many others.). Portner (2002) analyzes the scalar marker use of *dou* in a way similar to the inherent scalar semantics of the English focus sensitive particle *even*. Hole (2004) treats *dou* as a universal quantifier over the domain of alternatives. This section will review two representative studies on the semantics of *dou*, one is the distributor approach by Lin (1996), and the other is the maximality operator approach along the lines of Giannakidou & Cheng (2006) and Xiang (2008).

7.3.1. The distributor approach

Lin (1996, 1998) provides the first extensive treatment of the semantics of *dou*. He proposes that *dou* is an overt counterpart of the generalized distributor $D$ in the sense of Schwarzschild (1996). Unlike the regular distributor *each* which distributes over an atomic domain, the generalized $D$-operator distributes over the cover of the nominal phrase associated with *dou*. A cover of an individual $x$ is a set of subparts of $x$, as defined in (380). Its value is determined by the linguistic and non-linguistic context.

\[(380)\text{ Cov is a cover of } x \text{ if and only if} \]
\[
\begin{align*}
a. \text{ Cov is a set of subparts of } x; \\
b. \text{ every subpart of } x \text{ belongs to some member in Cov.}
\end{align*}
\]

The semantics of *dou* is thus schematized as follows.
Possible covers of \( a \oplus b \oplus c \) and the corresponding readings:

\[
\begin{align*}
\{a, b, c\} & \quad \text{Distributive} \\
\{a \oplus b, c\} & \\
\{a \oplus b, b \oplus c\} & \quad \text{Intermediate} \\
\{a \oplus b \oplus c\} & \quad \text{Collective}
\end{align*}
\]

(381) \([dou](P, x)\) is true if and only if

\[
x \in D(Cov)(P) \quad \text{if and only if} \quad \forall y \in Cov[P(y) = 1], \text{where Cov is a cover of } x.
\]

The distributor approach only considers the quantifier use of dou. It is unclear how one can extend it to the other uses such as the FCI-licenser use and the scalar marker use. Moreover, even for the quantifier use, this approach faces the following challenges.

First, dou triggers distributivity and blocks collective readings, but the generalized \( D \)-distributor does not. For instance, as seen in (372b) and repeated below, the presence of dou eliminates the collective reading of the prejacent sentence. As Xiang (2008) argues, if dou were simply a generalized distributor, it should be compatible with a single cover reading (viz. the collective reading): there can be a discourse under which the cover of tamen ‘they’ denotes a singleton set like \( \{a \oplus b \oplus c\} \); distributing over this singleton set yields a collective reading.

(382) \([\text{Tamen}] \text{ dou mai -le fangzi.} \]

\[
\begin{align*}
\text{they} & \quad \text{DOU buy -PERF house} \\
\text{‘They dou bought houses.’ (# collective)}
\end{align*}
\]

Second, unlike English distributors like each and all\(^1\), dou can be associated with a

\(^1\)Champollion (2015) argues that all is a distributor that distributes down to subgroups, while that each
distributed expression such as NP-gezi ‘NP each’.²

(383)  a. They each (*each/*all) has some advantages.

b. [Tamen gezi] **dou** you yixie youdian.

They each DOU have some advantage

‘They each **dou** has some advantages.’

### 7.3.2. The maximality operator analysis

Another popular approach, initiated by Giannakidou & Cheng (2006) and extended by Xiang (2008), is to treat **dou** as a presuppositional maximality operator. Briefly speaking, this approach proposes that **dou** operates on a non-singleton cover of the associated item, returns the maximal plural element in this cover, and presupposes the existence of this maximal plural element. I schematize this idea as follows.

(384) Let Cov be a cover of x, then **[dou](x)**

\[=|\text{Cov}| > 1 \land \exists y \in \text{Cov}[[\neg \text{Atom}(y) \land \forall z \in \text{Cov}[z \leq y]].\]

\[ty \in \text{Cov}[[\neg \text{Atom}(y) \land \forall z \in \text{Cov}[z \leq y]].\]

distributes all the way down to atoms.

²Similar arguments have been reached in previous studies (Cheng 2009; a.o.), but they are mostly based on the fact that **dou** can be associated with the distributive quantificational phrase **mei-CL-NP** ‘every NP’, as exemplified in 1. This fact, however, cannot knock down the distributor approach for the quantifier use of **dou**: observe in 1 that stress falls on the distributive phrase **mei-CL-NP**, not the particle **dou**; therefore here **dou** functions as a scalar marker, rather than a quantifier.

(1)  a. [MEI-ge ren] **dou** you youdian.

   every-CL person DOU have advantage

   ‘Everyone **dou** has some advantages.’

b.??[Mei-ge ren] **DOU** you youdian.

   every-CL person **DOU** have advantage
([\textit{dou}](x) is defined only if the cover of \(x\) is non-singleton and has a unique non-atomic maximal element; when defined, the reference of \([\textit{dou}](x)\) is this maximal element.)

This approach is close to the standard treatment of the definite determiner \textit{the} (Sharvy 1980; Link 1983): \textit{the} picks out the unique maximal element in the extension of its NP complement and presupposes the existence of this maximal element.

\begin{equation}
[\textit{the}](P_{<a,t>}) = \exists x_a [x \in P \land \forall y \in P[y \leq x]].\not x[x \in P \land \forall y \in P[y \leq x]]
\end{equation}

(([\textit{the}](P_{<a,t>}) is defined only if there is a unique maximal object \(x\) such that \(P(x)\) is true (based on an ordering on elements of type \(a\)); when defined, the reference of \([\textit{the}](P_{<a,t>})\) is this maximal element.)

The maximality operator approach has advantages over the distributor approach in two respects: first, it captures the maximality requirement; and second, it can be extended to the scalar use of \textit{dou} (see details in Xiang 2008).

Nevertheless, this approach still faces many conceptual or empirical problems. First, the plurality requirement comes as a stipulation on the presupposition of \textit{dou}: \textit{dou} presupposes that the selected maximal element is non-atomic. It is unclear why is that so; the definite article \textit{the} does not trigger such a plural presupposition. Moreover, as we will see in section 7.5.3, this plural presupposition is neither sufficient nor necessary in dealing with the relevant facts.

Second, this approach predicts no distributivity effect at all. Under this approach, “[\(X\) \textit{dou} did \(f\)]” only asserts that \textit{the maximal element in the cover of \(X\) did \(f\)}, not that each element
in the cover of X did f. For instance in (382), repeated below, if the cover of tamen ‘they’ is \( \{a \oplus b, a \oplus b \oplus c\} \), the predicted assertion is simply that \( a \oplus b \oplus c \) bought houses, which says nothing as to whether \( a \oplus b \) bought houses.

(386) [Tamen] **dou** mai -le fangzi.
they DOU buy -PERF house
‘They **dou** bought houses.’ (# collective)

### 7.4. Defining **dou** as a special exhaustifier

In this section, I will start with the semantics of the canonical exhaustifier *only*, so as to introduce the basics of the exhaustification theory. Then I present a definition for the Mandarin particle **dou**. I define **dou** a special exhaustifier: **dou** is a presuppositional pre-exhaustification exhaustifier that operates on sub-alternatives.

#### 7.4.1. Canonical exhaustifier *only*

The exclusive particle *only* is a canonical exhaustifier. Using Alternative Semantics for focus (Rooth 1985, 1992, 1996), we can summarize the standard treatment of the semantics of *only* into two parts. First, a focused element is associated with a set of focus alternatives. This alternative set grows point-wise (Hamblin 1973), as recursively defined in (387), adopted from Chierchia (2013: 138).

(387) a. Basic Clause: for any lexical entry \( \alpha \), \( \text{Alt}(\alpha) = \)

   i. \( \langle [\alpha] \rangle \) if \( \alpha \) is lexical and does not belong to a scale;

   ii. \( \langle [\alpha_1], ..., [\alpha_n] \rangle \) if \( \alpha \) is lexical and part of a scale \( \langle [\alpha_1], ..., [\alpha_n] \rangle \).
b. Recursive Clause: \( \text{Alt}(\beta(a)) = \{ b(a) : b \in \text{Alt}(\beta), a \in \text{Alt}(\alpha) \} \)

Second, the exclusive particle only presupposes the truth of its prejacent proposition (Horn 1969) and asserts an exhaustivity inference. This exhaustivity inference negates all the focus alternatives that are excludable. An alternative is excludable as long as it is not entailed by the prejacent.\(^3\)

(388)   a. \([\text{only}] (p) = p. \forall q \in \text{Excl}(p)[\neg q] \) \hspace{1cm} (To be revised)

      b. \( \text{Excl}(p) = \{ q : q \in \text{Alt}(p) \land p \not\in q \} \)

In addition to the prejacent presupposition, I argue that only also triggers an additive presupposition, namely that the prejacent has at least one excludable alternative. In (389), only has a restricted exhaustification domain, namely \{ I will invite John, I will invite Mary, I will invite John and Mary \}. Contrary to the case of (389a), (389b) is infelicitous because the prejacent I will invite both John and Mary is the strongest one among the alternatives and has no excludable alternative. As Martin Hackl (p.c.) points out, the additive presupposition of only can be reduced to a more general economy condition that an overt operator cannot be applied vacuously. For sake of comparison, observe that (389c) is felicitous, which is because covert exhaustification is free from the economy condition and does not trigger an additive presupposition.

(389)   Which of John and Mary will you invite?

   a. Only JOHN\(_F\), (not Mary / not both).

\(^3\)For simplicity, here and throughout the chapter, propositional letters like \( p \) are sloppily used for both syntactic expressions and semantic values.
b. # Only BOTH$_F$.

c. BOTH$_F$.

I schematize the semantics of only as follows: it presupposes the truth of its prejacent and the existence of an excludable alternative; when the presuppositions are satisfied, it negates each excludable alternative.$^4$

\begin{equation}
\text{[only]}(p) = p \land \exists q \in \text{Excl}(p) \forall q \in \text{Excl}(p)[\neg q]
\end{equation}

\begin{enumerate}
  \item Prejacent presupposition: $p$
  \item Additive presupposition: $\exists q \in \text{Excl}(p)$
  \item Assertion: $\forall q \in \text{Excl}(p)[\neg q]$
\end{enumerate}

7.4.2. Special exhaustifier dou

I define dou as a pre-exhaustification exhaustifier over sub-alternatives, as schematized in (391): it presupposes an additive inference; it affirms the prejacent and negates the exhaustification of each sub-alternative.

\begin{equation}
\text{[dou]}(p) = \exists q \in \text{Sub}(p). p \land \forall q \in \text{Sub}(p)[\neg O(q)]
\end{equation}

$^4$For simplicity, I consider all exhaustifiers as propositional operators. Following Rooth (1985, 1992), I define the semantics of only cross-categorically as follows. Here $f$ and $P$ correspond to the left argument (namely the restrictor) and the right argument (namely the scope), respectively. This definition can easily extend to other exhaustifiers.

\begin{enumerate}
  \item Prejacent presupposition: $P(f)$
  \item Additive presupposition: $\exists f' \in \text{Alt}(f)[P(f) \not\subseteq P(f')]$
  \item Assertion: $\forall f' \in \text{Alt}(f)[P(f) \not\subseteq P(f') \rightarrow \neg P(f)]$
\end{enumerate}
The additive presupposition is motivated by the economy condition, just like what we saw with the canonical exhaustifier only. The exhaustivity inference asserted by dou differs from the one asserted by only in two respects. First, only operates on excludable alternatives, but dou operates on sub-alternatives. For now we can understand sub-alternatives as weaker alternatives, or say, the alternatives that are not excludable and distinct from the prejacent. A revision will be made in section 7.6.

\[(392) \quad \text{Sub}(p) = \{q : q \in \text{Alt}(p) \land p \subset q\} \]
\[= \text{Alt}(p) - \text{Excl}(p) - \{p\} \]

Second, dou has a pre-exhaustification effect: it negates the “exhaustification” of each sub-alternative. The pre-exhaustification effect is realized by applying an \(O\)-operator to each sub-alternative.\(^5\) The \(O\)-operator is a covert counterpart of the exclusive particle only, coined by the grammatical view of scalar implicatures (Fox 2007; Chierchia et al. 2013; Fox & Spector to appear; among the others). This \(O\)-operator affirms the prejacent and negates all the excludable alternatives of the prejacent.

\[(393) \quad \text{O}(p) = p \land \forall q \in \text{Excl}(p)[\lnot q] \quad \text{(Chierchia et al. 2013)} \]

Consider (394) for a simple illustration of the proposed definition. The prejacent and the sub-alternatives are schematized in (394a) and (394b), respectively. Employing dou affirms the prejacent and negates the exhaustification of each sub-alternative, as in (394c), yielding the inference that John and Mary arrived, not only John arrived, and not only

---

\(^5\)When dou is used as a scalar marker, the pre-exhaustification effect is realized by applying a scalar exhaustifier (\(\lnot\) just) to the sub-alternatives. See section 7.7.
Mary arrived. The exhaustivity inference (underlined above), while is entailed by the prejacent and attributes nothing new to the truth conditions.\textsuperscript{6}

(394) [John and Mary] **dou** arrived.

a. \( p = \text{arrive}^{*}(j \oplus m) \)

b. \( \text{Sub}(p) = \{\text{arrive}^{*}(j), \text{arrive}^{*}(m)\} \)

c. \( \lbrack \text{dou}\rbrack(p) = \text{arrive}^{*}(j \oplus m) \wedge \neg O[\text{arrive}^{*}(j)] \wedge \neg O[\text{arrive}^{*}(m)] \)

### 7.5. The universal quantifier use

Recall that *dou* evokes three requirements when used as a universal quantifier: (i) the “maximality requirement”, namely that *dou* forces maximality with respect to the domain denoted by the associated item; (ii) the “distributivity requirement”, namely that the prejacent sentence cannot take a collective reading; (iii) the “plurality requirement”, namely that the item associated with *dou* must take a non-atomic interpretation. In this section, I will show that the maximality requirement is a simple logical consequence of *dou*’s assertion, and argue that the other two requirements are illusions. Moreover, I will

\textsuperscript{6}One might wonder why *dou* is used if it does not change the truth conditions. Such uses are observed cross-linguistically. For instance in (1), the distributor *both* changes nothing to the truth conditions. One possibility, as raised by the audience at LAGB 2015, is that *dou* and *both* are used for the sake of contrasting with non-maximal operators like *only part of* or *only one of*. If this is the case, the question under discussion for (394) and (1) would be as follows: *it is the case that John and Mary both arrived or that only one of them arrived?*

(1) John and Mary BOTH arrived.
argue that all the facts that are thought to result from the latter two requirements actually result from the additive presupposition of *dou*.

### 7.5.1. Explaining the “maximality requirement”

The maximality requirement comes from the assertion of *dou*: *dou* asserts that, for each sub-alternative of the prejacent, its exhaustification is false. For instance in (371), repeated below, applying *dou* yields the inference that *it is false that only a subgroup of children went to the park*; therefore in presence of *dou*, (395) is true iff all the children went to the park.

\[(395) \quad (w: \text{most of the kids, with only one or two exceptions, went to the park.})\]

> [Haizimen] (#dou) qu-le gongyuan.
> children DOU go -PERF park

> ‘The children (#all) went to the park.’

### 7.5.2. Explaining the “distributivity requirement”

To generate sub-alternatives and satisfy the additive presupposition of *dou*, the prejacent of *dou* needs to be monotonic with respect to the position associated with *dou*, which therefore gives rise to the “distributivity requirement”. For instance, the sentence (396) rejects a collective reading because under this reading the prejacent proposition of *dou* is non-monotonic with respect to the subject position and hence has no sub-alternative, as shown in (396a). In contrast, when taking an atomic distributive reading or a non-atomic distributive reading, the prejacent of *dou* is monotonic with respect to the subject position and hence does generate some sub-alternatives, as shown in (396b) and (396c),

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respectively.\footnote{In (396c), for simplicity, Cov_{abc} stands for a contextually determined variable that is a cover of abc.}

(396) [abc] **dou** bought houses.

a. Collective $\times$

   i. abc together BH. $\not\equiv$ ab together BH.

   ii. Sub (abc together BH) = $\emptyset$

b. Atomic distributive $\checkmark$

   i. abc each BH. $\Rightarrow$ ab each BH.

   ii. Sub (\text{EACH}(x)(BH)) = \{\text{EACH}(x)(BH): x < abc\}

c. Nonatomic distributive $\checkmark$

   i. members of Cov_{abc} each BH.

   $\Rightarrow$ members of X each BH, where $X \subset Cov_{abc}$

   ii. Sub (D(Cov_{abc})(BH)) = \{D(X)(BH): X \subset Cov_{abc}\}

Hence, the particle **dou** itself is not a distributor; but in certain cases, the additive presupposition of **dou** evokes the use of a distributor. We can now easily explain why **dou** can be associated with a distributive expression NP-gezi ‘NP-each’: the presence of the distributor gezi ‘each’ is actually required for the sake of satisfying the additive presupposition of **dou**; if gezi is not overtly used, a covert distributor would be present in the LF.

(397) [Tamen gezi] **dou** you yixie youdian.

   They each DOU have some advantage

   ‘They each **dou** has some advantages.’
Moreover, *dou* can be applied to a collective statement as long as this statement satisfies the monotonicity requirement. For instance, *dou* is compatible with monotonic collective predicates (e.g., *shi pengyou* ‘be friends’, *jihe* ‘gather’, *jianmian* ‘meet’), as shown in (398). Consider (398a) for instance. Let *tamen* ‘they’ denote three individuals *abc*. The set of sub-alternative sets is {ab are friends, bc are friends, ac are friends}; applying *dou* yields the following inference: *abc are friends, not only ab are friends, not only bc are friends, and not only ac are friends*.

(398) a. [Tamen] (dou) *shi pengyou*.
   they DOU be friends
   ‘They are (all) friends.’

b. [Tamen] (dou) *zai dating jihe -le*.
   they DOU at hallway gather -ASP
   ‘They (all) gathered in the hallway.’

c. [Tamen] (dou) *jian-guo-mian -le*.
   they DOU see-EXP-face -ASP
   ‘They (all) have met.’

In comparison, *dou* cannot be applied to a collective statement that does not satisfy the monotonicity requirement, as shown in (399).8

8Note to distinguish the case in (399) from the following ones, where the prejacent sentences actually admit non-collective readings and thus satisfy the monotonicity requirement.

(1) a. [Tamen] *dou zucheng -le er-ren-zu*.
   they DOU form -PERF two-person-group
   ‘They all formed pairs.’

b. [Women he *tamen*] *dou zucheng -le lia er-ren-zu*.
   we and they DOU form -PERF two two-person-group
   ‘We formed two pairs, and they formed two pairs.’

In (1a), the extension of the predicate ‘formed pairs’ (FP) is closed under sum, just like any plural terms: 

\[ FP(ab) \land FP(cd) \Rightarrow FP(abcde) \]  

(see Kratzer (2008) for general discussions on plural verbal predicates);
7.5.3. Explaining the "plurality requirement"

I argue that the so-called "plurality requirement" of *dou* is illusive, and that the related facts all result from the additive presupposition of *dou*.

On the one hand, the plurality requirement is unnecessary: *dou* can be associated with an atomic as long as the remnant VP denotes a divisive predicate.

\[ P \text{ is divisive iff } \forall x \forall y [(P(x) \land y < x) \to P(y)] \]

\( (P \text{ is divisive iff whenever it holds of something, it also holds of each of its proper parts.}) \)

For instance in (401a), the associated item ‘that apple’ takes only an atomic interpretation; with a divisive predicate \( \lambda x. \text{John ate } x \), the prejacent sentence of *dou* has sub-alternatives, as schematized in (402a), which therefore supports the additive presupposition of *dou*. In contrast, in (401b), the predicate \( \lambda x. \text{John ate half of } x \) is not divisive and hence is incompatible with the presence of *dou*.

hence the prejacent sentence admits a covered/cumulative reading. In (1b), although the predicate ‘formed two pairs’ (F2P) is non-monotonic, the subject ‘we and they’ can be interpreted as a generalized conjunction, each conjunct of which yields a sub-alternative. A schematized derivation for the sub-alternatives in (1b) is given in (2).

\[
\begin{align*}
\text{(2) a. } & \text{[we and they]} = \exists P_{\text{ext}}. \forall w. P_w(\text{we}) \land P_w(\text{they}) \\
& \text{b. } [\text{we and they F2P}] = \exists w. F2P_w(\text{we}) \land F2P_w(\text{they}) \\
& \text{c. Sub(we and they F2P)} = \{F2P(\text{we}), F2P(\text{they})\}
\end{align*}
\]
(401)  a. Yuehan ba [na-ge pingguo] (dou) chi-le.
    John BA that-CL apple DOU eat-PERF
    ‘John ate that apple.’

    John BA that-CL apple DOU eat-PERF one-half
    Intended: ‘John ate half of that apple.’

(402)  a. ‘J ate that apple.’ ⇒ ‘J ate x.’ (x < that apple)
    Sub (J ate that apple) = {J had x: x < that apple}

    b. ‘J ate half of that apple.’ ≠ ‘J ate half of x.’ (x < that apple)
    Sub (John ate half of that apple) = Ø

On the other hand, the plurality requirement is insufficient. When applied to a mono-
tonic collective statement, dou requires its associated item to denote a group consisting of
at least three individuals, as exemplified in (403).

(403)  [Tamen -sa/*-lia] dou shi pengyou.
    they -three/-two DOU be friends
    ‘They three/*two are all friends.’

This fact is also predicted by the additive presupposition. As schematized in (404), the
proper subparts of an dual-individual denotes an atomic individual, which however is
undefined for the collective predicate ‘be friends’. Hence, if the item associated with dou
in (403) denotes only a dual-individual, the prejacent of dou has no sub-alternative, which
therefore leaves the presupposition of dou unsatisfied.

(404)  [ab] (*dou) are friends.
    a. [be friends] = λx[Atom(x) = 0.be-friends’(x)]
b. Sub\((ab \text{ are friends}) = \emptyset\)

### 7.6. The universal FCI-licenser use

*Dou* can license the universal FC use of polarity items, *wh*-items, and pre-verbal disjunctions. In this section, I argue that the asserted component of *dou* converts a disjunctive/existential statement into a conjunctive/universal statement, giving rise to a free choice inference. I will also explain why the licensing of universal FCIs requires the presence of *dou*, and why the licensing of a pre-verbal disjunction as a universal FCI exhibits the effect of modal obviation.

#### 7.6.1. Licensing conditions of Mandarin FCIs

In Mandarin, the licensing of a universal FCI requires the presence of *dou*. For instance in (405), the bare *wh*-word *shei* ‘who’ is licensed as a universal FCI only when it precedes *dou*.

\[(405) \quad [\text{shei}] \ast(\text{dou}) \text{jiao -guo jichu hanyu.} \]

\[ \text{who DOU teach -EXP intro Chinese.} \]

‘Everyone has taught Introductory Chinese.’

To license the universal FC use of a disjunction, *dou* must be present and followed by an existential modal, as shown in (406). This requirement is also observed with English emphatic item *any*: *any* is licensed as a universal FCI when it precedes an existential modal, but not licensed when it appears in an episodic statement or before a universal modal, as shown in (407).
(406)  a. [Yuehan huozhe Mali] **dou** keyi/*bixu jiao jichu hanyu.  
    John or Mary **DOU** can/must teach intro Chinese  
    Intended: ‘Both John and Mary can/must teach Introductory Chinese.’

    John or Mary **DOU** teach -EXP intro Chinese  
    Intended: ‘Both Johan and Mary have taught Introductory Chinese.’

(407)  a. Anyone can/*must come in.

b. * Anyone came in.

The licensing conditions of *na-CL-NP ‘which-NP’ and *renhe-NP ‘any-NP’ are less clear. Giannakidou & Cheng (2006) claim that the universal FC uses of these items are only licensed in a pre-*dou+◊* position; their judgements are illustrated in (408). Nevertheless, it is difficult to justice the data because judgements on (408) vary greatly among native speakers.

(408)  a. [Na-ge/Renhe -ren] **dou** keyi/*bixu jinlai.  
    which-CL/*anywhat -person **DOU** can/must enter  
    Intended: ‘Everyone can/must come in.’

    which-CL/*anywhat -person **DOU** get arrive -asp invitation  
    Intended: ‘Everyone got an invitation.’

Despite the noise in the judgments, the licensing conditions of universal FCIs in Mandarin can be summarized as follows. First, every universal FCI requires the presence of *dou*. Second, every universal FCI can be licensed before *dou+◊*. Third, in absence of the possibility modal, ‘which’/‘any’-NP is less likely to be licensed than bare *wh*-words, but more likely to be licensed than disjunctions. For other recent studies, see Liao (2011), Cheng & Giannakidou (2013), and Chierchia & Liao (2015).
7.6.2. Predicting the universal FC inferences

Wh-items are generally considered as existential indefinites; thus in (405), repeated below, the prejacent of *dou* is a disjunctive clause, and the sub-alternatives are the disjuncts. Applying *dou* affirms the prejacent and negates the exhaustification of each disjunct, yielding a universal FC inference. In a word, *dou* turns a disjunction into a conjunction.

(409)  [Shei] *(dou)* has taught Intro Chinese.

a. Prejacent: \( f(a) \lor f(b) \)  
   (Consider only two individuals \( a \) and \( b \))

b. \( \text{Sub}(f(a) \lor f(b)) = \{f(a), f(b)\} \)

c. \[
\llbracket \text{dou} \rrbracket (f(a) \lor f(b)) = [f(a) \lor f(b)] \land \neg f(a) \land \neg f(b) \\
= [f(a) \lor f(b)] \land [f(a) \rightarrow f(b)] \land [f(b) \rightarrow f(a)] \\
= [f(a) \lor f(b)] \land [f(a) \leftrightarrow f(b)] \\
= f(a) \land f(b)
\]

What makes the use of *dou* mandatory in (405)? Following Liao (2011) and Chierchia & Liao (2015), I assume that the sub-alternatives associated with a Mandarin *wh*-word are obligatorily activated in a non-interrogative sentence and must be used up via employing a c-commanding exhaustifier. If *dou* is absent, these sub-alternatives would be used by a basic *O*-operator, which has no pre-exhaustification effect.\(^9\) As schematized in (410b), a

\(^9\)Why is that the sub-alternatives cannot be used by a covert pre-exhaustification exhaustifier, such as the \(O_{\text{DOU}}\)-operator or Chierchia’s (2006, 2013) \(O_{\text{D-Exh}}\)-operator that we saw in section 2.7? The unavailability of placing these covert operators is due to what has been considered to be fundamental for the architecture of grammar, roughly, “Language-particular choices win over universal tendencies” or “Don’t do covertly what you can do overtly.” (Chierchia 1998). We consider an exhaustification over the sub-alternatives of a
basic $O$-operator affirms the prejacent disjunction and negates both disjuncts, yielding a contradiction.

\[(410)\]  
a. $O(p) = p \land \forall q \in \text{Excl}(p)[\neg q]$  
\[(\text{Chierchia et al. 2013})\]

b. $O(f(a) \lor f(b)) = [f(a) \lor f(b)] \land \neg f(a) \land \neg f(b) = \bot$

Now, a problem arises as to the definition of sub-alternatives: in section 7.4.2, I defined sub-alternatives as weaker alternatives, namely alternatives that are not excludable and distinct from the prejacent; but in (409) the disjuncts are stronger than the disjunction. This problem can be solved by a simple move from excludability to innocent excludability, a notion proposed by Fox (2007): an alternative is innocently excludable iff the inference of affirming the prejacent and negating this alternative is consistent with negating any excludable alternative. Thus, we can say that sub-alternatives are alternatives that are not innocently excludable and distinct from the prejacent.

\[(411)\]  
a. **Excludable alternatives**  
\[\text{Excl}(p) = \{q : q \in \text{Alt}(p) \land p \not\subseteq q\}\]  
(the set of alternatives that are entailed by the prejacent.)

polarity item as a grammatical operation. Recall that in most declaratives, $dou$ can only be associated with preceding item. If a polarity item appears in or can be overtly raised to a pre-verbal position, the exhaustification operation can be done by $dou$, and therefore cannot be done by a covert pre-exhaustification exhaustifier. In contrast, when an exhaustification operation cannot be done by $dou$, a covert pre-exhaustification exhaustifier would be available.

\[\text{(1) a. Ni [renhe-ren] *(dou) keyi jian.\} You any-person DOU can meet.\} You can meet anyone.}\}\]  
\[\text{OK dou/*O}_{DOU} / [you can meet anyone]\]

b. Ni *(dou) keyi jian [renhe-ren].\} You DOU can meet any-person\} You can meet anyone.\]
\[*dou/OK_{DOU} / [you can meet anyone]\]
b. **Innocently excludable alternatives** (Fox 2007)

\[ \text{IExcl}(p) = \{q : q \in \text{Alt}(p) \land \exists q' \in \text{Excl}(p) [p \land \neg q \rightarrow q'] \} \]

\((\{q : p \land \neg q \text{ does not entail any excludable alternatives}\})\)

c. **Sub-alternatives**

\[ \text{Sub}(p) = \text{Alt}(p) - \text{IExcl}(p) - \{p\} \quad \text{(final version)} \]

\((\text{the set of alternatives that are not innocently excludable and distinct from the prejacent})\)

In (409), the disjuncts are not innocently excludable to the disjunction: as schematized below, affirming the disjunction and negating one of the disjuncts entail the other disjunct; in other words, affirming the disjunction and negating both disjuncts would yield a contradiction. Hence, the sub-alternatives of a disjunction are the disjuncts.

\[(412) \quad [f(a) \lor f(b)] \land \neg f(a) \Rightarrow f(b)\]

A full definition of *dou* is schematized as follows.

\[(413) \quad \llbracket \text{dou} \rrbracket(p) = \exists q \in \text{Sub}(p). p \land \forall q \in \text{Sub}(p)[\neg O(q)] \]

i. Presupposition: *p* has some sub-alternatives.

ii. Assertion: *p* is true, while the exhaustification of each sub-alternative of *p* is false.

b. **Sub**

\[ \text{Sub}(p) = \text{Alt}(p) - \text{IExcl}(p) - \{p\} \]

\((\text{the set of alternatives that are not innocently excludable and distinct from the prejacent})\)
7.6.3. Modal Obviation

Recall the contrast between disjunctions and bare wh-words: *dou* alone is sufficient to license the universal FC use of a bare wh-word, but not that of a disjunction. To capture this contrast, I assume that disjunctions evoke scalar implicatures, while bare wh-words do not. Compare the episodic sentences in (414). In both examples, employing *dou* yields an FC inference that *John&Mary/everyone have/has taught Intro Chinese*; but (414a) also evokes a scalar implicature, namely that *not both John and Mary have taught Introductory Chinese*.

    John or Mary DOU teach -EXP intro Chinese

b. [Shei] *(dou) jiao -guo jichu hanyu.  
    who DOU teach -EXP intro Chinese
    ‘Everyone has taught Introductory Chinese.’

Hence, *dou* cannot be used in (414a) because it yields a universal FC inference which contradicts the scalar implicature, à la Chierchia’s (2013) explanation on the licensing condition of the FC *any*. In absence of *dou*, the sub-alternatives of a disjunction are not activated, and then (414a) simply means *that John or Mary but not both has taught Introductory Chinese*.

A pre-verbal disjunction is licensed as a universal FCI when it appears before *dou+◊*. This effect is called “modal obviation”, namely that the presence of a possibility modal eliminates the ungrammaticality. This effect is also observed with the English *any*, as seen in (407).

(415) a. [Yuehan huozhe Mali] **dou** keyi jiao jichu hanyu.  
    John or Mary DOU can teach intro Chinese
‘Both John and Mary can teach Introductory Chinese.’

b. [Yuehan huozhe Mali] (*dou) bixu jiao jichu hanyu.
John or Mary DOU must teach intro Chinese
‘Both John and Mary can teach Introductory Chinese.’

There have been a plenty of discussions on the phenomenon of Modal Obviation involved in licensing universal FCIs. Representative works include Dayal (1998, 2013), Giannakidou (2001), Chierchia (2013), and among the others. This dissertation is not in a position to do full justice to these discussions, but just adds one more accessible story to the market.

I propose that the scalar implicature of a pre-verbal disjunction can be assessed within a circumstantial modal base: the modal base is restricted to the set of worlds where the scalar implicature is satisfied. For instance, (415) intuitively suggests that the speaker is only interested in cases where exactly one person teaches Introductory Chinese. Assume that the property teach Introductory Chinese denotes only three world-individual pairs, as in (416a). For instance the pair \( \langle w_1, \{ j \} \rangle \) is read as only John teaches Introductory Chinese in \( w_1 \). The scalar implicature of the pre-verbal disjunction restricts the modal base into \( M \), namely the set of worlds where not both John and Mary teach Introductory Chinese. Employing dou yields the universal FC inferences in (416c) and (416d). Crucially, only (416c) is true under \( M \).

(416)  
a. \( f = \{ \langle w_1, \{ j \} \rangle, \langle w_2, \{ m \} \rangle, \langle w_3, \{ j, m \} \rangle \} \)

b. \( M = \{ w_1, w_2 \} \)

c. \( [\text{dou}] [\Diamond f(j) \lor \Diamond f(m)] = \Diamond f(j) \land \Diamond f(m) \) \hspace{1cm} \text{True under } M 

d. \( [\text{dou}] [\Box f(j) \lor \Box f(m)] = \Box f(j) \land \Box f(m) \) \hspace{1cm} \text{False under } M 

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More broadly speaking, there is no modal base, except the empty one, under which (416d) is true; therefore necessity modals cannot obviate the contradiction between the FC inference and the scalar implicature.

If I am on the right track, as for the licensing conditions for the universal FC uses of *na-CL*-NP and *renhe*-NP, whether a speaker accepts (408) in absence of the possibility modal is determined by whether he interprets these items with scalar implicatures.

### 7.7. Scalar marker

When *dou* is associated with a scalar item or occurs in the focus construction `[lian Foc dou ...]`, it functions as a scalar marker. In such a case, sub-alternatives are the alternatives are the ones rank lower than the prejacent with respect to a contextually relevant probability measure, and the pre-exhaustification effect is realized by the scalar exhaustifier `JUST`. In the following, I will firstly sketch out the semantics of a scalar *dou*, and then capture the ‘even’-like interpretation and the licensing conditions of minimizers in the `[lian Foc/Min dou ...]` construction.

#### 7.7.1. Association with a scalar item

When *dou* is associated with a scalar item, the sub-alternatives are alternatives that rank lower than the prejacent proposition in the considered scale, as schematized in (417), where $q <_\mu p$ says that $q$ is less likely than $p$ with respect to some contextually relevant probability measure $\mu$. For instance, in (418), sub-alternatives are propositions that rank lower than the prejacent in chronological order.
\[(417) \quad \text{Sub}(p) = \{q : q \in C \land q \preceq \mu \ p\}\]

\((\{q: q \text{ is a contextually relevant alternative of } p \text{ that rank lower than } p \text{ in the considered scale}\})\)

\[(418) \quad \textbf{D}ou \ [WU-dian] \ -\text{le.}\]

\text{DOU five-o’clock} - \text{ASP}

‘It is \textit{dou} [FIVE] o’clock.’

a. \text{Sub(it’s 5 o’clock}) = \{it’s 4 o’clock, it’s 3 o’clock, ...\}

b. \[\text{[dou [it’s 5 o’clock]]} = ‘it’s 5, not just 4, not just 3, ...’\]

Since here the alternatives are ordered based on their strength in the considered scale, the pre-exhaustification effect of \textit{dou} is realized by the scalar exhaustifier \textsc{Just}. Therefore, \textit{dou} is defined as in (419) when it functions as a scalar marker.

\[(419) \quad [\text{dou}] (p) = \exists q \in \text{Sub}(p).p \land \forall q \in \text{Sub}(p)[\neg \text{JUST}(q)]\]

a. \text{Sub}(p) = \{q : q \in C \land q \preceq \mu \ p\}

\text{(the set of contextually relevant alternatives that are ranked lower than } p \text{ in the considered scale)}

b. \text{JUST}(p) = \lambda w. p(w) \land \forall q \in C[q(w) \rightarrow q \preceq \mu \ p]\]

\text{(p is true; every contextually relevant true alternative of } p \text{ does not rank higher than } p \text{ in the considered scale)}

To generate sub-alternatives and satisfy the additive presupposition of \textit{dou}, the prejacent statement needs to be relatively strong among the quantificational statements. For instance in (420), \textit{dou} can be associated with ‘many-NP’ but not with ‘few-NP’.
7.7.2. The [lian Foc dou...] construction

In a [lian Foc dou ...] construction, alternatives are ordered with respect to likelihood. Subalternatives are focus alternatives that are less unlikely (i.e., more likely) to be true than the prejacent, as schematized in (421). Here the variable C is a set of focus alternatives that are contextually relevant. This definition is a natural transition from informativity to likelihood: a proposition that is less informative is less unlikely to be true.

\[
\text{(421) } \text{Sub}(p) = \{ q : q \in C \land q <_{\text{unlikely}} p \}
\]

For instance in (422), the set C consists of propositions of the form “\(x\) was late” where \(x\) is a relevant individual, and sub-alternatives are the team member A was late, the team member B was late, .... Thus (422) means that the team leader was late, not just that a team member was late.

\[
\text{(422) } \text{Lian} [\text{duizhang}] F \text{ dou} \text{ chidao -le.}
\]

Lian team-leader DUO late ASP

‘Even the team leader was late.’

Extending the definition of dou to the [lian Foc dou ...] construction, I schematize the meaning of dou as follows. The underlined inference, namely that every alternative that is
less unlikely to be true than \( p \) is less unlikely to be true than some true alternative, is asymmetrically entailed by the rest asserted part, namely that \( p \) is true. Hence, the asserted component of \( dou \) simply affirms its prejacent, or say, is vacuous.

(423) \[\text{[dou]}(p)\]

\[= \exists q \in \text{Sub}(p).p(w) \wedge \forall q \in \text{Sub}(p)[\neg \text{JUST}(q)(w)]\]

\[= \lambda w. \exists q \in C[q <_{\text{unlikely}} p].p(w) \wedge\]

\[\forall q \in C[q <_{\text{unlikely}} p \rightarrow \exists q' \in C[q'(w) \wedge q <_{\text{unlikely}} q']]\]

\[= \exists q \in C[q <_{\text{unlikely}} p].p\]

Notice that the presupposition of the scalar marker \( dou \) is simply the scalar presupposition of the additive scalar focus-sensitive operator \( \text{even} \), according to the tradition initiated by Bennett (1982) and Kay (1990): ‘the prejacent proposition is less likely to be true than at least one contextually relevant alternative.’\(^{10}\) Thus, it is plausible to say that the ‘even’-like interpretation of the \([\text{lian} \ Foc \ dou \ ...]\) construction comes from the presupposition of \( dou \) (Portner 2002; Shyu 2004; Paris 1998; Liu 2016), while that the particle \( \text{lian} \) is simply a focus marker and is present just for syntactic purposes.

\(^{10}\)Note that this additive presupposition says nothing about the truth value of any sub-alternative, as shown in (1).

(1) **Lian** [Yuehan] **dou** jige -le, qita-ren zenme mei -you?

\[\begin{align*}
\text{LIAN} & \quad \text{John} \\
\text{DOU} & \quad \text{pass \ -ASP, other-person how \ \neg \text{ASP}}.
\end{align*}\]

‘Even John passed [the exam]. Why is that the others didn’t?’
7.7.3. Association with a minimizer

Recall the contrast in (424) with respect to the mandatory presence of a post-*dou* negation in a \([lian \ MIN \ dou \ (NEG) ... ]\) construction. To license a minimizer, the presence of post-*dou* negation is mandatory in (424a) but optional in (424b).

\[(424)\]

\[\begin{align*}
\text{a.} & \quad \text{Yuehan (lian) [YI-ge ren]}_F \quad *(\text{dou}) \quad *(\text{bu}) \quad \text{renshi}.
& \text{John LIAN one-CL person DOU NEG know}
& \quad \text{‘John doesn’t know anyone.’}

\text{b.} & \quad \text{Yuehan (lian) [YI-fen qian]}_F \quad *(\text{dou}) \quad (\text{bu}) \quad \text{yao}.
& \text{John LIAN one-cent money DOU NEG request}
& \quad \text{Without negation: ‘John even doesn’t want one cent.’}
& \quad \text{With negation: ‘John wants it even if it is just one cent.’}
\end{align*}\]

I argue that the distributional pattern of the post-*dou* negation is also constrained by the additive presupposition of *dou*: the additive presupposition of *dou* requires the prejacent not to be weakest proposition among the alternatives. In (424a), this requirement forces the minimizer *YI-ge ren* ‘one person’ to take reconstruction and get interpreted below negation, as shown in (425): \textit{there is at least one person that John didn’t invite} is weaker than any sentence of the form \textit{there are at least N people that John didn’t invite} where \(N > 1\); while \(\neg[John \ invited \ at \ least \ one \ person]\) is stronger than any sentence of the form \(\neg[John \ invited \ at \ least \ N \ people]\) where \(N > 1\).

\[(425)\]

\[\begin{align*}
\text{a.} & \quad \ast \text{Dou} \quad [[\text{one person}], \ \text{NOT} \ [\text{John knows } t_i ]] \quad \exists! x[(\neg P(x)) \iff \exists x[(\neg P(x)]

\text{b.} & \quad \text{Dou} \quad [ \ \text{NOT} \ [\text{John knows one person}]] \quad \neg \exists! x[P(x)] \Rightarrow \neg \exists x[P(x)]
\end{align*}\]

This reconstruction-based analysis is supported by the contrast in (426): when the min-
imizer ‘one person’ is a subject, its surface position and reconstructed position are both higher than negation, and hence the ungrammaticality in (426a) cannot be salvaged by reconstruction.

(426) a.  * (Lian) [Yi-ge ren] \textit{F} dou bu renshi Yuehan.
    LIAN one-CL person DOU NEG know John.
    Intended ‘no one knows John.’

b. Yuehan (lian) [Yi-ge ren] \textit{F} dou bu renshi.
    John LIAN one-CL person DOU NEG know
    ‘John doesn’t know anyone.’

In (424b), however, under the assumption that John shouldn’t want the money if the amount of money is too little, we expect that John wants one cent is more unlikely to be true than John wants two cents; therefore, the additive presupposition of dou can be satisfied even in absence of the post-dou negation.

7.8. Summary

In this chapter, I offered a uniform semantics to capture the seemingly diverse functions of Mandarin particle dou, including the quantifier use, the FCI-licenser use, and the scalar use. I proposed that dou is a special exhaustifier that operates on sub-alternatives and has a pre-exhaustification effect: dou presupposes the existence of at least one sub-alternative, asserts the truth of the prejacent and the negation of each pre-exhaustified sub-alternative.

In a basic case, sub-alternatives are alternatives that are not innocently excludable and distinct from the prejacent, and the pre-exhaustification effect is realized by a regular exhaustifier (viz. the \textit{O}-operator). Depending on the meaning of its associated item, dou
functions either as a universal quantifier or as a universal FCI-licenser.

When *dou* is applied to a scalar statement, sub-alternatives are alternatives less unlikely than the prejacent sentence with respect to the considered probability measure, and the pre-exhaustification effect is realized by the scalar exhaustifier *JUST*.

The additive presupposition of *dou* explains the distributional pattern of *dou* and many of its semantic consequences, such as the requirements regarding to distributivity, plurality, and monotonicity, the ‘even’-like interpretation of [lian Foc *dou* ...] construction, the distributional pattern of the post-*dou* negation in licensing minimizers, and so on.
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