2

A theory of questions and answers

This chapter develops a theory of questions and answers that provides a reference point for the rest of the book. Chapter 1 introduced the rudiments of an account of questions and classified it as a Hamblin–Karttunen account. Under this view, a question denotes a set of propositions and an answer is the conjunction of the true members of that set. Here I provide the historical context for this view, clarifying in what sense it is a blend of the two theories. I refine the analysis in a number of ways, incorporating insights from later research into the semantics of questions and answers.

We start with a discussion of three papers, Hamblin (1973), Karttunen (1977), and Groenendijk and Stokhof (1982), which form the basis of most current work on the topic. In addition to the view of questions as denoting sets of propositions, the idea of questions as partitions on possible worlds is introduced. Whether an answer merely needs to denote the true propositions (weak exhaustiveness) or whether it must also rule out the false ones (strong exhaustiveness) is of particular relevance to the construction of an adequate theory of questions. The proper interpretation of the common noun inside the wh phrase is also significant.

We present possibilities for bridging the different positions in these three papers, providing ways of synthesizing insights from all of them. Crucial to this enterprise is the possibility of separating the question denotation from an *answerhood* operation that takes questions as argument. The possibility of more than one type of answerhood operator, capturing weak and strong exhaustiveness, is explored. The possibility of moving the truth requirement from the question denotation to the answerhood operator, and allowing answers to be restricted on the basis of properties other than truth is discussed.

We introduce the notion of maximality, something not entertained in the early theories of questions. Maximality plays a role in the interpretation of number morphology in wh phrases as well as in the definition of the *answerhood* operator, capturing presuppositions about existence and informativity associated with questions and answers.

We end with a snapshot of a baseline theory of questions and answers. While subsequent chapters will suggest many possible ways of refining and rethinking various aspects of the semantics and pragmatics of questions, the theory endorsed here should provide a reasonable backdrop for evaluating those proposals.

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2.1 The classics

This section summarizes the three papers that can be considered classics in the field: Hamblin (1973), Karttunen (1977), and Groenendijk and Stokhof (1982), henceforth Gr&S. In discussing these works, I will use as far as possible a uniform syntactic structure for interrogatives of the kind presented in Chapter 1 (Heim 1989; Bittner 1994; von Stechow 1996). I will stay largely faithful to the original semantics, except for the uniform use of Ty2 (Gallin 1975) to facilitate comparison of theories.[1]

2.1.1 Questions as sets of propositions

In five pages of a short paper, Hamblin (1973) laid out a semantics for questions that has proven extremely influential. He took on the challenge of showing that Montague's program for "the construction of a theory of truth . . . as the basic goal of serious syntax and semantics" was not limited to declaratives, an idea that seems obvious to current day semanticists but was still in need of defense in the early 1970s. There are two primary modifications to Montague's semantics that Hamblin proposes in order to make this extension: a shift from denotations to denotation sets for natural language expressions, and the interpretation of wh expressions as multi-membered sets.[2] He posits a recursive definition for combining denotation sets, which results in the distinction between declaratives (singleton denotation sets) and interrogatives (multi-membered denotation sets). The following derivations show how this is accomplished, assuming that Bill and Mary are the two individuals in the domain:

(1)

a. $[\![\text{Mary walks}]\!] = \{\lambda w\,[\text{walk}_w\,(\text{m})]\}$

IP $\{\lambda w[walk_w\,(m)]\}$

DP $\{m\}$ — Mary

VP $\{walk_w\}$ — walks

b. $[\![\text{Who walks}]\!] =$
$\{\lambda w[\text{walk}_w\,(\text{m})],\ \lambda w[\text{walk}_w\,(\text{b})]\}$

IP $\{\lambda w[walk_w\,(m)],\ \lambda w[walk_w\,(b)]\}$

DP $\{m, b\}$ — who

VP $\{\text{walk}_w\}$ — walks

[1] Ty2 allows for explicit quantification over worlds. The subscripts on predicates in these derivations indicate world variables: P_w, the extension of P at w, is equivalent to $P(w)$. See Chapter 1 fn 9 for connections with Montague's system.

[2] See Dowty et al. (1981) for an introduction to Montague Grammar. A noteworthy feature inherited by the papers discussed is that each rule has distinct syntactic and semantic components. To keep the presentation accessible I do not reproduce the original rules, merely showing their contribution to the syntax–semantic mapping adopted here.

Trees (1a)–(1b) show that the denotation sets of lexical items combine through point-wise functional application. The compositional procedure anticipates the account of focus in Rooth (1992).[3] The fact that a proper name denotes a singleton set while a wh expression denotes a set with as many individuals as there are entities of the relevant type projects upwards. Thus, a declarative comes to denote a set with one proposition in it, and is identified with that proposition, while an interrogative denotes a set with as many propositions as there are entities in the domain.

The system generalizes to multiple constituent questions in the expected way ((2a)). Hamblin also defines the adverb "is it the case that" as the set with the identity function on the question nucleus and its negation for polar questions ((2b)):

(2) a. $[\![\text{Who likes who?}]\!] =$
$\{\lambda w[\text{likes}_w(m,m)], \lambda w[\text{likes}_w(m,b)], \lambda w[\text{likes}_w(b,m)], \lambda w[\text{likes}_w(b,b)]\}$
b. $[\![\text{Is it the case that Mary walks?}]\!] = \{\lambda w\,[\text{walk}_w(m)], \lambda w\,\neg[\text{walk}_w(m)]\}$

Hamblin briefly addresses the role of the common noun in complex wh expressions, such as *what N*. Although he entertains the notion that the restriction to entities in the denotation of *N* may be a presupposition, he seems to lean towards the view that this membership is asserted. Mono-morphemic wh expressions, *who* and *what*, are treated as implicitly restricted to humans and non-humans, respectively.

Questions for Hamblin, then, denote the set of possible answers. He does not explicitly discuss what counts as an actual answer to a question. From his comment, "pragmatically speaking a question sets up a choice-situation between a set of propositions, namely, those propositions that count as answers to it" (Hamblin 1973: 254), one infers that the subset of possible answers that would count as acceptable in a given situation is contextually determined.

2.1.2 Questions as sets of true propositions

Hamblin's theory is based on a consideration of full answers to questions. As a consequence, questions of all types, single/multiple constituent questions, questions about individuals, times or manners, polar questions, etc, all have a uniform semantic type, as opposed to a multitude of types based on the category and number of wh expression(s). While Hamblin only considered direct questions, this aspect of his theory is particularly attractive in the context of indirect questions, the starting point for Karttunen (1977). Question embedding predicates, for the most part, do not distinguish between various question types, so a uniform semantics for questions leads to a simpler semantics for embedding predicates (see Chapter 5 on indirect questions).

[3] Rooth (1992: 84) acknowledges Dietmar Zaefferer for making the connection between his earlier work on focus (Rooth 1985) and Hamblin's semantics for questions. See also Chapter 8.

Karttunen's interest in indirect questions leads to a significant modification of Hamblin's theory of questions, namely the restriction of question denotations to true propositions. The following verbs of communication prompt this revision: *tell*, *show*, *indicate*, *inform*, *disclose*. Take, for illustration, *tell* and *indicate*. These verbs are non-factive when embedding declaratives, but lead to veridicality when embedding interrogatives:

(3) a. John told Mary that Bill and Susan left.
 b. John indicated that Bill and Susan left.

(4) a. John told Mary who left.
 b. John indicated who left.

Sentences (3a)–(3b) can be true even if the embedded declaratives are false; (4a)–(4b) cannot be true if John told/indicated that Bill and Susan left when that is not the case. Since the restriction to truth cannot come from the embedding verb, Karttunen concludes, it must come from the question itself.

Another argument for introducing truth into the denotation of questions rests on verbs like *depend on:*

(5) Who is elected depends on who is running.

Karttunen points out that it is simpler to define the meaning of the matrix verb on the basis of true answers to the two embedded questions than on the basis of possible answers to them.

Karttunen's modification of Hamblin's theory is cast within the general framework of natural language quantification in Montague grammar and is also informed by insights from transformational analyses in Katz and Postal (1964), Baker (1968), and Chomsky (1975). Although Karttunen follows Hamblin in taking interrogatives to denote sets of propositions, declaratives are interpreted at their normal semantic type as propositions. Wh expressions are treated as existential generalized quantifiers, adjusted to apply to interrogative level meanings. Crucial to Karttunen's proposal is the shift from declarative to interrogative meaning, mediated through the formation of *proto-questions* (Karttunen 1977:13). The output of the proto-question rule does not correspond to any natural language question but it serves two crucial purposes. It shifts the meaning to a set of propositions and it introduces the truth requirement on propositions.

In our syntactic framework, the proto-question rule can be ascribed most naturally to the $C^0_{[+WH]}$ node. Let us try to understand Karttunen's proto-question rule with reference to constituent and polar questions:

(6) a.

C′ $\lambda q\, \lambda p[p_w \wedge p = q]\ (\lambda w\, [walk_w(m/x_i)])$
$\Rightarrow \lambda p[p_w \wedge\ p = \lambda w\, [walk_w(m/x_i)]]$

$C^0{}_{[+WH]}$
$\lambda q\, \lambda p[p_w \wedge p = q]$

IP $walk_w(m/x_i)$
Mary /t_i walks

b. $[\![C']\!] = \{\lambda w[walk_w(x_i)]\}$ *for constituent questions*;
$\{walk_w(m)]\}$ or $\varnothing$ *for polar questions.*

With constituent questions, C′ denotes a set of true propositions, whose determination requires the binding of the free variable inside the nucleus. With polar questions, C′ denotes either the singleton set or the empty set, depending on the facts in the evaluation world. C^0[–WH] would be a simple identity function on propositions: $\lambda p[p]$, as in a standard graft of Montague's semantics to this syntactic structure.[4]

Karttunen proposes further operations on proto-questions in order to generate meanings associated with actual natural language questions. Let us consider the *Yes/No Question Rule* first (Karttunen 1977:15). For our purposes, we can encode the content of the rule in a null operator in SpecCP, as in (7a). Karttunen's *Y/N Ques* rule is complicated by the truth requirement in the proto-Ques rule. Thus two separate cases must be considered, one in which C′ denotes a set with the single true proposition (7b), and one in which the set is empty (7c):[5]

(7) a. $[\![OP_{Y/N}]\!] = \lambda\mathbb{Q}\,\lambda p[\mathbb{Q}(p) \vee [\neg\exists q\, \mathbb{Q}(q) \wedge p = {}^\wedge\neg\exists q\, \mathbb{Q}(q)]]$ *$\mathbb{Q}$: type <<s,t>,t>*
b. $[\![C']\!] = \{\lambda w[walk(w)(m)]\}$
$[\![[_{CP}\ OP_{Y/N}\ C']]\!] = \{\lambda w[walk(w)(m)]\}$
c. $[\![C']\!] = \varnothing$
$[\![[_{CP}\ OP_{Y/N}\ C']]\!] = \{\lambda w\ \neg[walk(w)(m)]\}$

In (7b), the question denotes the set with the true proposition, because of the first condition in (7a). The second condition in (7a) takes care of the case where the nucleus proposition is false. The question now includes the set of worlds in which the question nucleus does not hold. For direct questions, it seems reasonable to adopt a null operator with the relevant meaning, as we have done. For indirect questions, the same could be taken as the meaning of *whether/if*. The procedure is often simplified in later accounts by interpreting $C^0_{[+WH]}$ in polar questions as $\lambda q\,\lambda p\,[p_w \wedge p = q \vee p = \lambda w\ \neg q_w]$.

Karttunen's treatment of constituent questions is a straightforward adaptation of Montague's quantification rule for indefinites, since he treats the wh phrase as an existential. Proto-questions, with an indexed free variable, feed into the *Wh Quantification Rule* and the *Wh Phrase Rule* (Karttunen 1977: 19, 24–5). We can keep the meaning of the wh determiner as an ordinary existential quantifier (8a), and capture quantifying into questions with the schema in (8b):

(8) a. $[\![which]\!] = \lambda P\,\lambda Q\,\exists x\,[P(x) \wedge Q(x)]$ *P and Q: type <e,t>*
b. $[\![[_{CP}\ [_{DP\text{-}n}\ which\ N]\ C']]\!] = \lambda p\,[\,[\![which\ N]\!](\lambda x_n[\,[\![C']\!](p)]]$

[4] Recall from Chapter 1 that IP meanings are shifted from type *t* to type *<s,t>* at C′, enabling functional application with $[\![C^0]\!]$. See also *Intensional Functional Application* in Heim and Kratzer (1998: 308).

[5] The relationship between the second clause of (7a) and (7c) is not transparent, but hopefully, the discussion in Section 2.2.1 will help.

The quantifying-in rule in (8b) involves the following steps. First, the ⟦C′⟧ is converted into type *t* by saturating the lambda expression denoted by C′with the variable *p*. Then the individual variable is abstracted over, producing an expression of type *<e,t>*. This combines with the generalized quantifier denoted by the wh expression. By abstracting over *p* again, we get back a set of propositions as the meaning of the question. If Mary and Bill are the only students who walk in the actual world, though there may well be other individuals under consideration, we get sets such as (9c) for the single constituent question in (9a). Analysis (9b) provides the steps of the derivation, all involving simple functional application:[6]

(9) a. Which student walks?

b. CP (1)

DP $\lambda Q\ \exists x[student_w\ (x) \wedge Q(x)]$ — Which student$_i$

C′ $\lambda p'\ [p'_w \wedge p' = \lambda w[walks_w\ (x_i)]]$ — t_i walks

$[\![1]\!] = \lambda p\ [\lambda Q\ \exists x[\text{student}_w\ (x) \wedge Q(x)]\ (\lambda x_i[\boldsymbol{\lambda p'}[\mathbf{p'}_w\ \wedge \mathbf{p'} = \lambda w[\text{walks}_w\ (x_i)]](\mathbf{p})])]$

$\Rightarrow \lambda p[\boldsymbol{\lambda Q}\ \exists x[\text{student}_w\ (x) \wedge \mathbf{Q}(x)]\ (\boldsymbol{\lambda x_i}[\mathbf{p_w} \wedge \mathbf{p} = \boldsymbol{\lambda w}[\textbf{walks}_w\ (\mathbf{x_i})]])]$

$\Rightarrow \lambda p[\exists x[\text{student}_w\ (x) \wedge \boldsymbol{\lambda x_i}[p_w \wedge\ p = \lambda w[\text{walks}_w\ (\mathbf{x_i})]](\mathbf{x})]$

$\Rightarrow \lambda p[\exists x[\text{student}_w\ (x) \wedge\ p_w \wedge p = \lambda w[\text{walks}_w\ (x)]]$

c. ⟦which student walks⟧ = $\{\lambda w[\text{walks}_w\ (m)], \lambda w[\text{walks}_w\ (b)]\}$

Since the wh question rule is recursively defined, multiple wh questions are easily accommodated. If Mary's reading of *Emma* and Bill's reading of *Persuasion* exhaust the readings of books by students in the world of evaluation, a multiple constituent question is interpreted as (10):

(10) a. ⟦which student read which book⟧ =

$\lambda p \exists y[\text{book}_w(y) \wedge \exists x[\text{student}_w(x) \wedge p_w \wedge p = \lambda w'[\text{read}_{w'}\ (x,y)]]]$

b. $\{\lambda w[\text{read}_w\ (m,E)], \lambda w\ [\text{read}_w\ (b, P)]\}$

A standard simplification, one that was adopted in Chapter 1, is to leave the proposition *p* as a free variable at C^0 and abstract over it at the top node. This makes the procedure for interpreting multiple constituent questions more user friendly while achieving the same results.

The final piece of Karttunen's theory involves the embedding of questions. The question embedding rule (Karttunen 1977: 17) takes the intension of the interrogative meaning as its internal argument. The nature of the embedding predicate determines whether the intension or the extension of this argument will be relevant in the final computation. The internal argument of *wonder* is a function from worlds *w′* to the set of propositions *p* that are true at *w′* (11). By contrast, the internal argument of *know* takes the extension of the question (12) and yields the set of propositions that are true at the world of evaluation *w*:

6 I use bold font to indicate the key elements of the lambda expression that is to be resolved in the next step of the derivation.

(11) a. [John ***[wonders what Bill bought]***]
b. $[\![\text{wonder}]\!] = \lambda\mathbb{Q}_{<s,<<s,t>,t>>}\ \lambda y[\text{wonder}_w(y,\mathbb{Q})]$
c. $[\![\text{wonder what Bill bought}]\!] =$
$\boldsymbol{\lambda\mathbb{Q}}\lambda y[\text{wonder}_w(y,\boldsymbol{\mathbb{Q}})]\ (\boldsymbol{\lambda w'\ \lambda p\ \exists x\ [p_{w'} \wedge p = \lambda w''[\text{bought}_{w''}\ (b, x)]]})$
$\Rightarrow\lambda y[\text{wonder}_w(y, \lambda w'\ \lambda p\ \exists x\ [p_{w'} \wedge p = \lambda w''[\text{bought}_{w''}\ (b, x)]])]$

(12) a. [John ***[knows what Bill bought]***]
b. $[\![\text{know}]\!] = \lambda\mathbb{Q}_{<s,<<s,t>,t>>}\ \lambda y[\text{know}_w\ (y,\mathbb{Q}(w))]$
c. $[\![\text{know what Bill bought}]\!] =$
$\boldsymbol{\lambda\mathbb{Q}}\lambda y[\text{know}_w(y,\mathbb{Q}(w))]\ (\boldsymbol{\lambda w'\ \lambda p\ \exists x\ [p_{w'} \wedge p = \lambda w''[\text{bought}_{w''}\ (b, x)]]})$
$\Rightarrow\lambda y[\text{know}_w(y, \boldsymbol{\lambda w'}\ \lambda p\ \exists x\ [p_{w'} \wedge p = \lambda w''[\text{bought}_{w''}\ (b, x)]]\boldsymbol{(w)})]$
$\Rightarrow\lambda y[\text{know}_w(y, \lambda p\ \exists x[p_w \wedge p = \lambda w''[\text{bought}_{w''}\ (b, x)]])]$

Karttunen further relates question embedding verbs with their proposition embedding counterparts by a *Meaning Postulate* (Karttunen 1977: 18 ff):[7]

(13) $\forall x\ \forall\mathbb{Q}\ \Box\ [\text{know}_Q(x, \mathbb{Q}) \leftrightarrow$
$[\forall p\ [\mathbb{Q}(p) \rightarrow \text{know}_t(x,p)] \wedge [\neg\exists q\ \mathbb{Q}(q) \rightarrow \text{know}_t(x, \wedge \neg\exists q\mathbb{Q}(q))]]]$

This licenses inferences from question denotations to propositions, for verbs like *know*, *tell*, etc. It guarantees that if someone stands in the *know/tell* relation to a question, then they must stand in the *know/tell* relation to every proposition in that question. And if the question denotes the empty set, then the individual stands in that relation to the proposition that there are no true propositions of the relevant sort. In the case of (12), if Bill bought *Emma* and *Persuasion*, knowing *what he bought* is tantamount to knowing *that Bill bought Emma and Persuasion*, and, if he bought nothing, to knowing *that Bill bought nothing*. This makes it explicit that Karttunen takes an answer to a question to be the conjunction of all the propositions in the question denotation. And, in case the question denotation is empty, as the proposition that states this fact.

2.1.3 Questions as partitions

Gr&S (1982) respond to Karttunen, arguing that the basic type of a question is the same as that of a declarative, a proposition. A question is *index-dependent* so the proposition denoted varies from world to world while a declarative is *index-independent* and denotes the same proposition at every world. A question, then, determines a partition on possible worlds. A similar proposal is made in Higginbotham and May (1981) and Higginbotham (1996). I focus on Gr&S's version as an exemplar of this general perspective on questions.

The treatment of questions as propositions is motivated by the fact that it is possible to conjoin them with ordinary declaratives. If conjunction requires syntactic and semantic parallelism, an analysis of questions as propositions is appealing:

[7] Meaning Postulates, first proposed by Carnap (1947), are used in Montague Grammar to capture language specific lexical properties by placing constraints on admissable models (Dowty, Wall and Peters 1981: 224; Chierchia and McConnell-Ginet 2000: 448–449).

(14) a. John knows *that Peter has left for Paris*, and also *whether Mary has followed him*.
b. Alex told Susan *that someone was waiting for her*, but not *who it was*.

As in the case of a uniform meaning for different question types, a move in the direction of uniformity between interrogatives and declaratives also allows for a simpler semantics for verbs that can embed either. It bears mentioning, though, that such co-ordination is ungrammatical under question embedding verbs: **John wondered/asked whether Peter has left for Paris and that Mary has followed him.*

Mapping Gr&S's interpretive procedure onto a GB-style syntax and adapting the original rules (Gr&S 1982: 192), we get the following for a declarative:

(15) a. (that) Mary walks
b.

C′ $\lambda w\ walk_w\ (m)$ $<s,t>$

$C^0_{[-\text{WH}]}$ IP $\boldsymbol{\lambda P_{<s,<et>>}\ [P_w(m)]\ (\lambda w\ walk_w)}$
$\Rightarrow [(\boldsymbol{\lambda w}\ walk_w)\ (\boldsymbol{w})\ (m)]$
$\Rightarrow walk_w\ (m)$ t

DP VP
Mary $\lambda P[P_w\ (m)]$ walks $walk_w$

Simplifying somewhat, *Mary* denotes the set of properties $P_{<s,<e,t>>}$ that characterize the individual Mary at world *w*, and $walk_w$ the extension of the property *walk* at the same world. By *Intensional Functional Application* we have the formula $walk_w(m)$ which is true or false, depending on the facts at *w*. The specification on C^0 being [−WH], the world variable is abstracted over at C′ and the result is a proposition, the set of worlds where Mary walks.

A C^0 specified[+WH], conversely, creates index dependence in the proposition, (16c). Instead of abstracting over the world of evaluation *w*, it looks for worlds *w′* having the same value as *w* with respect to the question nucleus. The relevant rule (Gr&S 1982: 192) derives the interrogative version of (15a):

(16)
a. Does Mary walk? / Whether Mary walks.
b.

C′ $\boldsymbol{\lambda p}\ \lambda w\ \lambda w'\ [\boldsymbol{p}(w) = \boldsymbol{p}(w')]\ (\boldsymbol{\lambda w''[walk_{w''}\ (mary)]})$
$\Rightarrow \lambda w\ \lambda w''\ [\boldsymbol{\lambda w''}\ [walk_{w''}\ (mary)](\boldsymbol{w}) = \boldsymbol{\lambda w''}[walk_{w''}\ (mary)]\ (\boldsymbol{w'})]$
$\Rightarrow \lambda w\ \lambda w'\ [walk_w\ (mary) = walk_{w'}\ (mary)]$ <s,<s,t>>

$C^0_{[+\text{WH}]}$ IP $walk_w\ (mary)$ t
Does Mary walk

c. $[\![C^0_{+\text{WH}}]\!] = \lambda p_{<s,t>}\ \lambda w\ \lambda w'\ [p(w) = p(w')]$

Let us parse (16c) to see how index-dependence is achieved. C^0 takes a proposition and creates a relation between the world of evaluation *w* and a proposition in the following way. Saturating the world variable in the proposition with the world of evaluation *w* yields, on the left of side of the equation, the extension of the proposition at *w*, either true or false. Saturating the world variable on the right side of the equation with a different variable *w′*, collects all the worlds in which the extension of the proposition on the right matches the extension of the proposition on the left, that is, at the world of evaluation. We thus get a partition that defines an equivalence relation on worlds. At each world *w*, the question denotes the set of worlds *w′* that is equivalent to *w* with respect to the question.

Though interrogatives and declaratives denote the same semantic type at a given world, that is, propositions (type <*s,t*>), they are clearly different. No matter which world we interpret a declarative at, it denotes the same set of worlds. The interpretation of the interrogative varies depending on the facts at the world of evaluation. To make this concrete, consider the following model:

(17) a. M: W = {w1, w2, w3, w4};

$$\text{Walk} = \begin{bmatrix} \text{w1} \rightarrow \{\text{mary, sue}\} \\ \text{w2} \rightarrow \{\text{bill, mary}\} \\ \text{w3} \rightarrow \{\text{sue}\} \\ \text{w4} \rightarrow \varnothing \end{bmatrix}$$

b. Does Mary walk?
Extension at w2: $\lambda w\, \lambda w'\, [\text{walk}_w\, (m) = \text{walk}_{w'}\, (m)]\, (w2) = \{w1, w2\}$
the set of worlds in which Mary walks
Extension at w3: $\lambda w\, \lambda w'\, [\text{walk}_w\, (m) = \text{walk}_{w'}\, (m)]\, (w3) = \{w3, w4\}$
the set of worlds in which Mary doesn't walk

Example (17) illustrates the difference between the intension and extension of a question. The intension of a polar question denotes a partition of worlds with two cells, one where Mary walks, one where she doesn't. The extension of the question varies with worlds. At *w2*, for example, we get the proposition *that Mary walks,* at *w3* the proposition *that Mary doesn't walk.*[8]

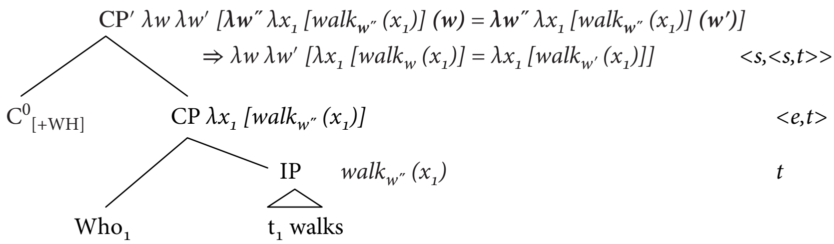
Turning to constituent questions, an important step in interpretation is the creation of an abstract. The rules for abstract formation and abstract constituent complement formation (Gr&S 1982: 196) translate into derivations like (18). Note that this semantics requires interpreting wh phrases lower in the structure than C^0:

[8] The intension of a proposition: $\lambda w\, \lambda w'[walk(w')(m)]$ yields the same proposition at every world since the variable *w* does not occur inside the nucleus—the facts in the world of evaluation are not relevant to the proposition. Here, it would be the set *{w1, w2}*, whether evaluated at *w2* or *w3*.

(18)

a. Who walks?

b.



The argument position associated with the wh expression is interpreted as an indexed variable, and the wh expression as a lambda abstractor over it. Since abstraction has to happen below the point at which index dependence is introduced, wh expressions adjoin below C^0, at the lower CP. The only adjustment needed in the semantics is to allow index dependency to apply to categories of type $<s,<e,t>>$, not just type $<s,t>$. The lower CP meaning can then feed into the meaning of C^0, after the requisite intensionalization. This yields a function from worlds w to the set of worlds w' in which the set of walkers are the same as in w: $\lambda w\, \lambda w'\, [\lambda u[walk_w(u)] = \lambda u\, [walk_{w'}(u)]]$. Once again, we have an equivalence relation on worlds, this time with respect to the set of walkers. Schematically, if there are two entities in the domain, a question intension represents a partition with four cells, exhausting the space of possibilities:

(18) c.

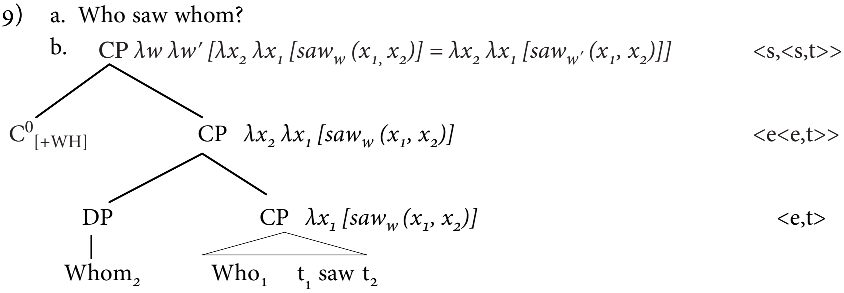
a	b
a,b	

At any world, the question denotes exactly one cell, the proposition that is its complete answer.

The rule for abstract formation generalizes to multiple constituent questions. Each wh expression in (19a) abstracts over one argument position (19b). The schema in (19c) represents the partition induced by this question, with a two-member domain of entities and an irreflexively interpreted predicate:

(19) a. Who saw whom?

b.



c.

<a,b> <b,a>	
<a,b>	<b,a>

The rule for embedding applies without modification to interrogatives, since they have the same semantic type as declaratives (Gr&S 1982: 192). The type of the internal argument starts out intensional. As in Karttunen, embedding verbs vary along the intensional/extensional dimension. Verbs like *tell/know* are extensional, while verbs like *wonder/ask* are intensional. For completeness, I include an embedded declarative in the first class:

(20) a. [John ***[knows that Mary walks]***]
b. $\text{know}_w (j, \lambda w \lambda w' [\text{walk}_{w'} (m)] (w))$
$\Rightarrow \text{know}_w (j, \lambda w' [\text{walk}_{w'} (m)])$

(21) a. [John ***[knows whether Mary walks]***]
b. $\text{know}_w (j, \lambda w \lambda w' [\text{walk}_w (m) = \text{walk}_{w'} (m)] (w))$
$\Rightarrow \text{know}_w (j, \lambda w' [\text{walk}_w (m) = \text{walk}_{w'} (m)])$

(22) a. [John ***[knows who walks]***]
b. $\text{know}_w (j, \lambda w \lambda w' [\lambda u[\text{walk}_w (u)] = \lambda u[\text{walk}_{w'} (m)]](w))$
$\Rightarrow \text{know}_w (j, \lambda w' [\lambda u[\text{walk}_w (u)] = \lambda u[\text{walk}_{w'} (u)]])$

(23) a. [John ***[wonders who walks]***]
b. $\text{wonder}_w (j, \lambda w \lambda w' [\lambda u[\text{walk}_w (u)] = \lambda u [\text{walk}_{w'} (u)]])$

The crucial point is that extensional verbs relate to a proposition (*type <s,t>*), while intensional verbs relate to a propositional concept, a function from worlds to propositions (*type <s, <s,t>>*).

2.1.4 Advantages of questions as partitions

We have seen the core of Gr&S's theory, and the points of departure from Karttunen's. We will now review those aspects that, according to Gr&S, favor their theory.

The first is the distinction between *weak* and *strong exhaustiveness*. The main point of difference can be illustrated schematically:

(24)

w1 *a b c*	w2 *a*	w3 *b*	w4 *c*
w5 *a b*	w6 *a c*	w7 *b c*	w8

Assume we are in a world where *a* and *b* walk, say *w5*. Karttunen's theory requires that the propositions $\lambda w[a\ walks_w]$ and $\lambda w[b\ walks_w]$ be in the question denotation. And knowing the question in such a world requires knowing the conjunction of these two propositions. This will include worlds in which *a* and *b* both walk, but also worlds where *c* walks as well: *{w1, w5}*. Gr&S's theory, however, singles out the set of worlds in which *a* and *b* are the only individuals who walk: *{w5}*. That is, under Karttunen's theory the attitude holder may have false beliefs or no beliefs about non-walkers at *w5*. Gr&S term this *weak exhaustiveness* and argue that the *strong exhaustiveness* their theory delivers is required. Consider the following inference patterns.

(25) a. John believes that Bill and Suzy walk
Only Bill walks
John doesn't know who walks

b. John knows who walks
John knows who doesn't walk

Gr&S claim that if only Bill walks, but John believes falsely of Suzy that she also walks, speakers do not judge *John knows who walks* true. Similarly, they argue that if John knows who walks, and knows who the set of individuals are, then he must know who doesn't walk. Since neither of these follows under weak exhaustiveness, they claim that questions must encode strong exhaustiveness.

A second respect in which Gr&S claim their theory to be superior to Karttunen's has to do with the interpretation of the common noun inside wh phrases. They take embedded questions like (26) to be ambiguous between a *de dicto* and a *de re* reading:

(26) John knows which student walks.

If *a* and *b* are the two students who walk in the world of evaluation, (26) can be taken to mean that John knows that *a* and *b* are students who walk. If asked, *do you know which students walk?* he would answer in the affirmative. This is the *de dicto* reading. Alternatively, it is possible for John to know that *a* and *b* walk without knowing that they are students. If asked *do you know who walks?* he would answer affirmatively and pick out *a* and *b*, but if asked *do you know which students walk?* he might say he doesn't. This is the *de re* reading. This distinction is shown below, focusing on the direct question counterpart of (26) and skipping the obvious steps in the derivations (Gr&S 1982: 198–9):

(27) a. Which student walks?

CP $\lambda w\, \lambda w'\, [\lambda w''\, \lambda x_o\, [student_{w''}(x_o) \wedge walk_{w''}(x_o)]\,(w) = \lambda w''\, \lambda x_o\, [student_{w''}(x_o) \wedge walk_{w''}(x_o)](w')]$

$\Rightarrow \lambda w\, \lambda w'\, [\lambda x_o\, [student_w(x_o) \wedge walk_w(x_o)] = \lambda x_o [student_{w'}(x_o) \wedge walk_{w'}(x_o)]]$

$C^o_{[+WH]}$ CP $\lambda x_o\, [student_{w''}(x_o) \wedge walk_{w''}(x_o)]$

DP $student_{w''}$ IP $walk_{w''}(x_o)$

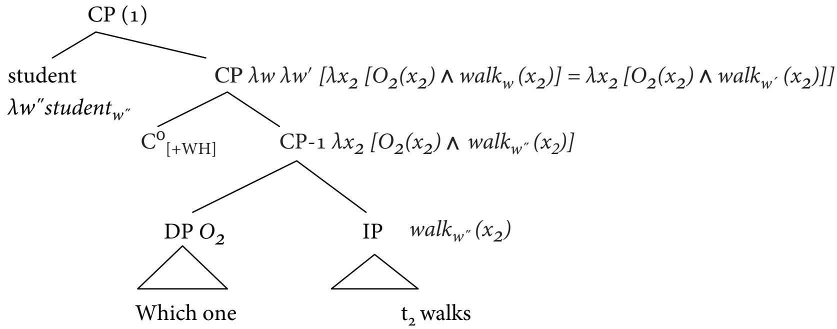
Which student t_o walks

The common noun is interpreted at the point where the abstract is formed. Thus, when the abstract combines with C^0 and the interrogative meaning is obtained, the denotation of the common noun varies on two sides of the equation. We get the set of worlds w' in which the set of student-walkers are the same as the set of student-walkers in the world of evaluation w. To know this proposition is to know the set of student-walkers in the actual world, the *de dicto* reading.

The second option differs crucially in having the common noun enter the derivation after question formation has taken place:[9]

(27)

b.



$$[\![1]\!] = \lambda w_@\, [\lambda O_2\, [\mathbf{\lambda w}\, \lambda w'\, [\lambda x_2\, [O_2(x_2) \wedge walk_w(x_2)] = \lambda x_2\, [O_2(x_2) \wedge walk_{w'}(x_2)]]\, (\mathbf{w_@})]\, (\mathbf{\lambda w''}student_{w''}\, (\mathbf{w_@}))]$$

$$\Rightarrow \lambda w_@\, [\mathbf{\lambda O_2}\, [\lambda w'\, [\lambda x_2\, [\mathbf{O_2}(x_2) \wedge walk_{w@}(x_2)] = \lambda x_2\, [\mathbf{O_2}(x_2) \wedge walk_{w'}(x_2)]]]\, (\mathbf{student_{w@}})]$$

$$\Rightarrow \lambda w_@\, \lambda w'\, [\mathbf{\lambda x_2}\, [student_{w@}(x_2) \wedge walk_{w@}(x_2)] = \lambda x_2\, [student_{w@}(x_2) \wedge walk_{w'}(x_2)]]]$$

There are two important steps here. First, there is a place-holder for the common noun at the point of abstract creation: O_2 of type <*e,t*>. After interrogative formation, this place-holder is replaced through lambda abstraction and conversion with the denotation of the common noun in the actual world: $student_{w@}$. When this happens, the property-in-extension replaces O_2 on both sides of the equation. We now have the set of worlds w' such that the set of walkers in w' are the same as the set of student-walkers in the world of evaluation, the *de re* reading. Their status as students in w' is not relevant.

It is easy enough to see how these two ways of deriving common noun meanings will yield the perceived ambiguity of questions when they are embedded under attitude verbs. Gr&S point out that Karttunen's theory only captures *de re* readings because the existential quantifier is interpreted outside the scope of the propositional variable where the question nucleus is interpreted. Their system, instead, allows for the required flexibility.

9 The use of $w_@$ in the final step has no significance and could be replaced with w to get the familiar looking question intension. The important point is that the world variable on O_2 be anchored to the same world as the predicate on the left side of the equation.

2.1.5 Section summary

In this section I have presented the key features of three seminal papers. Among the issues highlighted are the possibility of a uniform analysis of direct and indirect questions, an explicit connection between question denotations and possible answers regarding true propositions, and a distinction between weak/ strong exhaustiveness. In presenting these ideas, I took liberties with the syntax but stayed faithful to the semantics, except for the use of Ty2 across the board and the simplification of certain details of Montague grammar. The goal of this section was two-fold, to provide the relevant historical background for the particular semantics we are adopting and to pave the way for later developments in the theory.

2.2 Answerhood operators

The previous discussion was restricted to arguments made by the authors themselves. In this section we will present suggestions for incorporating insights from the different approaches into a single theory of questions. We will first see how two key insights of Gr&S's theory can be incorporated into Karttunen's. We will then see how Karttunen's insights can be incorporated into Hamblin's theory. We will settle upon a blend that has broad acceptance in current work, the Hamblin–Karttunen theory of questions. Central to the enterprise is the introduction of an operator that mediates between question denotations and answers.

2.2.1 Exhaustiveness and Ans-H

Heim (1994) addresses the criticism made by Gr&S that the set of propositions approach fails to capture strong exhaustiveness. In a theory like Karttunen's, an extensional question embedding verb like *know/tell* relates individuals to the set of true propositions denoted by the question (cf. (13)). If the facts are such that John and Bill walk, then (28a) is true iff Mary stands in the *know* relation to (the conjunction of) the two propositions in (28b), underlined to indicate that they are true in the world of evaluation. But what if no one walks? Then the embedded question will denote the empty set (28c). The intersection of the empty set is the tautological proposition, which one cannot fail to believe, regardless of how ignorant one is. That is, (28a) will be automatically true if no one walks, even if Mary is totally unaware of the relevant fact since any rational person can be assumed to know a tautology:

(28) a. Mary knows who walks.
b. If john and bill are the individuals that walk in w,
$[\![\text{who walks}]\!](w) = \{\underline{\lambda w\ \text{walks}_w\ (j)}, \underline{\lambda w\ \text{walks}_w\ (b)}\}$
c. If no one walks in w, $[\![\text{who walks}]\!](w) = \varnothing$

Karttunen, we saw, provides a disjunctive semantics for *know* to cover the two cases. Heim taps into Karttunen's solution and proposes two notions of answerhood within his theory, which she dubs Ans_1 and Ans_2 (Heim 1994: 136). I add H to indicate authorship of the idea:

(29) a. $\text{Ans-H}_1(\alpha, w) = \cap\ [\![\alpha]\!]_K(w)$
b. $\text{Ans-H}_1(w)$ (who walks) $= \cap\ (\lambda p\ \exists x\ [p_w \wedge p = \lambda w' \text{walk}_{w'}\ (x)])$
c. John and Bill walk.

(30) a. $\text{Ans-H}_2(\alpha,w) = \lambda w'\ [\text{Ans-H}_1(\alpha,w') = \text{Ans-H}_1(\alpha,w)]$
b. $\text{Ans-H}_2(w)$ (who walks) $= \lambda w'\ [\cap\ (\lambda p\ \exists x\ [p_w \wedge p = \lambda w' \text{walk}_{w'}\ (x)]) = \cap\ (\lambda p\ \exists x\ [p_{w'} \wedge p = \lambda w' \text{walk}_{w'}\ (x)])$
c. Only John and Bill walk.

Ans-H_1 delivers the weak exhaustiveness of Karttunen's original theory. Assuming that Bill and John are the only individuals who walk, it yields the conjunction of the two propositions denoted by the question at the world of evaluation. It admits worlds where there are no other walkers, as well as worlds with extra walkers. Ans-H_2 imports the strong exhaustiveness that Gr&S championed. It picks out all the worlds in which the answer to the question matches the answer in the world of evaluation. Effectively, proposition (30c).

Heim notes that with this enrichment, Karttunen's theory becomes a richer system since it allows for the possibility of weak as well as strong exhaustiveness, while Gr&S's is rigidly bound to strong exhaustiveness. The upshot is that the choice between the two theories must turn on empirical considerations. If there are natural language phenomena corroborating the existence of weakly exhaustive questions, Karttunen's theory, supplemented with Ans-H_2, is to be preferred over an alternative that only has the power of Ans-H_2. We will return to this issue in Chapter 3, but what Heim establishes is that strong exhaustiveness is not a knock-down argument against the set of propositions theory of questions.

Implicit in this discussion is also an answer to the argument in Gr&S from the conjoinability of interrogatives and declaratives. If the interpretation of an indirect question is mediated through $\text{Ans-H}_1/\text{Ans-H}_2$, which involve the intersection of the propositions in the set, the conjunction facts are no longer a challenge:

(31)
a. Bill knows what Mary bought and that Sue danced.
b. $\text{know}(\text{bill},[\underbrace{\cap[\lambda p\ \exists x[p(w) \wedge p = \lambda w\ \text{bought}(w)(\text{mary},x)]]}_{<s,t>} \cap \underbrace{\lambda w[\text{danced}(w)(\text{sue})]}_{<s,t>}])$
c. *Bill wonders what Mary bought and Sue danced.

In fact, it has the potential advantage of accounting for (31c), on the view that question embedding verbs do not have access to this type-shift (see also Uegaki 2015).

Heim also notes the problem of incorporating *de dicto* readings in Karttunen's theory. Her suggestions are picked up by Beck and Rullman (1999) and Sharvit (2002) who capture *de dicto/de re* ambiguities using Ty2:

(32) a. Which student walks?
b. $\lambda p\ \exists x\ [\text{student}_w\ (x) \wedge p_w \wedge p = \lambda w'(\text{walk}_{w'}\ (x))]$
c. $\lambda p\ \exists x\ [p_w \wedge p = \lambda w'[\text{student}_{w'/w}\ (x) \wedge \text{walk}(w')(x)]]$

Formula (32b) is Karttunen's original version with the common noun outside the question nucleus. Its world variable is obligatorily anchored to the actual world, resulting in the *de re* reading. The crucial move involves interpreting the common noun in the base position (32c).[10] Its world variable can be bound or remain free, in the spirit of Enç (1986). When bound, the set has propositions of the form *λw′ [x is a student in w′ and walks in w′]*, the *de dicto* reading of the question. When free, propositions are of the form *λw′[x is a student in w and walks in w′]*, referring to those *x*'s who are students in the actual world, the *de re* reading. Setting aside some intricacies related to the selection of *de dicto/de re* readings of questions, this ambiguity is easily captured in this straightforward extension of Karttunen's theory.

The three arguments from Gr&S against Karttunen, we see, are tractable under reasonable modifications of the latter. The real contribution of Gr&S's paper, then, is in enriching the empirical desiderata for a theory of questions rather than in motivating a shift from questions as sets of propositions to questions as (index-dependent) propositions.

2.2.2 Truth and Ans-D$_{PRELIM}$

The idea that an operator mediates between question denotation and embedding predicates is also proposed by Dayal (1994). The primary argument comes from the truth requirement that Karttunen introduced into question denotations and which is hard-wired into Gr&S's theory. The proposal is to shift this requirement into the *answerhood operator*, allowing questions to denote Hamblin sets. The motivation comes from an analysis of a construction known variously in the literature as *scope marking, partial wh movement*, and *expletive wh construction.* Initially, this construction was thought not to exist in English, but we now know that a variant of it is found in spoken English (Dayal 1996). This makes it convenient for purposes of demonstration.

To get a feel for the construction, consider a sequence of questions like (33a):

(33) a. Where did you go? What did you buy?
b. What do you think? What should we buy?
c. What do you think we should buy?

A good answer to (33a) specifies values for places and objects: *I went to the store. I bought apples*, *I went to the store and bought apples*, or perhaps *I went to the store to buy apples.* That is, we would interpret the sequence as a conjunction of two

[10] This can be accomplished by reconstruction of the common noun at LF or, assuming the copy theory of movement, by interpreting the common noun at the tail of the movement chain, or through the use of choice functions, as favored by Beck and Rullmann.

questions. We are more likely to interpret the sequence in (33b), instead, as a single question and answer it by specifying a value for objects: *I think we should buy apples.* In that sense, it seems equivalent to (33c), which involves extraction of the embedded wh to matrix SpecCP. The intonational contour differentiates between a sequence interpreted as a conjunction of two questions (33a) and one interpreted as a single question (33b).

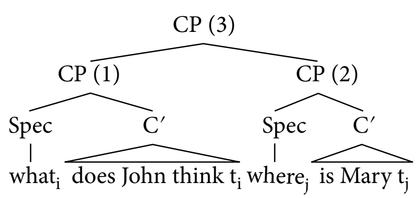
There is a vast literature on scope marking but broadly speaking it separates into two categories, dubbed *direct dependency* and *indirect dependency* in Dayal (1994). Briefly, the direct dependency approaches align scope marking with long distance extraction like (33c). I refer the reader to my earlier work as well as to recent surveys such as Fanselow (2005), Dayal (2013), Dayal and Alok (2016), and references cited therein for arguments against the direct dependency approach. We will be concerned only with sequential scope marking here which cannot be analyzed through direct dependency. This makes it possible to focus on the truth requirement in questions without getting bogged down in that controversy.[11]

A concrete example shows the workings of the indirect dependency approach and highlights the implications for a choice between Karttunen and Hamblin:[12]

(34)

a. What does John think? Where is Mary?

b.



$[\![1]\!] = \lambda p\ \exists p'\ [T(p') \wedge p = \lambda w'\ (\text{think}_{w'}\ (j,p'))]$

$[\![2]\!] = \lambda q\ \exists x\ [\text{place}_w\ (x) \wedge q = \lambda w''\ (\text{in}_{w''}\ (m,x))]$

$[\![3]\!] = \lambda T_{<<s,t>,t>}\ [\![CP1]\!]\ ([\![CP2]\!]\ )$

$\Rightarrow \lambda p\ \exists p'\ [\lambda q\ \exists x\ [\text{place}_w\ (x) \wedge q = \lambda w''(\text{in}_{w''}\ (m,x))]\ (p') \wedge p = \lambda w'\ (\text{think}_{w'}\ (j, p'))]$

$\Rightarrow \lambda p\ \exists p'\ [\exists x\ [\text{place}_w\ (x) \wedge p' = \lambda w''(\text{in}_{w''}\ (m,x))] \wedge p = \lambda w'\ (\text{think}_{w'}\ (j, p'))]$

[11] The absence of syntactic subordination is shown by the impossibility of variable binding across the two questions: *What does everyone$_i$ think? What should he$_{*i}$ do?* Extraction cannot, therefore, apply across these clauses. Additionally, scope marking is possible with co-ordination, which is resistant to extraction. The following, based on Höhle (2000) and discussed in Dayal (2000), is relevant: Ques: *What do you think? When will Mary come and what will she bring?* Ans: *I think she'll come around 10 and bring pasta.*The two questions combine as follows: $\lambda p\ [p = \lambda w\ \exists q \in Q1\ \exists q' \in Q2\ [q(w) \wedge q'(w)]$.

[12] Dayal (1994, 1996) assumes the syntactic structure given here for scope marking generally. Dayal (2000), however, argues for variation in the syntax of scope marking but a uniform semantics cross-linguistically. The structure in (34) applies to English. The intonational contour that clubs the two questions together may be taken as a reflex of the syntactic adjunction of two CPs.

Each question is interpreted as a Hamblin set. There are two points worth noting. First, since *think* takes propositional complements, the first question must quantify over propositions. Second, the variable quantified over has a (covert) restriction, just like individual variables that *what/who* and *which N* bind. We can think of this restriction as the Topic. It follows that if the quantification is over variables of type <*s,t*>, the restriction must be of type <<*s,t*>,*t*>. Nothing special so far, but it paves the way for combining the two questions through standard functional application, as shown in (34b). The net effect is that CP3 only denotes those propositions that John believes and furthermore are in the denotation of CP2. That is, John's beliefs about the weather or about Sue's whereabouts are eliminated from consideration. We have sets such as (35a) for the question in (34a):

(35) a. $\{\underline{\lambda w\ think_w\ (j, \lambda w'\ in_{w'}\ (m,L))}, \lambda w\ think_w\ (j, \lambda w'\ in_{w'}\ (m, P))\}$
b. John thinks Mary is in London.

What is the result if Mary happens to be in Paris in the world of evaluation? It turns out that (35b) is a perfectly legitimate truthful answer to (34a). This can only be if questions denote Hamblin sets (36a), not Karttunen sets (36b):

(36) a. $[\![CP2]\!] = \{\lambda w'\ in_{w'}\ (m,L), \underline{\lambda w'\ in_{w'}\ (m, P)}\}$
b. $[\![CP2]\!] = \{\underline{\lambda w'\ in_{w'}\ (m, P)}\}$

But what about Karttunen's original motivation for enforcing truth inside the question denotation? Dayal's solution (Dayal 1994: 163) is to disassociate the truth requirement from the question denotation and move it to the answerhood operator in (37a). We get Hamblin sets at the CP level and Karttunen sets when a CP is directly embedded under a predicate or when a CP is a matrix question. The crucial distinctions are shown for scope marking (37b) and embedded questions (37c):

(37) a. $\text{Ans-D}_{\text{PRELIM}}\ (Q) = \lambda w\ \lambda p\ [p_w \wedge p \in Q]$ *to be revised in (48a)*
b. $\text{Ans-D}_{\text{PRELIM}}\ ([\![[_{CP3}$ what does John think? Where is Mary?$]]\!])$
$\Rightarrow \text{Ans-D}_{\text{PRELIM}}\ (\lambda p\ [\exists q \in \{\lambda w'\ in_{w'}\ (m,L), \underline{\lambda w'\ in_{w'}\ (m,P)}\} \wedge$
$p = think_w\ (j,q)])$
$\Rightarrow \text{Ans-D}_{\text{PRELIM}}\ (\{\underline{\lambda w\ think_w\ (j, \lambda w'\ in_{w'}\ (m,L))},$
$\lambda w\ think_w\ (j, \lambda w'\ in_{w'}\ (m, P))\})$
$\Rightarrow \lambda w\ think_w\ (j, \lambda w'\ in_{w'}\ (m,L))$
c. John knew/told Bill where Mary is.
$= \lambda w\ knew_w\ /\ told_w\ (j, b, (\text{Ans-D}_{\text{PRELIM}}\ [\![$where Mary is$]\!]))$
$\Rightarrow \lambda w\ knew_w\ /\ told_w\ (j, b, (\text{Ans-D}_{\text{PRELIM}}\ (\{\lambda w'\ in_{w'}\ (m,L), \underline{\lambda w'\ in_{w'}\ (m, P)}\})))$
$\Rightarrow \lambda w\ knew_w\ /\ told_w\ (j, b, \lambda w'\ in_{w'}\ (m, P))$

What $\text{Ans-D}_{\text{PRELIM}}$ does is to sift out those propositions from the Hamblin set that are true at the world of evaluation to yield Karttunen sets. Since scope marking structures do not involve direct embedding of CP2 under the matrix predicate, Ans-D_{PRELIM} does not come into play in its interpretation. It only applies at the matrix level. This captures the fact that truth with respect to John's beliefs matters but not with respect to Mary's location. When the same question is embedded under extensional verbs, as in (37c), Ans-D_{PRELIM} requires truth with respect to Mary's location.[13]

An unsatisfactory aspect of Ans-D_{PRELIM} is that it still requires a shift from sets of propositions to propositions in embedded contexts. This will be addressed in revising Ans-D_{PRELIM} in Section 2.3. For now, focusing on the truth requirement, we note that it is quite easy to import the effect of Heim's solution to the exhaustiveness problem:

(38) a. $\text{Ans}_1\text{-D}_{PRELIM}\ (Q) = \lambda w \cap [\lambda p\ [p_w \wedge p \in Q]]$
b. $\text{Ans}_2\text{-D/H}_{PRELIM}\ (Q) = \lambda w\ \lambda w'[\text{Ans}_1\text{-D}\ (w)\ (Q) = \text{Ans}_1\text{-D}\ (w')\ (Q)]$

These versions of Ans-D_{PRELIM} apply to Hamblin sets and derive weakly/strongly exhaustive Karttunen sets, respectively.

2.2.3 *Beyond truth*

Another advantage of separating the truth requirement from question denotations is that it allows different embedding predicates to encode different relations to their internal argument. Although Karttunen listed a number of embedding predicates that do not show veridicality with embedded questions, he was influenced by non-factive predicates like *tell/indicate* that become veridical when they embed wh questions. From that perspective, the conclusion that the locus of veridicality is the question denotation seemed plausible enough. But as Lahiri (1991, 2000, 2002a) has discussed at length, other predicates like *be certain/agree on* do not show discernible veridicality:

(39) a. John is certain who was at the party.
b. John and Mary agree who was at the party.

Neither (39a) nor (39b) entails that if Bill and Sue were at the party John should be certain about their presence or that he and Mary should agree about their presence. To accommodate such facts, Lahiri takes a proposition *p* as an answer to a question *Q*, iff it is in the Hamblin set denoted by the question and in the set of propositions *C* (Lahiri 2002a: 99–100):

(40) a. $\text{Ans}(p, Q) = C(p) \wedge Q(p)$
b. $\forall x\ [x \text{ is the agent of V-ing} \rightarrow C \subseteq \lambda p[\text{consider-likely}_w\ /\text{possible}_w\ (x,p)]])$ (*be certain*)
c. $C \subseteq \lambda p[p_w]$ (*tell, communicate, know etc.*)

[13] Dayal (1994) suggests that Ans-D_{PRELIM} is also present when embedded under intensional embedding predicates like *wonder/ask*, as functions from worlds to propositions. See Chapter 4 for scope marking with question embedding verbs and Chapter 5 for a general discussion of embedding.

C is partly determined by the lexical semantics of the embedding predicate, which can impose specific requirements based on its presuppositions (cf. 40b). The truth requirement is a default option for predicates that do not have relevant lexical presuppositions (cf. 40c).

The notion of a default, then, is a way of navigating between Hamblin and Karttunen denotations for direct questions and for some indirect questions as well. A point that is obvious enough, but still bears emphasizing, is that some restriction on the Hamblin set is required to ensure that question–answer paradigms vary across worlds.[14] Such variation is essential to deriving the distinction between interrogatives as speech acts of questioning and declaratives as speech acts of assertion.

We have seen arguments here for repackaging the Hamblin and Karttunen approaches to questions. We have Hamblin sets as question denotations across the board, moving the truth requirement into an answerhood operator. To incorporate Lahiri's insight, we would replace p_w in Ans-D_{PRELIM} with $C(p)$, with C as in (40b)–(40c). Making the truth requirement a default for a contextually parameterized restriction, we create the flexibility that different question embedding predicates require. Obviously, this flexibility is not there in Karttunen, which builds the restriction to truth into the proto-question rule, nor is it there in Gr&S, where propositions are anchored to the facts of the world of evaluation. Of course, one could take Karttunen's theory to include the variable C instead of the default truth requirement, as he may have intended it to. Note that such a move would not help with the problem of scope marking discussed in Section 2.2.2 which requires the restriction to be separate from the question denotation.

2.2.4 Section summary

In this section I discussed the developments that allow us to incorporate key insights from three different approaches to questions within a single theory. Taking Hamblin sets as question denotations and building into a separate answerhood operator a contextual restriction with a default setting for the truth requirement, we capture the variation in inferences licensed by different embedding predicates. Having a basic answerhood operator that delivers weak exhaustiveness and defining another operator that picks out worlds where the answerhood operator gives the same value, we derive strong exhaustiveness.[15] Finally, interpreting the common noun inside the question nucleus and allowing for flexibility in the binding of its world variable we capture the *de dicto/de re* ambiguity in embedded contexts.

[14] Keeping a fixed domain of quantification, a Hamblin denotation remains constant across worlds. If the domain varies, the Hamblin denotation will vary but not in a way that can represent a speaker's ignorance about the nucleus proposition.

[15] Some recent approaches derive Hamblin sets by optionally building in strong exhaustivity within the question nucleus (George 2011 and Nicolae 2013). They also illustrate the general point made here, that it is possible to mix and match various theories in different ways (see Chapter 3 for details).

2.3 Maximality in question–answer paradigms

We will now consider the role of number morphology in interrogative phrases, something that does not feature in the three classics discussed so far in this chapter. We will consider different proposals for importing the semantics of number into the semantics of questions and explore their impact on the relationship between questions and answers. While we will see further support for question denotations as Hamblin sets, the answerhood operator will be revised radically to capture number sensitive inferences.

2.3.1 Number in wh expressions

Dayal (1991a, 1991b, 1996), draws attention to the following paradigm where singular, plural, and mono-morphemic wh expressions differ on the felicity of possible answers:

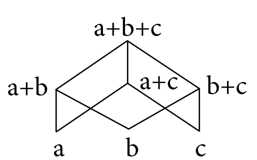
(41) a. Which woman does John like?
b. Which women does John like?
c. Who does John like?

(42) a. John likes Mary.
b. John likes Mary and Sue.

Sentence (41a) can be felicitously answered only by (42a), which names a single woman, while (41b) can be answered only by (42b), which names a plurality of women. Sentence (41c) can be answered by either (42a) or (42b). These data establish that the analyses of questions and number must intersect. Intuitively, it is easy enough to describe what is at issue. The choice between a singular and a plural wh reflects the expectations of the speaker regarding the number of individuals who should be named in the answer. In the case of a mono-morphemic wh phrase, with no discernible number specification, no such expectation is in evidence. Capturing this fact, however, turns out to be non-trivial.

Dayal adopts the view, due to Sharvy (1980) and Link (1983), and by now widely accepted, that the domain of discourse includes atomic as well as plural individuals. Schematically:

(43)



The domain of individuals is an atomic semi-lattice closed under sum formation, and partially ordered by the individual part-of ($\leq$) relation: $a \leq a + b$ and $a + b \leq a + b + c$. The elements at the bottom are the atoms, those with no proper parts:

there is no x s.t. x ≤ a and x ≠ a. Given this, one can treat singular common nouns as denoting in the atomic domain, and plural common nouns as denoting in the full domain.[16]

Applied to wh expressions, we get an existential quantifier which ranges over atomic individuals for *which* N_{SING}, and an existential quantifier which ranges over atomic and sum individuals for *which* N_{PL}. For mono-morphemic wh expressions, we can either posit a null N, which could be singular or plural, or we can treat them as having a covert restriction which makes no reference to number. These moves, in and of themselves, do not deliver the presuppositions we are interested in, regardless of which theory we adopt, Hamblin, Karttunen, or Gr&S. Let us see why.

Assume three (atomic) women in the domain of discourse, Mary, Sue, and Betty. Then, (41a) will denote the Hamblin set in (44a), and (41b) the one in (44b):

(44) a. $\{\underline{\lambda w\ like_w\ (j,m)}, \underline{\lambda w\ like_w\ (j,s)}, \lambda w\ like_w\ (j,b)\}$
b. $\{\underline{\lambda w\ like_w\ (j,m)}, \lambda w\ like_w\ (j,s), \lambda w\ like_w\ (j,b),$
$\lambda w\ like_w\ (j,m{+}s), \lambda w\ like_w\ (j,m{+}b), \lambda w\ like_w\ (j,s{+}b),$
$\lambda w\ like_w\ (j,m{+}s{+}b)\}$

None of the answerhood operators we have looked at so far say anything about how many propositions in these sets can be true. If John liked Mary and Sue, for example, Ans-D_{PRELIM} when applied to (44a) would yield the answer in (42b) via the set: $\{\lambda w\ like_w\ (j,m), \lambda w\ like_w\ (j,s)\}$. Likewise, if John likes only Mary, Ans-D_{PRELIM} applied to (44b) would yield $\lambda w\ like_w\ (j,m)$, the answer in (42a). Similar problems arise with applying Ans-H_1 to Karttunen sets, which in the situations under discussion would denote subsets of (44a) and (44b) for the singular and the plural cases, respectively. Since both versions of strong answerhood operators build on the weak answerhood operator, the problem is inherited in the strongly exhaustive readings as well. And, as pointed out in Dayal (1991a, 1991b), the original theories of Karttunen and Gr&S face the same challenge. The problem is that, as things stand, the presuppositions about number that underlie our intuitions about felicitous answers to (41) do not play a role in determining the number of true propositions in the question denotation.

2.3.2 Maximality in wh expressions

There have been two attempts to address the problem outlined in Section 2.3.1, one using Karttunen sets, the other using Hamblin sets. I will review both but will settle on the latter, which is also in keeping with the conclusion reached in

[16] The plural domain could be argued not to include atoms (Chierchia 1998) but the consensus seems to have settled in favor of including them and treating the plurality requirement as an implicature (Sauerland 2003; Spector 2007b; Zweig 2009; Chierchia 2010). Note that the plurality implicature does not arise in all contexts. *Do you have children?* is neutral with respect to the number of children expected in the answer (Schwarzschild 1996).

Section 2.2. Dayal (1991a, 1991b) builds uniqueness/maximality presuppositions into Karttunen sets by encoding definiteness into the meaning of wh expressions:

(45) a. Which woman does John like?
b. $\lambda p\ \exists x\ [x = \max y[\text{woman}(y) \wedge \text{like}(j,y)] \wedge p_w \wedge p = \lambda w'\ \text{like}_{w'}\ (j,x)]$

Quantification is over those individuals *x* that maximally satisfy the common noun and the question nucleus, that is, individuals who are not themselves part of any other individual that satisfies these two conditions. Since the number restricts quantification to atomic individuals, the question presupposes that only a single woman is liked by John. The question becomes, in effect, one of establishing her identity. The resulting Karttunen set is a singleton. Assuming that natural language quantification presupposes non-empty quantificational domains, the question is undefined in contexts where more than one individual meets the relevant conditions because the domain of quantification is empty.

For questions with plural wh expressions, the proposition must name a unique maximal individual with that property. This can be an atomic individual or a plural individual. Crucially, though, the choice of a plural over a singular wh expression implicates that the singleton proposition will name a plural individual. Thus even though it is semantically possible for the plural version of (45a) *Which women does John like?* to denote a propositional set naming a single woman, it is ruled out, I suggest, because the question has an existence presupposition with a plurality implicature *John likes some women*. With *who*, instead, no such implicature arises because the expression is neutral with respect to number.[17] Thus the paradigm discussed in Section 2.3.1 is adequately captured. As would be obvious, this account is inspired by accounts of singular vs. plural definite descriptions (Sharvy 1980; Link 1983).

The non-standard part of the proposal is that the question nucleus contributes its meaning in two places. The primary motivation for this in Dayal's account concerns the fact that uniqueness for singular wh expressions is over-ridden in multiple wh questions: *Which man likes which woman?*, a topic taken up in Chapter 4. The results for single constituent questions in (45) can be replicated in the proposal for encoding definiteness in Rullmann (1995). And because multiple constituent questions are not considered there, Rullman's proposal works in a more straightforward way.

Following Jacobson's (1995) suggestions for extending her account of free relatives to questions, Rullmann builds maximality into Karttunen denotations inside the question nucleus. The question in (45a) would be interpreted as in (46a), with quantification restricted to atomic individuals. Its plural counterpart would be interpreted as in (46b), with quantification over atomic and plural individuals. The implicatures associated with number would be captured in a parallel fashion to the one in Dayal (1991a, 1991b):

[17] We will see in Section 3.2 that positing an ambiguity between a silent N_{SING} and a silent N_{PL} will not always yield the right results, so an analysis in which number remains unspecified is to be preferred.

(46) a. $\lambda p\ \exists x\ [\text{woman}(x) \wedge p_w \wedge p = \lambda w'\ [x = \max\ (\lambda y(\text{like}_{w'}\ (j,y)))]]$
b. $\lambda p\ \exists x\ [\text{women}(x) \wedge p_w \wedge p = \lambda w'\ [x = \max\ (\lambda y(\text{like}_{w'}\ (j,y)))]]$

Rullmann's use of maximality in wh expressions is particularly successful in explaining negative island effects, a major focus of his work:

(47) a. How tall is Marcus?
b. *How tall isn't Marcus?

The contrast in (47) follows from the fact that there does not exist a unique maximal degree in the negative extension of Marcus' height but one does exist in its positive extension (see also Chapter 6).

We have seen two very similar ways of interpreting wh expressions as definites, based on Karttunen's theory of questions. Building number sensitivity into the wh phrase is an important piece of the explanation, but something more has to be added to derive the results. And as noted, the list reading of multiple constituent questions introduces further complications. This suggests the need to consider alternative solutions to the problem.

2.3.3 *Maximality and Ans-D*

Section 2.2 pointed out that scope marking constructions argue for Hamblin sets, with a separate answerhood operator for deriving Karttunen-like effects. The challenge of deriving the sensitivity to number morphology in question–answer paradigms using Hamblin sets is taken up in Dayal (1996). While number morphology on wh expressions is still interpreted as explicated in Section 2.3.1, number-based presuppositions are captured by defining the notion of a unique maximally informative answer. Definition (48a) replaces Ans-D_{PRELIM} (Dayal 1996: 116). As before, we adapt Heim's solution for capturing strong exhaustiveness. The operators are notated with subscript W for weak exhaustiveness and subscript S for strong exhaustiveness:

(48) a. $\text{Ans-D}_W\ (Q) = \lambda w\ \iota p[p_w \wedge p \in Q \wedge \forall p'\ [[p'_w \wedge p' \in Q] \rightarrow p \subseteq p']]$
b. $\text{Ans-D/H}_S\ (Q) = \lambda w\ \lambda w'\ [\text{Ans-D}_W\ (Q)(w) = \text{Ans-D}_W\ (Q)(w')]$

Applying (48a) to the singular case yields (49), where each proposition names an atomic individual and none of the propositions entails any other. In any situation where John likes exactly one woman, there will be a unique maximally informative answer. Otherwise, Ans-D_W will be undefined:

(49) a. Which woman does John like?
b. $\lambda p\ \exists x\ [\text{woman}_w\ (x) \wedge p = \lambda w'\ \text{like}_{w'}\ (j,x)]$
$\Rightarrow \{\underline{\lambda w\ \text{like}_w\ (j,m)}, \lambda w\ \text{like}_w\ (j,s), \lambda w\ \text{like}_w\ (j,b)\}$
c. $\text{Ans-D}_W\ (49b) = \lambda w\ \text{like}_w\ (j,m)$

The plural counterpart in (50) has quantification over singular and plural individuals:

(50) a. Which women does John like?

b. $\lambda p\ \exists x\ [\text{women}_w\ (x) \wedge p_w = \lambda w'\ \text{like}_{w'}\ (j,x)]$

$$\begin{array}{lll} \Rightarrow\{\underline{\lambda w\ \text{like}_w\ (j,m)}, & \lambda w\ \text{like}_w\ (j,s), & \underline{\lambda w\ \text{like}_w\ (j,b)}, \\ \ \ \underline{\lambda w\ \text{like}_w\ (j,m+b)}, & \lambda w\ \text{like}_w\ (j,m+s), & \lambda w\ \text{like}_w\ (j,b+s), \\ & \lambda w\ \text{like}_w\ (j,m+b+s)\} & \end{array}$$

c. $\text{Ans-D}_W\ (50b) = \lambda w\ \text{like}_w\ (j,m+b)$

If the situation has John liking Mary and Betty, there will be three true propositions in the question denotation, but only one of them will entail the other two. This is the one that Ans-D_W picks out. I assume, as before, that there is an existential presupposition behind the question, which is sensitive to the number on the wh: *John likes some women*. This captures the intuition that an answer naming a single individual is infelicitous.[18] If the wh expression is monomorphemic, the existential presupposition will be neutral in this regard, allowing the maximally informative answer to name an atomic or a plural individual. The shape of the explanation, once again, is exactly what we are familiar with from analyses of definite descriptions, this time framed within the Hamblin–Karttunen blend of theories.

Bittner (1998) points out an added advantage of this approach. Karttunen (1977: 12) observed that constituent and polar questions do not combine well:[19]

(51) a. *?Does John like which woman/women?

b. $$\begin{array}{ll} \{\underline{\lambda w\ \text{like}_w\ (j,m)}, & \lambda w\ \neg\ \text{like}_w\ (j,m) \\ \ \ \lambda w\ \text{like}_w\ (j,s), & \underline{\lambda w\ \neg\ \text{like}_w\ (j,s)}\} \end{array}$$

c. $$\begin{array}{ll} \{\lambda w\ \text{like}_w\ \underline{(j,m)}, & \underline{\lambda w\ \neg\ \text{like}_w\ (j,m)}, \\ \ \ \lambda w\ \text{like}_w\ (j,s), & \underline{\lambda w\ \neg\ \text{like}_w\ (j,s)}, \\ \ \ \lambda w\ \text{like}_w\ (j,m+s), & \underline{\lambda w\ \neg\ \text{like}_w\ (j,m+s)}\} \end{array}$$

Assume that there are exactly two women in the domain of discourse, Mary and Sue. With a singular wh expression and the domain restricted to atomic individuals, it is clear that there will be no maximally informative answer. For every individual, either the nucleus proposition or its complement will be true and there will be no unique proposition that entails the other. Bittner does not consider the plural case but the situation does not greatly improve. In (51c), for example, the proposition $\lambda w\ \neg like_w\ (j, m+s)$ will be true since John does not like Sue, but it does not entail the two true propositions: $\lambda w\ like_w\ (j, m)$ and $\lambda w\ \neg like_w\ (j,s)$. Ans-D_W (51c) is therefore undefined. $\text{Ans-D}_W\ (Q_{PL})$ will be defined only in situations where the nucleus holds positively for all the individuals in the domain. Since it is

[18] Thanks to Mingming Liu for raising this issue and forcing me to clarify my assumptions.

[19] See Chapter 1, fn 15, on how these denotations would be derived.

not defined for the general case, polar questions with wh expressions are deemed unanswerable, therefore deviant.

It is worth comparing the account above to a closely related, but ultimately distinct, proposal. Beck and Rullmann (1999) also start with Hamblin sets and have answerhood operators pick out maximally informative propositions. Adapting Heim's proposal, they define the following operators to capture weak and strong exhaustiveness (Beck and Rullmann 1999: 259, 268):

(52) a. $\text{Ans-BR}_1(w)(Q) = \cap\{p: Q(w)(p) \wedge p(w)\}$
b. $\text{Ans-BR}_2(w)(Q) = \lambda w' \ [\text{Ans-BR}_1(w')(Q) = \text{Ans-BR}_1(w)(Q)]$

Beck and Rullmann's starting point is the paradigm in (53), where upward scalar predicates like *be sufficient* call for the minimum number to be specified, while downward scalar predicates like *leave* call for the maximum number to be specified:

(53) a. How many eggs are sufficient to bake this cake?
b. {^one egg is sufficient, ^<u>two eggs are sufficient</u>, ^<u>three eggs are sufficient</u>...}
c. How many people left?
d. {^<u>one person left</u>, ^<u>two persons left</u>, ^<u>three persons left</u>...}

In a situation where two eggs are sufficient, it holds that for any *n* greater than two, *n*-many eggs are sufficient. In a situation in which three people left, it holds true for any *n* less than three, that *n*-many people left. By intersecting the true propositions, we get the proposition that entails all others.

Beck and Rullmann characterize their proposal as compatible with Dayal (1996) but there are crucial differences. Most significant is that they set aside the semantics of number morphology and do not build maximality into the definition of an answer. Example (52a) takes the subset of true propositions in a Hamblin denotation and intersects them. Consider a question with a wh expression over individuals, not degrees. With no lexically based entailment relations to appeal to, (52) fails in the same way as the earlier accounts discussed in Section 2.3.1 failed. If John likes Mary and Sue, regardless of whether the question *Which woman/women does John like?* has a singular wh expression or not, (52) will give us the proposition $\lambda w \ like_w(j, m+s)$. Similarly, if he likes only Mary it will give us the proposition $\lambda w \ like_w(j,m)$ even if the question uses a plural wh expression.

The need for combining maximality in the answerhood operator with a semantics for number in the interpretation of wh expressions is also seen in the following contrast:

(54) a. John knew only one answer to the question which Dutch Olympic athletes won a medal.
b. #John knew only one answer to the question which Dutch Olympic athlete won a medal.

Beck and Rullmann present (54a) as support for the view, originally suggested in Heim (1994), that Ans-H_1 is the lexical meaning of the common noun *answer*. The fact that it can combine with an indefinite determiner is argued by them to establish the reality of *mention-some* answers. They do not consider examples like (54b), however, which has a singular wh in the embedded question and is infelicitous. Chapter 3 will explore *mention-some answers*, but the relevant point here is that the shift from a plural to a singular term affects acceptability.[20] Once again, the vital connection between number morphology and felicity of answers is missed. Certainly, one could build number sensitivity into their account, but that would be tantamount to the proposal in Dayal (1996).

Let me mention two other phenomena where number specification on the wh plays a role, emphasizing that my goal in doing so is simply to show that number matters. The particular analyses for these paradigms will be discussed in Chapters 4 and 7. Examples (55a)–(55b) show that questions with universal quantifiers and definite plurals allow answers of the kind given in (55c), pairing men with women. Dayal (1992, 1996) and Krifka (1992) point out that the parallelism between universals and definite plurals breaks down when we replace *who* with a singular wh *which woman*. An answer to (55a) with *which woman* can still pair each man with a woman but the same does not hold for (55b) with *which woman*:

(55) a. Who does every man love?
b. Who do these men love?
c. Bill loves Mary and John loves Sue.

The second data set, (56a)–(56b), shows a similar sensitivity to number:

(56) a. Who knows where Mary bought which book?
b. Who knows where Mary bought these books?
c. Bill knows where Mary bought *Emma* and John knows where she bought *Persuasion*.

Baker (1968) argues that the possibility of answers specifying values for the matrix wh and the embedded wh in-situ (56c) shows that the wh in-situ has matrix scope. Kuno and Robinson (1972) point out that the structurally similar example (56b) also allows (56c) but is unlikely to involve matrix scope for the plural definite. Setting aside the implications for scope for now, we note an observation from Dayal (1996). Replacement of the matrix wh with singular *which student* does not affect the possibility of a pair-list answer for (56a) but it does for (56b). The significance of these facts in the present context is that they show the pervasive nature of number-based effects and argue for an answerhood operator like Ans-D that, in conjunction with the appropriate semantics for the wh phrase, delivers number sensitivity.

[20] See also Preuss (2001) for a more detailed discussion of Beck and Rullmann's proposal.

2.3.4 Existential presupposition and Ans-D

We have seen ample evidence that a constituent question with a singular wh expression is infelicitous in contexts where uniqueness is not satisfied. We will now examine the status of constituent questions in contexts where existence fails. Question–answer paradigms like (57a) are fully acceptable. This raises questions about the use of the *iota* operator in Ans-D, which would be undefined in such contexts:

(57) a. Speaker A: Who left the party?
Speaker B: No one.
b. #I'm not sure whether Mary likes any student. Which student does she like?

But the anomaly of (57b), from Karttunen and Peters (1976: 355), points to the reality of the existential commitment (see also Katz 1972; Keenan and Hull 1973; Comorovski 1989, 1996; Dayal 1991a, 1991b, 1996).[21] These data establish that existence can only ever be denied in cross-speaker exchanges. It is, of course, possible for a speaker to ask a question while overtly suspending the existential presupposition, as noted in Horn (1972):

(58) a. I'm not sure if anyone left the party but I'd like to know who, if anyone, did.
b. Who, if anyone, does Mary like?

Questions with clefts are interesting in this connection because they do not brook negative responses nor do they allow the speaker to suspend the existential commitment:

(59) a. Who was it that left the party?
#No one.
b. *Who, if anyone, was it that left the party.

As far as I know, this distinction between clefted and regular questions has not been investigated at any length.[22]

The status of the existence commitment in questions and the status of the existence commitment in clefted assertions have, however, been analyzed recently by Abusch (2010). She establishes that existence is a soft presupposition that can be canceled in the former, but it is a hard presupposition which cannot be canceled in the latter (see also Romoli 2013). In asking a question,

[21] Karttunen (1977: 20, fn 13) recognizes that the existential presupposition is not captured in his theory. It is also not built into Comorovski's (1989, 1996) assumptions about questions and answers.

[22] It is reported that many languages have obligatorily clefted questions but my preliminary and rather perfunctory investigations have not established that they are like English clefted questions in this regard.

we can assume that the speaker takes it to be answerable. That is, she expects Ans-D to be defined. The ordinary question has a soft presupposition about a positive answer to a prior polar question, making it, for all practical purposes, the conditional question: *Assuming that someone left, who did?* The hard presupposition of the cleft projects to its interrogative counterpart: *Someone left. Who did?* Schematically:

(60) a. Who left? Presupposes: $\mathrm{I}_{\text{SPEAKER}}$ assume that someone left.
b. Who is it that left? Presupposes: $\mathrm{We}_{\text{SPEAKER+HEARER}}$ believe that someone left.

The distinction between the existence commitments of clefted and regular questions bears further investigation, of course, but the possibility of distinguishing them on the basis of soft and hard presupposition triggers is promising.

Let me end with a more general point. Answers denying the existential commitment behind the question should be carefully assessed in determining their import for the semantics of questions. For example, revisiting the inference pattern Gr&S (1982) present to argue for strong exhaustiveness, we arrive at a more nuanced picture:

(61) a. John knows who left the party.
<u>No one left the party.</u>
John knows that no one left the party.
b. #No one left so John knows who did/left.

While (61a) seems valid enough, it does not prepare us for the fact that (61b) is anomalous. The only difference between the two is that (61b) makes the connection between the question and the lack of existential commitment in the same sentence, that is, by one individual, the speaker.

2.3.5 Section summary

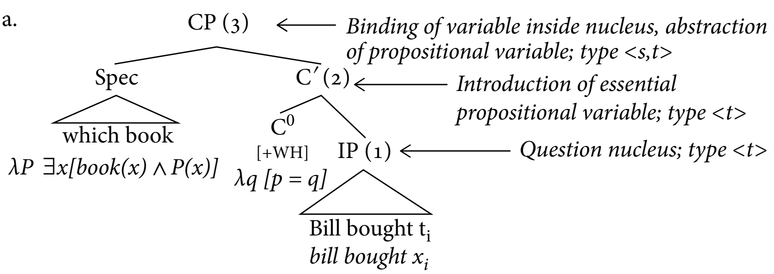
Importing the semantics of number into the denotation of questions is not a controversial move but most researchers have set it aside, taking the view that it is orthogonal to the issues they are concerned with. The result of such an omission, we saw, is not always benign since number-based effects are pervasive in question–answer paradigms. We reviewed two proposals to capture number sensitivity. We settled on the one framed within Hamblin's theory since Hamblin denotations were seen in Section 2.2 to provide greater empirical coverage. Uniqueness/maximality at the propositional level, encoded in the answerhood operator Ans-D, as well as the standard semantics of number for wh phrases are both needed to capture the facts. The existential presupposition, also encoded in Ans-D, was discussed in relation to differences between regular and clefted questions and was shown to be an integral part of the meaning of questions.

2.4 The baseline theory

In this concluding section I will pull together the conclusions reached in previous sections, without repeating the arguments for those conclusions or noting alternatives that have been proposed. The idea is to provide an account that is explicit enough to be used as a launching pad for the discussions to follow in the rest of the book.

We begin by recalling the analysis of questions given in Section 1.2:

(62) a.



$[\![2]\!] = \lambda q\ [p = q]\ ({}^\wedge\text{bought(Bill}, x_i))$ *Intensional Functional Application*

$[\![3]\!] = \lambda P\ \exists x\ [\text{book}(x) \wedge P(x)](\lambda x_i[p = {}^\wedge\text{bought(Bill}, x_i)])$ *Functional Application*

$\Rightarrow \exists x[\text{book}(x)\ \wedge \lambda x_i[p = {}^\wedge\text{bought(Bill}, x_i)](x)]$ *λ-conversion*

$\Rightarrow \exists x[\text{book}(x)\ \wedge [p = {}^\wedge\text{bought(Bill}, x)]$ *λ-conversion*

$\Rightarrow\ \lambda p \exists x\ [\text{book}(x) \wedge p = {}^\wedge\text{bought(Bill}, x)]$ *Abstraction over p*

b. {^Bill bought Emma, ^Bill bought Persuasion}

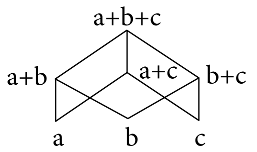
c. Set of Individuals = {b, j, b+j} Set of objects = {E, P, E+P}

We now know the sense in which this is a blend of the Hamblin–Karttunen analyses of questions. The mapping from syntax to semantics, following the lead of Heim (1989), Bittner (1994, 1998) and von Stechow (1996), is closely modeled after Karttunen. C^0 is the point in the structure where the question nucleus is determined and the shift to interrogative meaning effected. The wh phrase is interpreted as an existential quantifier binding a variable from outside C^0 into a position inside the nucleus.[23] Based on arguments in Dayal (1996), it removes reference to truth from the conditions placed on propositions, resulting in the kind of Hamblin sets seen in (62b).

An addition to this system is the interpretation of number in the wh phrase. Following Dayal (1991a, 1991b), we adopt the ontology of individuals from Sharvy (1980) and Link (1983): singular terms denote in the atomic domain while plural terms denote atomic and plural individuals. This gives rise to different Hamblin sets for singular, plural, and neutral wh terms:

[23] For recent developments in the syntax–semantics mapping for questions, see Fox (2012) and its presentation in Nicolae (2013).

(63) a.



b. {^Bill saw a, ^Bill saw b, ^Bill saw c} *for which N_{SING}, for what/who*

c. {^Bill saw a, ^Bill saw b, ^Bill saw c,
^Bill saw a+b, ^Bill saw b+c, ^Bill saw a+c,
^Bill saw a+b+c} *for which N_{PLURAL}, for what/who*

We also adopt from Dayal (1996) the answerhood operator in (64a), and incorporate into it Heim's (1994) proposal for a second answerhood operator, in (64b). These operators introduce Karttunen's truth requirement. They are defined to apply to Hamblin sets and, when defined, to pick out a unique maximally informative true proposition from that set:

(64) a. $\text{Ans-D}_W\ (Q) = \lambda w\ \iota p[p_w \wedge p \in Q \wedge \forall p'\ [[p'_w \wedge p' \in Q] \rightarrow p \subseteq p']]$

b. $\text{Ans-D/H}_S\ (Q) = \lambda w\ \lambda w'[\text{Ans-D}_W(Q)(w) = \text{Ans-D}_W(Q)(w')]$

The first operator captures weak exhaustiveness: knowing or telling a question, for example, merely requires the attitude holder to bear the relevant relation to the true propositions in the question denotation but says nothing about their relation to the false ones. The second operator captures strong exhaustiveness which requires the attitude holder to distinguish between the true and the false propositions in the set. For now, we remain neutral on whether both answerhood operators are needed in the grammar, noting only the flexibility afforded by the two operators.

The combination of questions as Hamblin sets, wh phrases restricted by the semantics of number, and answerhood operators, gives us the following question–answer paradigms. Assume a situation where Bill saw Alice but not Betty or Cal for (65), and a situation where Bill saw Alice and Betty but not Cal for (66):

(65) a. Which woman/who did Bill see?
b. Ans-D_W (63b): Bill saw Alice.
c. Ans-D/H_S (63b) = Bill saw only Alice

(66) a. Which women/who did Bill see?
b. Ans-D_W (63c): Bill saw Alice and Betty.
c. Ans-D/H_S (63c) = Bill saw only Alice and Betty.

If Bill saw no one or more than one woman, (65a) with a singular wh, is infelicitous because Ans-D is undefined. If Bill saw no one or only one woman, (66a) with the plural wh, is infelicitous. The source of the infelicity is different in the two cases. If he saw no one, Ans-D is undefined. If he saw only one woman, however, Ans-D is defined but the implicature of plurality that stems from the presupposition behind the question is not satisfied. As a consequence of the theory adopted here, the response *no one* is not a direct answer to the question and must be handled separately.

We also noted differences between ordinary and clefted questions and the possibility of differentiating them on the basis of soft vs. hard presupposition triggers, following Abusch (2010). A constituent question has a soft presupposition: (*Assuming that someone left*), *who left?* The clefted question has a hard presupposition: *(Someone left*), *who was it that left?*

Turning to embedded contexts, we followed Lahiri (1991, 2000, 2002a) in allowing answerhood operators to include other types of restrictions based on the lexical semantics of the embedding verb, while keeping the truth requirement as a default. We followed Beck and Rullmann (1999) and Sharvit (2002) in deriving the difference between *de dicto* and *de re* readings of wh phrases by interpreting the common noun inside the question nucleus and allowing its world variable to be bound within the nucleus, yielding *de dicto* readings, or to remain free and be identified with the world of evaluation, yielding *de re* readings. In the first case, the attitude holder recognizes the membership of the relevant individuals in the common noun predicate, in the second the attitude holder need not have this knowledge.

Examples (65) and (66) show that answerhood operators mediate between question–answer dialogues across speakers. They also mediate in embedded contexts such as the one in (67a). Since *know* is extensional, we get a relation between individuals and propositions (67b):

(67) a. [John knows [where Mary is]]
b. $\text{know}_w\ (j, \lambda w'\ \iota p(p_{w'} \wedge p \in Q \wedge \forall p'\ [[p'_{w'} \wedge p' \in Q] \rightarrow p \subseteq p'])\ (w))$
$\Rightarrow \text{know}_w\ (j, \iota p(p_w \wedge p \in Q \wedge \forall p'\ [[p'_w \wedge p' \in Q] \rightarrow p \subseteq p']))$

We have not addressed the precise status of these operators. The following possibilities suggest themselves (thanks to Gennaro Chierchia, p.c. for discussion):

(68) a. $\text{know}(x,Q) \leftrightarrow \text{know}\ (x, \text{Ans-D}(Q))$ *via a Meaning Postulate*
b. $[\![\text{know}_Q]\!] = \lambda Q\ \lambda x\ [\text{know}\ (x, \text{Ans-D}(Q))]$ *via lexically triggered type-shift*
c. $[\text{know}\ [\text{OP}_{\text{ANS}}\ [_{\text{CP}} \ldots]]]$ *via a syntactically projected null OP*

We know we want a dependency between the presuppositions of the embedding predicate and the restrictions encoded in the answerhood operator. At this point, all three options appear plausible enough ways of capturing this dependency.

Let us end with two contexts where answerhood operators do not play a role. We saw that in scope marking constructions the second question must contribute pure Hamblin sets, without the mediation of Ans-D. The schema in (69a) has Ans-D associating with the Hamblin set denoted by the full structure, but not with the set denoted by CP2:

(69) a. $^{\text{OK}}$Ans-D(CP3) *Ans-D(CP2)
$[_{\text{CP3}}\ [_{\text{CP1}}$what does John think?] $[_{\text{CP2}}$Where is Mary?]]]
b. $[_{\text{VP}}$ wonder/ask (?Ans-D) $[_{\text{CP}}$ where is Mary]]

We might also ask whether Ans-D is implicated in the case of predicates like *wonder* or *ask* that exclusively embed questions rather than questions and propositions (69b). It may well not come into play in such cases, thereby allowing the relation to hold directly with the Hamblin set denoted by the question. Alternatively, such predicates may also involve Ans-D but the predicates would not license the shift from a propositional concept to a proposition. This would maintain the distinction between intensional and extensional predicates going back to Karttunen, but would replicate Gr&S's (1982) distinction between type $<<s,<s,t>>,<e,t>>$ for intensional predicates and type $<<s,t>,<e,t>>$ for extensional ones.

This, then, is a snapshot of where we are at this point in the study of questions. If you have thought about questions at all you will most likely balk at the somewhat monolithic feel of this concluding section. But hopefully it will not stop you from reading on. If you haven't thought much about questions, consider this one possible take on a complex aspect of natural language, one that has been subjected to forty years of formal analysis. The picture presented here should help you get started on some of the rich history that will unfold in the pages to come.

3

Exhaustive and non-exhaustive answers

We have emphasized that our access to the meaning of questions is through possible answers. And while we have intuitions about the (in)appropriateness of question–answer paradigms, our theoretical conclusions are shaped by our assessment of what counts as a direct answer. A response classified as a direct answer reflects a reading of the question but not one classified as a conversationally relevant indirect answer. Here we consider (non)-exhaustiveness in answers to determine what they may say about the meaning or meanings of questions. Three types of answers are analyzed from this perspective: weakly exhaustive, strongly exhaustive, and non-exhaustive answers. The terms *non-exhaustive answers* and *mention-some answers* are used interchangeably, as are the terms *exhaustive answers* and *mention-all answers*.

Bearing a relation to a question, or answering a direct question, requires the relevant relation to hold with each of the true propositions in the set of propositions denoted by the question. Weak exhaustiveness is satisfied with this, but strong exhaustiveness requires the false propositions to be excluded. Does the weak–strong distinction need to be hard-wired into the semantics or is it possible to posit one kind of exhaustiveness and derive the other from it? One approach takes the variation to be encoded in answerhood operators, another takes it to be part of the question nucleus. Choosing between them brings into the discussion the broader context of conversational dynamics.

The significance of conversational dynamics increases as we turn to non-exhaustive answers. Are questions ambiguous between *mention-some* and *mention-all* readings, with different contexts or grammatical features making different readings salient? Alternatively, do they only have *mention-all* readings, though partial answers are sufficient in contexts where they satisfy conversational goals? We consider the empirical balance between semantic and pragmatic factors and the possibility that there may be more than one type of *mention-some* answer that natural language countenances.

We also consider exhaustiveness from the perspective of embedding predicates. There are predicates that seem to select exclusively for strong exhaustiveness, those that select for both strong and weak exhaustiveness, and those that select only for weak/non-exhaustiveness. Negative polarity items provide an important window into the grammatical status of these divides. Data regarding the licensing of negative polarity items in questions is also probed.

A point worth noting before we begin. A question can be posed to a single addressee who is expected to provide a satisfactory answer or it can be posed to a group, with individual responses adding up to a satisfactory answer.[1] We follow the literature in focusing on the former. With suitable adjustments, the discussion applies also to the latter.

3.1 The weak–strong distinction in exhaustive answers

This section discusses arguments against weak exhaustiveness in embedded as well as direct questions, saving discussion of arguments in favor of weak exhaustiveness for Section 3.3. Weak exhaustiveness is shown to hold its own in embedded contexts, when differences between the agent's and the speaker's attitudes are taken into account. Insights gained from embedded contexts are then applied to direct question contexts, taking due note of discourse dynamics. This section also engages with the formal representation of this distinction and presents a way of capturing the facts, using the answerhood operators from Chapter 2. Some recent proposals building strong exhaustiveness into the question nucleus are reviewed as well.

3.1.1 The agent, the speaker, and the question under embedding

Let us recall Groenendijk and Stokhof's (1982) argument for strong exhaustiveness (Section 2.1.4):

(1) Situation: John believes that Bill and Suzy walk
 a. John knows who walks.
 b. {^ <u>bill walks</u>, ^suzy walks, ^bill+suzy walk}

Incorporating plural individuals for completeness, the embedded question in (1a) denotes the Hamblin set in (1b). If the underlined proposition is the only true one in the world of evaluation, for John to be in the *know* relation to the embedded question in (1a) requires him to know that Bill walks and Suzy does not. Speakers judge (1a) to be false in the situation under discussion. This means that John's attitude towards the false propositions in the question denotation is relevant to the truth of (1a), not just his attitude towards the true ones. Let us probe this further.

Stepping back, note that there are four factors at play in cases like (1a): a speaker, an agent, the facts of the world, and the properties of the embedding predicate. All of them have an impact on our intuitions about exhaustiveness.

[1] Thanks to Matt Barros (p.c.) for pointing this out.

Focusing on the first three here, consider (2a) and (2b) with a slightly richer cast of characters:

(2) a. Bill told Sue who danced at the party.
 b. Bill knows who danced at the party.
 c. {^john danced at the party, ^mary danced at the party, ^harry danced at the party . . . .^john+mary+harry danced at the party}
 d. John danced at the party.

Chapter 2 established that both the non-factive *tell* and the factive *know* impose veridicality on their interrogative complements. Thus if John was the only person who danced, then of the propositions in the Hamblin set (2c), the proposition uttered by Bill to Sue and/or the proposition that Bill believes (and hence knows) is the one given in answer (2d). But who has knowledge of the relation between proposition (2d) and the fact that this proposition is the answer to the embedded question? There are exactly three possibilities.

The first possibility is that in making the reports in (2a)–(2b), the speaker is not privy to the fact that (2d) is the answer to the embedded question. This is shown by the following felicitous continuations. Here, the speaker's knowledge is incomplete and it is the agent who knows the facts of the matter:

(3) a. Bill knows/told Sue who danced at the party but he didn't tell me.
 b. Bill knows/told Sue who danced at the party but I don't know who did.

The same report is also possible when it is the speaker who knows the facts of the matter, while the agent's knowledge is incomplete. Suppose Bill utters (2d) to Sue or gives evidence of believing this fact, but he has not given any thought to whether anyone else danced. If the speaker knows that John is the only one who danced, she can assert (2a)–(2b) truthfully even though if Bill were asked the question *Did you tell Sue?/Do you know who danced at the party?* he might declare only knowing a partial answer *all I told her/all I know is that John danced.* This is reflected in the following:

(4) a. Bill told Sue who danced at the party but he doesn't know that he did that.
 b. Bill knows who danced at the party. He just doesn't know that he knows it.

So we see that (2a)–(2b) can be used as long as either the speaker or the agent is aware that (2d) is the exhaustive answer to the embedded question. The third option, of course, is that both the speaker and the agent are in the know. Statements (2a)–(2b) cannot be used if neither the agent nor the speaker is aware of this connection, even if both happen to know the fact reported in (2d). One way to think about this, then, is to take the interrogative to be a description of the set of propositions to which an attitude holder is related. The interpretation of an embedded interrogative must make reference to the link between the intensional object (the answerhood operator applied to a question denotation) and its identity with a particular proposition. The ambiguity can be represented as in (5a)–(5b). The definition of the answerhood operator from Chapter 2 is repeated in (5c):[2]

(5) a. know_w (b, λw [identical_w ([$\mathbf{Ans\text{-}D_W}$ $\mathbf{(Q)(w)}$], λw [danced_w (j)])])
b. know_w (b, λw [danced_w (j)])
∧ know_w (speaker, λw [identical_w ([$\mathbf{Ans\text{-}D_W}$ $\mathbf{(Q)(w)}$], λw [danced_w (j)])])
c. $\text{Ans-D}_W\ (Q) = \lambda w\ \iota p\ [p_w \wedge p \in Q \wedge \forall p'\ [[p'_w \wedge p' \in Q] \rightarrow p \subseteq p']]$

The extension of $\text{Ans-D}_W(Q)$ at the world of evaluation, the maximally informative true proposition in Q, is the description denoted by the embedded interrogative and this description is identified with a particular proposition. Assuming that the identification actually holds, whether the agent or the speaker identifies the description with the true proposition is crucial to judgments involving embedded questions.

Let us apply this to the inference pattern in (1). An illustration helps:

(6) a.

w1: b walks	**w2:** b walks
w3: s walks	**w4:** b+s walk

b. Ans-D_W (who walks)(w2): λw [walk_w(b)] = {w1, w2, w4}
c. The proposition that John believes: λw [walk_w(b+s)] = {w4}

Given this state of affairs, the agent's identification of *Ans-D_W (who walks)(w2)* with *λw [walk_w(b+s)]*, as in the logical form (5a), fails because *know* is factive.[3] It also fails under a construal like (5b), where the reader/speaker in the role of the omniscient third party makes that identification, because the facts do not line up. We correctly predict the inference pattern in (1).

Locating a potential ambiguity between the agent and the speaker as the bearer of the link, as I have done here, might help explain a refinement of Gr&S's paradigm due to Spector (2005), recently discussed by George (2011). George argues that neither weak nor strong exhaustiveness quite explains the set of facts presented in (7). Assume a domain with Mary and Alice and a situation in which only Mary left the party:[4]

[2] The second clause of (5b), attributing identification of $\text{ANS-D}_W(Q)$ at *w* with the specific proposition to the speaker, would probably be better characterized as a presupposition rather than part of the at-issue content.

[3] The identity would, of course, hold in John's belief worlds but that is not what is at issue here.

[4] A version of this scenario is briefly mentioned by Gr&S. I have characterized the situation a bit differently from George (2011: 127–37). The discussion here is based on George (2011) but see also George (2013a, 2013b).

(7) a.

	Mary	Alice
Bill's beliefs	Y	N
John's beliefs	Y	Y
Sue's beliefs	Y	?
The facts	Y	N

Reported Judgments

b. Bill knows who left. *True*
c. John knows who left. *False*
d. Sue knows who left. *Not quite true but not false either.*

Bill, John and Sue have different beliefs about the world. They all correctly believe, hence *know-weakly*, that Mary left. Bill is the model know-all citizen who *knows-strongly* that only Mary left. There is no doubt that (7b) will be judged true, and uncontroversially so. John, on the other hand, erroneously believes of Alice that she left. There is no doubt that (7c) will be judged false, and uncontroversially so—this is what (1) and (6) establish.

The twist comes when we look at Sue who has no beliefs about Alice. George reports that speakers hesitate to consider (7d) true but neither do they feel comfortable classifying it as false. Let us see the predictions made by strong and weak exhaustiveness here:[5]

(8) a.

w1: m left	**w2:** m left
w3: a left	**w4:** m+a left

b. Sue's belief worlds: $\lambda w\ [\text{left}_w\ (m) \wedge [\text{left}_w(a) \vee \neg\text{left}_w(a)]] \Rightarrow \{w1, w2, w4\}$

c. $\text{Ans-D}_W(\text{who left})\ (w2)$: $\lambda w\ \text{left}_w\ (m) \Rightarrow \{w1, w2, w4\}$ *weak exhaustiveness*

d. $\text{Ans-D/H}_S(\text{who left})(w2)$:
$\lambda w'\ [\text{Ans-D}_W(\text{who left})\ (w2) = \text{Ans-D}_W(\text{who left})\ (w')] \Rightarrow \{w1, w2\}$
strong exhaustiveness

Weak exhaustiveness predicts ready acceptance of (7d) while strong exhaustiveness suggests categorical rejection of it. So the reported intuitions do not match the predictions of either weak or strong exhaustiveness. George reports that Spector captures the nuances of this situation by enhancing the meaning of the embedding predicate with a ban against false beliefs. George himself takes this conflict as an argument against weak exhaustiveness. Here we take a slightly different view of the matter, drawing on the distinction between the speaker's

[5] See Section 2.3.3 for discussion related to Ans-D/H_S. As its application in (8d) shows, it uses the extension of the weak answerhood operator Ans-D_W at the world of evaluation w on one side of the equation. By collecting together the worlds w' that agree with w it captures strong exhaustiveness.

vs. the agent's relation to Ans-D_W(Q) as a description for the proposition $\lambda w[left_w(m)]$.

If someone were to ask Sue *do you know who left* she would not say *yes*, while both Bill and John would (though, of course, John would be misinformed). But if the speaker/reader were asked the same question, they would be justified in saying *yes*. So, this is a case where Sue's beliefs/knowledge are measured against the speaker's and judged true because it is the speaker who recognizes the link between the proposition Sue believes and its description as *Ans-D(Q)* at the world of evaluation. The judgment changes if the speaker does not know the facts because the onus then falls on Sue, and in that case, lack of knowledge about Alice would makes the sentence false. The flexibility between the agent and/or the speaker recognizing the connection between the proposition and its description as an answer to the question, illustrated in (5), seems to be the key to the problem of navigating between weak and strong exhaustiveness in such cases. The source of shiftiness in the judgment reported, I believe, is due to the fact that the presentation of the situation highlights the agent's knowledge of the connection but the inference can only go through on the basis of the speaker's knowledge. Note that this way of looking at the puzzle does not make formal reference to strong exhaustiveness. The fact that speakers do not judge (7d) as outright false is therefore not surprising.

To conclude, what I am arguing for here is an account of embedded questions in terms of the classical *de dicto–de re* ambiguity. I have suggested that there is a distinction between the role of the speaker and the role of the agent in recognizing the connection between a proposition and its description as an answer to a question. The role of the protagonists that I have emphasized here is not radical and has, in fact, been anticipated in previous work. What I have identified as the agent knowing the proposition but not its description as *Ans-D_W(Q)*, the *de re* reading of the embedded question, is what Berman (1991) terms "knowing in an objective sense." Heim (1994) argues that such knowledge is not "really knowing."[6] I opted to present the distinction in terms of agent vs. speaker knowledge in order to articulate the idea in theory-neutral terms. I refer the reader to the articles cited to determine points of overlap.

3.1.2 The addressee and the question posed

When we turn to direct question–answer paradigms, we have to accommodate a changed set of factors: an addressee, a proposition, and the relation between that proposition and the question posed. Consider the following question–answer pair:

(9) a. Which numbers between 1 and 10 are prime?
    b. 1, 2, 3, 5, 7.

[6] See Karttunen (1977: 21–3), Berman (1991: ch. 4, sec. 3.2), and Heim (1994: 130–1).

Suppose this question were posed by a teacher to a student, and in answering it the student left out one of the prime numbers, say 1, the teacher would not consider it a satisfactory answer. If the student listed all the correct numbers but included an extra number incorrectly, say 9, the teacher would not consider that satisfactory either. A lenient teacher might give partial credit, but only if there weren't too many omissions or too many false entries. Our intuitions here are fairly clear: a satisfactory answer must list all and only those entities that satisfy the question nucleus.

Let us assume a context where the facts are not known to the questioner, making (10a) a genuine request for information:

(10) a. Who danced at the party?
b. John and Bill danced.
c. John and Bill danced and Harry did not.
d. Only John and Bill danced.

If the domain includes John, Bill, and Harry, and the addressee is well-informed about the relevant facts, the questioner would infer from (10b) that Harry did not dance. Though the addressee has not said anything about Harry, we intuitively take the omission to be a negative assertion about him. If the addressee were in doubt about Harry, she would be expected to indicate her ignorance by flagging (10b) as a partial answer with a hedge like *well, for instance* or perhaps even making it overt: *I don't know about Harry.* Absent such indication, the proposition in (10b) is taken to be the stronger statement (10c), or equivalently (10d). The issue is how exactly this strengthening happens.

This problem was brought to the fore by Gr&S (1984: 251–439), who consider several pragmatic as well as semantic solutions, which we will not review here. The account they settle on does not transfer over smoothly to the Hamblin–Karttunen semantics we have adopted.[7] I will present instead the proposal in Spector (2007a), translating it into the terms of the discussion in Section 3.1.1 first.

The idea is that the addressee, in answering a question, does not assert just the simple proposition. Rather, the assertion is that the proposition is the complete answer to the question posed, as shown in (11a). Examples (11b)–(11c) illustrate how it works:

[7] See van Rooij and Schulz (2004) and Schulz and van Rooij (2006) for other ways of capturing the strong exhaustiveness of answers to direct questions, inspired by Gr&S (1984).

(11) a. $\lambda w'$ identical$_{w'}$ [**Ans-D$_W$**(⟦**10a**⟧)(**w**), ⟦10b⟧]
b. W = {w1, w2, w3, w4}

$$\text{Dance at the party} = \begin{bmatrix} w1 \rightarrow \{john, bill\} \\ w2 \rightarrow \{john, harry\} \\ w3 \rightarrow \{john, bill\} \\ w4 \rightarrow \{john, bill, harry\} \end{bmatrix}$$

$$\text{Ans-D}_w(10a) = \begin{bmatrix} w1 \rightarrow \lambda w\ dance_w\ (j+b) \\ w2 \rightarrow \lambda w\ dance_w\ (j+h) \\ w3 \rightarrow \lambda w\ dance_w\ (j+b) \\ w4 \rightarrow \lambda w\ dance_w\ (j+b+h) \end{bmatrix} = \begin{bmatrix} w1 \rightarrow \{w1, w3, w4\} \\ w2 \rightarrow \{w2, w4\} \\ w3 \rightarrow \{w1, w3, w4\} \\ w4 \rightarrow \{w4\} \end{bmatrix}$$

c. λw dance$_w$ (j+b) *which is:* {w1, w3, w4}
d. λw'[Ans-D$_W$(⟦10a⟧)(w') = {w1, w3, w4}] *which is:* {w1, w3}

So, in answering (10a) with (10b), the addressee is not asserting (11c) but, rather, (11d). Now, what are the worlds in which the values for Ans-D$_W$(10a) coincide with the proposition in (10b), that is, (11c)? They are *w1* and *w3*, the worlds where the set of dancers are all and only those named in (10b). In effect, we get a strongly exhaustive interpretation of the answer because the only available attitude holder, the addressee, asserts the relationship between a proposition *p* and a question, under the description *Ans-D$_W$(Q)*.

What we have, then, is a way of tapping into Heim's insight that strong exhaustiveness is derivative on weak exhaustiveness. The only novelty is in making explicit that the identity predicate is sensitive to discourse factors. To that extent, it can be considered a uniform account of questions as weakly exhaustive. Embedded and direct questions always compose under a single answerhood operator, namely Ans-D$_W$, but can give rise to strong exhaustiveness under appropriate conditions.

Similar variation with respect to the exhaustive interpretation of propositions elsewhere provides an analogy:

(12) a. We had a party last night. John and Bill came.
b. We invited John, Bill, Mary, and Sue to our party last night. John and Bill came.

The proposition *John and Bill came* need not have an exhaustive interpretation (*only John and Bill came)* in (12a). An exhaustive interpretation for the same proposition is at least strongly implicated in (12b), because the prior sentence mentions other invitees explicitly and makes those possibilities salient. Not including them in the assertion is tantamount to asserting that they are false. This provides support for the position that exhaustive interpretations are sensitive to the context of use, not just in connection with question–answer paradigms but in language generally.

To complete the discussion, the proposal by Spector (2007a) just discussed is given in its original formulation in (13). Spector adopts a null operator with the semantics of *only*, from Krifka (1993). This operator, defined in (13a), takes scope over the answer and imposes the requirement that it be the strongest true proposition in the question denotation (Spector 2007a: 291). Note that Spector is working with Karttunen sets so the truth requirement enters the derivation at a different point than in our system, but the net effect is similar:

(13) a. $[\![OP_Q\ S]\!](w) = 1$ if S is the strongest member of Q(w)
b. $[\![OP_Q]\!] = \lambda\varphi.\ \lambda w.\ (\varphi \in Q(w) \wedge \forall\ \Psi\ (\Psi \in Q(w) \rightarrow (\varphi \subseteq \Psi)))$

Appealing to covert exhaustivity is part of a growing body of work that argues for the pervasive influence of covert operators in the grammar of natural language (see Chierchia 2006, 2013; Fox 2007; Chierchia et al. 2011; among others). Klinedinst and Rothschild (2011), Fox (2012), Mayr (2013, 2014), and Nicolae (2013) are other works in this category that deal specifically with questions.

3.1.3 Domain certainty and complementation

Groenendijk and Stokhof (1984) present another argument in favor of strong exhaustiveness. Sentence (14a), they claim, entails (14b):

(14) a. Bill knows who danced at the party.
b. Bill knows who didn't dance at the party.

(15) dancers =

w1 a	**w2** b	**w3**	**w4** a b
w5 b	**w6**	**w7** a	**w8** a b

We can use our answerhood operators to see why. At w1, Ans-D_W looks for worlds in which *a* is a dancer for (14a) and worlds in which *b* is not a dancer for (14b), so we get different propositions for the two embedded questions (cf. (16)). There is no entailment relation between them, so knowing one should be independent of knowing the other. Ans-D/H_S, on the other hand, looks for worlds in which *a* is the only dancer and worlds in which *b* is the only non-dancer, which gives us the same set of worlds for both (cf. (17)):

(16) a. Ans-D_W(who danced)(w1) = {^a danced} *{w1, w4, w7, w8}*
b. Ans-D_W(who didn't dance)(w1) = {^b didn't dance} *{w1, w3, w6, w7}*

(17) a. Ans-D/H_S(who danced)(w1) = {^a danced but not b} *{w1, w7}*
b. Ans-D/H_S(who didn't dance)(w1) = {^b didn't dance but a did} *{w1, w7}*

The inference pattern in (14) would seem to argue for strong exhaustiveness.

But how reliable is this diagnostic? Gr&S add the important caveats that the inference between positive and negative counterparts of a question only holds if the agent is aware of the domain of quantification and this domain stays constant. There is an important example which underscores this point, albeit with a twist. Lahiri (1991: 141) credits Sylvain Bromberger for (18a), which shows that *[x know wh not p]* cannot be inferred from *[x know wh p]*:[8]

(18) a. Feynmann knew which elementary particles had been discovered by 1978.
b. Feynmann knew which elementary particles had not been discovered by 1978.

Example (18a) is felicitous and true, assuming Feynmann knew his particles! Though the set of elementary particles is not known, we can restrict quantification to those that had been discovered by 1978. However, the set of particles not discovered by 1978 cannot be known and (18b) can simply not be true, at least if evaluated in 1978. So the inference from (18a) to (18b) does not go through. However, if these statements describe what Feynmann knew about elementary particles later, say in 1985, and assuming that several more elementary particles had been discovered between 1978 and 1985, the judgment for (18b) changes. If we take (18a) to be true, then (18b) follows.[9] That is, in order for (18b) to be true, the existential presupposition, which we have encoded in Ans-D_W, must be satisfied. In general, though, since the existential presupposition of an embedded question projects up to the complex structure, there may well be contexts which only support the truth of the positive version of a question.

The relationship between positive and negative counterparts of questions is an important and frequently used diagnostic. Example (19a) illustrates Sharvit's (2002: 112) use of it for her claim that *know* can select for weak exhaustiveness

[8] Chapter 6 discusses differences in questions with negation based on a fixed, contextually salient domain of quantification. This ties in with the reliance of negative questions on D-linking, in the sense of Pesetsky (1987). See also Section 3.2.

[9] Even if the sentence was evaluated at a later date the domain of quantification would have to be restricted for it to be acceptable. That is, the inference can go through if the sentences are interpreted as (i)–(ii):

(i) Of the elementary particles now (in 1985) known, F knew which ones had been discovered in 1978.
(ii) Of the elementary particles now (in 1985) known, F knew which ones had not been discovered in 1978.

(see also Heim 1994; Beck and Rullmann 1999). The variant in (19b), however, is odd:

(19) a. I know who was admitted to the program, but I have no idea who wasn't admitted.
 b. Rupert knows which of his four students were admitted, but he doesn't know which weren't.

If *know* unambiguously selected for strong exhaustiveness, (19a) would be a contradiction. Under weak exhaustiveness the first clause simply asserts knowledge about those who were in fact admitted, leaving open knowledge about who weren't. A scenario where the agent (who in this case is the speaker) is not on the admissions committee but has seen the final list of admitted students would be one in which he or she would know the positive but not the negative extension of the predicate.

George (2011: 87) takes issue with Sharvit's conclusion. He points out that *who* in (19a) is contextually restricted to range over the set of applicants and acceptability crucially rests on the agent not knowing this set. George's point is that (19a) is consistent with the classification of *know* as strongly exhaustive. He presents (19b) to factor out domain uncertainty by restricting quantification to a small enough group that acquaintance can be guaranteed. He reports that the sentence is judged odd by many, but not all, speakers. His explanation for those who find it acceptable rests on the following two scenarios. Rupert is unaware of which of his students actually applied. Assuming that not being admitted presupposes applying, the reason Rupert cannot identify those who were not admitted is that he is uncertain about which of his students applied. As we have noted in connection with the Feynmann examples, the inference from *[V wh P]* to *[V wh not P]* is contingent on knowledge about the domain of quantification. George terms this *domain uncertainty.* A second scenario in which, according to George, (19b) is accepted is when the admission process is not yet complete. Even if Rupert knows the set of applicants and the set already admitted, he cannot separate out the rest into those who have been rejected and those who are on hold. This a case of *complementation failure*, and the inference under discussion does not go through here either.

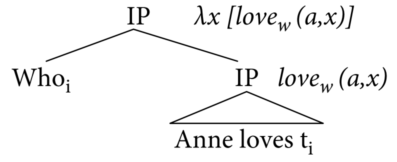
George's arguments are not meant as arguments against weak exhaustiveness. They are arguments for keeping the relevant caveats in place when using the negation diagnostic. Note, for example, that under the *de re* scenario where it is the speaker who is the bearer of the ascription described in Section 3.1.1, *domain uncertainty* and *complementation failure* are controlled for and a weakly exhaustive ascription goes through. I should add that the literature on the properties of *know* with regard to exhaustiveness is vast and the short discussion in this and the following subsections does not do justice to it. The reader is referred to the references cited to explore this issue further. The take-home message for work on questions is to consider other embedding predicates, in addition to *know*, when drawing conclusions.

3.1.4 Alternative routes to exhaustiveness

There are other ways of capturing the weak–strong distinction in exhaustive answers. One is due to George (2011), who resurrects Gr&S's account of wh expressions as restricted lambda operators.[10,11] I simplify his definitions, which are meant to apply generally, and demonstrate for single constituent questions where abstracts yield sets of individuals:

(20) a. Who does Anne love?

b.



George (2011: 30) defines the question forming operator in (21), which takes a property and creates a Hamblin set. It does this by collecting the propositions obtained by existential quantification over the bearers of that property. Applied to (20b), it yields (22a)–(22b), assuming that John and Bill provide the domain of quantification:

(21) Q: $\boldsymbol{\lambda P}_{<s<et>>}\ \lambda p_{<s,t>}\ \underline{\exists y}_{<e>}\ [p = \lambda w'\ (\mathbf{P}\ (w')(\underline{y}))]$

(22) a. $\lambda \mathbf{P}\ \lambda p\ \exists y\ [p = \lambda w'\ (\mathbf{P}\ (w')(y))]\ (\boldsymbol{\lambda w\ \lambda x}\ [\mathbf{love_w}\ \mathbf{(a,x)}])$

$\Rightarrow \lambda p\ \exists y\ [p = \lambda w'\ (\boldsymbol{\lambda w}\ \lambda x\ [love_{\mathbf{w}}\ (a,x)]\ (\mathbf{w'})(y))]$

$\Rightarrow \lambda p\ \exists y\ [p = \lambda w'\ (\boldsymbol{\lambda x}\ [love_{w'}\ (a,x)](\mathbf{y}))]$

$\Rightarrow \lambda p\ \exists y\ [p = \lambda w'\ [love_{w'}\ (a,y)]]$

b. $\{\lambda w\ loves_w\ (a,j),\ \lambda w\ loves_w\ (a,b)\}$

George (2011: 36) allows for a second operator *X* between abstract formation and question formation, shown in (23). I demonstrate only for properties, though the actual definition applies generally. Applied to (20b), we get (24), the set of individuals *S* that are the same as the individuals Ann loves in world *w:*

(23) a. $[_{CP}\ Q\ [_{IP}\ X\ [_{IP}\ \text{Abstract}]]]$

b. X: $\lambda R_{<e,t>}\ \lambda S_{<e,t>}\ (R = S)$

(24) $\lambda \mathbf{R}\ \lambda S\ (\mathbf{R} = S)\ (\boldsymbol{\lambda x}\ [\mathbf{love_w}\ \mathbf{(a,x)}])$

$\Rightarrow \lambda S\ (\lambda x\ [love_w\ (a,x)] = S)$

[10] Haida (2007) also takes abstract formation to be an essential step in building up interrogative meanings within a dynamic framework. However, constraints of space prevent me from presenting his analysis.

[11] This is the essence of George's Chapter 2 'The Baseline Theory'. I set aside here modifications he entertains in his later chapters.

The question formation operation in (21), quantifying now over sets of individuals, takes (24) as input and yields (25). The set of propositions are exhaustified with respect to the individuals that Ann loves. As in Gr&S, we get a partition on the set of worlds:

(25) a. $\lambda \mathbf{P}\ \lambda p\ \exists S'\ [p = \lambda w'\ (\mathbf{P}\ (w')(S'))]\ (\boldsymbol{\lambda w\ \lambda S\ (\lambda x\ [love_w\ (a,x)] = S)})$
$\Rightarrow \lambda p\ \exists S'\ [p = \lambda w'\ (\boldsymbol{\lambda w}\ \lambda S\ (\lambda x\ [love_w\ (a,x)] = S)\ (\mathbf{w}')(S'))]$
$\Rightarrow \lambda p\ \exists S'\ [p = \lambda w'\ (\boldsymbol{\lambda S}\ (\lambda x\ [love_{w'}\ (a,x)] = \mathbf{S})\ (\mathbf{S}')]$
$\Rightarrow \lambda p\ \exists S'\ [p = \lambda w'\ \lambda x\ [love_{w'}\ (a,x)] = S')]$

b. $\{\lambda w'\ \lambda x\ [love_{w'}\ (a, x)] = \{john\},$ *Ann loves John not Bill*
$\lambda w'\ \lambda x\ [love_{w'}(a, x)] = \{bill\},$ *Ann loves Bill not John*
$\lambda w'\ \lambda x\ [love_{w'}(a, x)] = \{john, bill\},$ *Ann loves John and Bill*
$\lambda w'\ \lambda x\ [love_{w'}(a, x)] = \varnothing\ \}$ *Ann doesn't love John or Bill*

This is how the distinction between strongly exhaustive and non-exhaustive propositional sets is derived. George (2013a: 424) takes an answer to be some proposition in the question denotation:

(26) x knows Q iff $\exists p$ s.t. p is in the answer set of Q and x knows that p.

When the question undergoes exhaustification the propositions in the answer set are mutually incompatible, so picking out any proposition amounts to picking out the unique strongly exhaustive answer to the question. Without exhaustification, the question denotes a standard Hamblin set and we get something weaker than the weakly exhaustive answer of Karttunen. George thus takes a question to be ambiguous between a strongly exhaustive and a *mention-some* reading. A non-trivial aspect of his proposal, then, is that weak exhaustiveness has no formal status. It is taken to be a special case of the *mention-some* answer.

Note that the issue of truth does not feature in George's analysis. In this, he follows Egré and Spector (2007) who challenge the basis for the truth requirement, citing (27) as evidence:

(27) a. Every day the meteorologists tell us what the weather will be, but they are often wrong.
b. The pundit told us who we should blame, but she doesn't know what she's talking about.

George recognizes that this move requires an explanation for the perceived veridicality in basic cases of questions embedded under predicates like *tell*. Examples like (28) indicate the existence of a veridical version of declarative embedding *tell*:

(28) a. The distribution of the debris tells us that the bomb was placed under the stairs.
b. The spacing of the puncture wounds told Anne that the victims were killed in a vampire attack.

This is an interesting tack to take, but we will not pursue it further, referring readers to George's and Egré and Spector's work.

A second approach that makes the question itself ambiguous between weakly and strongly exhaustive sets falls within what can be called the alternatives and exhaustification approach, mentioned at the end of Section 3.1.2. The theory proposed in Nicolae (2013) delivers results similar to George's at the level of the question denotation but the manner in which the sets are derived, and the implications for embedding, are substantially different. I will simplify the details of the mapping from syntax to semantics, keeping only those of immediate relevance to exhaustiveness.

The weakly exhaustive set of propositions is the basic Hamblin set and needs no elaboration. The crucial step in deriving a strongly exhaustive set of propositions is attributed to a covert operator just below C^0 ((29a)). The semantics of this operator (Nicolae 2013: 30), given in (29b), is fashioned after Rooth (1992). It takes a prejacent (the nucleus proposition *p*) as its argument and a contextual variable, *Alt(p)*. This set of alternatives is derived by substitutions of the individual variable denoted by the wh trace in the nucleus, yielding the familiar Hamblin set. The semantic contribution of the operator is to require the prejacent to be the only true member of this set. This yields a set of mutually incompatible propositions (29c):

(29) a. $[_{CP}$ who $[_{C'}$ C^0 $[_{IP}$ ***only*** $[_{IP}$ Ann loves $t_F]]]]$

b. $[\![\text{only}]\!](\text{Alt}(p))(p) = \lambda w.\ \forall q \in \text{Alt}(p)\ [\neg p \subseteq q \rightarrow q(w) = 0]$ *equivalently*
$= \lambda w.\ \forall q \in \text{Alt}(p)\ [q(w) = 1 \rightarrow p \subseteq q]$

c. $\{\lambda w$ Ann loves_w only john, λw Ann loves_w only bill,
λw Ann loves_w only john and bill$\}$

Nicolae's primary motivation for introducing covert ***only*** involves NPI licensing, to be discussed in Section 3.3. For now, we note that it derives the same ambiguity in questions as George. The difference between them is in embedding.

Nicolae imports Ans-D_W but in a way that preserves the type of questions as sets of propositions. She defines an operator I_D with scope over the question that builds in the content of Ans-D_W as its presupposition, while allowing the question denotation itself to be passed up the tree (Nicolae 2013: 51). This effectively recasts Ans-D_W as a filter on question denotations:

(30) a. $[\![I_D]\!](Q)(w) = \exists p \in Q \wedge p = \iota p\ [p(w) = 1 \wedge \forall p' \in Q\ (p'(w) \rightarrow p \subseteq p')]$ *presupposition*
$\lambda p.\ p \in Q$ *denotation*

b. $[_{VP}$ V $[_{CP}$ I_D $[_{CP}$ $\lambda p \ldots]]]$

I_D checks for a unique maximally informative true proposition in the set. In the case of exhaustified propositional sets, this is trivial but in the case of non-exhaustified sets, I_D preserves the effects of Ans-D_W with respect to number implicatures.[12] The advantage of modulating Ans-D_W as an identity function for Nicolae has to do with selection. Instead of selecting for weak vs. strong answerhood operators, she has the embedding predicate select for strong vs. weak propositional sets.

To conclude, both George and Nicolae take questions to have both strongly exhaustive and weak or non-exhaustive interpretations, and they take embedding predicates to be sensitive to this distinction. Deferring discussion of embedding to Section 3.3, it is worth noting that something along the lines of our discussion in Section 3.1.2 is also needed under Nicolae's proposal for direct questions. Since the selectional properties of embedding predicates are not in play, the effect of strong exhaustiveness will have to be captured separately (see Nicolae 2013: 68–9). The problem with direct questions does not arise for George since the ambiguity he posits is between strong exhaustiveness and *mention-some readings*, both of which are arguably available in direct questions.

3.1.5 Section summary

Here we probed strong and weak exhaustiveness in embedded and direct questions. We noted the relevance of whether the agent or the speaker makes the connection between a proposition and its description as an exhaustive answer to the question in the case of embedded questions. The fact that direct questions seem to allow only for strongly exhaustive answers was addressed by positing that an answer is used not just to assert the proposition *simpliciter* but to assert its status as the strongest member of the question denotation. By including this conversational aspect into the analysis, we showed that it is possible to maintain a single answerhood operator that encodes weak exhaustiveness and derive the effect of strong exhaustiveness from it. The relationship between positive and negative versions of a question, a point on which strong and weak exhaustiveness differ, was considered and the conditions under which inferences are valid noted. We also presented alternative approaches that maintain an ambiguity between strong and weak/non-exhaustiveness, but at the level of the question nucleus.

3.2 Non-exhaustive answers

Exhaustive answers, our focus so far, are generally taken to represent the unmarked case. We now turn our attention to non-exhaustive answers with a view to determining whether they represent an independent reading of questions or whether they are partial answers that are considered satisfactory in specific contexts. In doing so, we review the structural as well as the pragmatic properties

[12] George does not engage with the issue of number-based effects, though he mentions the possibility of incorporating plural individuals into his system. The relevant facts will not be derived even with the proposed extension. The arguments in Section 2.3.2 will apply to it in the same way as it does to the theories critiqued there.

that have been considered necessary and/or sufficient for *mention-some answers* and, in light of that, consider various proposals.

3.2.1 The tourist and the entrepreneur

Consider the following paradigm, fashioned after Gr&S (1984: 458). We continue to use underlining to indicate the true propositions in the question denotation:[13]

(31) a. Where can I buy Italian newspapers?
b. {^you can buy Italian newspapers at the corner bookstore,
^you can buy Italian newspapers at the station,
^you can buy Italian newspapers at the co-op,
^you can buy Italian newspapers at the corner bookstore + the station, . . .
^you can buy Italian newspapers at the corner bookstore + the co-op+the station}

(32) a. You can buy Italian newspapers at the corner bookstore.
b. You can buy Italian newspapers at the corner bookstore and the railway station.

(33) a. Well, you can buy Italian newspapers at the corner bookstore (I'm not sure about other places).
b. You can buy Italian newspapers at the corner bookstore or at the railway station.

Gr&S point out that (31a) can be answered satisfactorily with the *mention-some* answer in (32a) if asked by an Italian tourist in Amsterdam who wants to get news of home. Any one of the places that sells such papers suffices for the tourist's purpose. If asked by an entrepreneur who wants to set up a distribution network for foreign language newspapers, however, only the *mention-all* answer in (32b) would do. If the addressee were to respond with a partial answer to the prospective distribution agent, because she does not really know every place that sells Italian newspapers for example, she would have to flag it as such with a hedge, as shown in (33a). Not to do so would make her an errant Gricean interlocutor. Along the same lines and perhaps stating the obvious, the addressee speaking to the homesick Italian could also give the *mention-all answer* in (32b), leaving it up to the tourist to decide which option would be the most convenient. The same would be true of the response in (33b), with the disjunction conveying her awareness that the tourist's goals could be met with either of the options mentioned.

This illustration highlights the importance of conversational goals in determining the appropriateness of responses. While both the tourist and the entrepreneur

[13] As far as I know, the choice of conjunction vs. disjunction in *mention-some answers* has not been systematically studied. Disjunction in questions and answers is interesting in its own right and will be touched upon in Chapter 4.

ask the same question, the addressee understands that they have different expectations. Like all conversational factors, there is great variation in this domain as well. The homesick tourist may well want full information for future reference, even though for his immediate needs any one store would do. In that case, he might make this overt, if his dialect of English has the locution *where-all* instead of *where*. In the same vein, the entrepreneur might not really need to know the exhaustive answer. If he knows that one foreign newspaper outlet is all that the city can support, even a *mention-some answer* gives him the information he needs to abandon his plans. German wh+*alles* (Beck and Rullmann 1999) and Hindi-Urdu wh-reduplication are other examples of strategies to mark requests for exhaustive answers.

An important point to note is that the distinction between *mention-some/mention-all answers* also holds in embedded contexts. I use small caps to indicate that the point only holds in languages/dialects with strategies like *where all*:

(34) a. Luigi wants to know where one can buy Italian newspapers.
b. Luigi wants to know where ALL one can buy Italian newspapers.

Depending on whether Luigi is the homesick tourist or the entrepreneurial twin, and depending on what wh phrase he opts for, he is likely to get different answers.

Before going further, I would like to mention and then set aside the case of questions with indefinites. Consider a context where Prof. Smith, who has just received an award for *Mentor of the Year*, is being interviewed by a reporter. The reporter would like to talk to one of her students, and in preparation for that, asks (35a). Here, the conversational goals are in keeping with a *mention-some answer* and Prof. Smith could respond with (35b) or (35c):[14]

(35) a. What topic is one of your students working on?
b. John is working on NPI.
c. Mary is working on FCI.

The indefinite signals the possibility for different answers depending on the choice of the student. Such questions have sometimes been called *choice questions* (Gr&S 1984; Chierchia 1993, among others). Recently, however, they have been clubbed with questions soliciting *mention-some answers* (George 2011; Fox 2012; Chierchia and Caponigro 2013; Nicolae 2013). I will maintain the old distinction and defer discussion of their properties to Chapter 4, but let me state the reason for this decision.

A *mention-some answer* typically requires a mono-morphemic wh expression but (35a) clearly allows for choice even with a complex wh phrase. Example (31a) with *what store* instead of *where* would lose its status as a *mention-some* question. Furthermore, replacing *what topic* with *what topics* or *what all* in (35a) does not

[14] I find that such answers sound better if the particular student is introduced first: *Well, there's John. He's working on NPI.*

take away the flavor of choice, while we saw that such replacements shift (31a) towards a *mention-all answer*.

A second argument for keeping *choice questions* separate from *mention-some questions* is that it is possible, in certain contexts, to have *mention-some* readings for questions with universal terms. Gr&S (1984: 460) present the following as admitting a *mention-some* answer. You have to imagine that the person asking (36a) is interested in buying all of Nooteboom's books in a single visit to a store:

(36) a. Where do they have all [the] books written by Nooteboom in stock?
b. At Barnes and Noble. (Or at Rutgers Books....)

Now, note that shifting to *at which store* or *where all* has the same effect it does in (31a). Analyses that take questions with indefinites to be *mention-some* questions typically tap into differences between indefinites and universals so that the alignment of (36a) and (31a) to the exclusion of (35a) with regard to the substitutions discussed is unexpected. I take these two points as justification for keeping questions with indefinites separate from *mention-some questions*.

3.2.2 Mono-morphemic vs. complex wh phrases

Let us consider whether the two grammatical features typical of *mention-some* questions are strict requirements or mere propensities: the use of mono-morphemic rather than complex wh phrases, and the choice of possibility modals. It turns out that what counts as a restriction and what counts as a propensity seems to depend on whether we are looking at direct question–answer paradigms or embedded questions, a difference that to the best of my knowledge has not so far been systematically studied. I should emphasize that this conclusion is based on preliminary data and needs to be tested further.[15]

Comorovski (1996: 39) notes that *mention-some* answers are only possible with non-D-linked mono-morphemic wh expressions.[16] In the canonical Italian tourist example, the domain of quantification is non-D-linked since the tourist is obviously unfamiliar with the city. Consider two variants of the relevant question:

(37) a. In which store can one buy an Italian newspaper?
b. John knows in which store one can buy an Italian newspaper.

(38) a. In which stores can one buy an Italian newspaper?
b. John knows in which stores one can buy an Italian newspaper.
c. #At the corner bookstore.

[15] Discussions with Gennaro Chierchia (p.c.) have helped shape my understanding of the problem but he may or may not agree with the conclusions I have drawn.

[16] D(iscourse)-linking, a term due to Pesetsky (1987), refers to wh phrases like *which N*. They typically require a contextually salient domain of quantification, unlike *who/what* which are comfortable with domains that are not salient in the context. See also Chapters 4, 6, and 7. Many thanks to Roger Schwarzschild for very helpful discussion.

Replacing the wh expression with a complex wh expression seems to block *mention-some* answers regardless of whether the NP is singular, as in (37a), or plural, as in (38a). This holds for indirect questions as well, as in (37b) and (38b). One might argue that the singular version in (37) has a uniqueness presupposition which obfuscates the *mention-all/mention-some* distinction.[17] The same, however, would not hold for the plural version in (38) where a plurality of propositions is expected to be true and a distinction between *mention-some/mention-all* potentially available. However, an answer like (38c) has to be flagged as a partial answer to be felicitous.[18,19] Comorovski takes this to show that the plurality on wh is antithetical to the phenomenon.

Although the data in (37)–(38) seem to support Comorovski's generalization, let us make sure that the resistance to plurality/D-linking is absolute. Suppose a researcher needs a few people with AB blood type to test a new drug. We can reasonably assume that the study requires her to test a plurality of patients but not necessarily all the patients in the hospital. Let us also assume that the researcher has a list of patients (but not their blood types) so we know we are dealing with a D-linked context. The researcher asks (39a) of the administrator who has information mapping patients to blood types:

(39) a. Which (of the) patients can we approach for this test?
b. You could approach Bill and John.
c. Or you could approach Sue and Tom.

Response (39b) is a possible *mention-some answer*, made explicit by the continuation in (39c). Thus we can say with some confidence that in the right context a D-linked plural wh phrase can allow for *mention-some* answers, contra Comorovski.

[17] Gr&S (1984: 460) allow a *mention-some* answer to (i), which has a singular wh:

i. On which route to Rotterdam is there likely to be no police controls?

To me this seems possible only with a plural wh *which routes*. Answering the singular version with *Route 21 or Route 25*, naming two of the routes that are free of police controls, gives the impression of denying the speaker's presupposition of uniqueness. Gr&S, of course, do not engage with the issue of number sensitivity. They present (i) to show that it is not a choice question: *no N* behaves like *every N* (cf. (36)) in this respect. Therefore, a non-exhaustive answer to (i) or (36) has to be a *mention-some answer*. Their point goes through on the plural version of (i).

[18] Question (38a) is not likely to be asked by our Italian tourist; it really seems to be the prospective enterpreuner's question.

[19] Roger Schwarzschild (p.c.) brought up the following scenario: A tourist (let us say Roger) is standing on a street in New Delhi in front of several stores with signs only in Devanagiri (which he could not then read, and for all I know, still cannot!). Which of the following would Roger ask?

i. Where can I buy batteries?
ii. In which store can I buy batteries?
iii. In which stores can I buy batteries?

(i) seems inappropriate because the stores are right in front of him, a canonical D-linked situation, (ii) presupposes that there is a unique store that sells batteries but the stores all seem to be of a similar character, (iii) seems to be over-reaching. After all, he only needs to go into one store to buy his batteries. My sense is that (i), or even (ii), might work, albeit not perfectly. I have set aside this very interesting problem in the discussion here.

Based on the above, then, it does not seem wise to think of D-linking as a factor prohibiting *mention-some answers*. What seems more likely is that D-linked singular wh expressions mask the distinction between *mention-some/mention-all* answers, while plural D-linked wh expressions require special contexts to bring out the expectation that a sub-group rather than a single individual would constitute a satisfactory non-exhaustive answer. Note that canonical cases of *mention-some answers* typically name singular entities, even though the mono-morphemic wh expression in them would allow for pluralities.

Finally, we should establish whether the canonical *mention-some answer* to a question with a mono-morphemic wh necessarily names a singularity or whether, in the right context, a plural *mention-some answer* can be given. The latter seems to be the case:

(40) a. I need two people to help me move my things. Who can I ask?
b. You could ask Bill and Tom. (Or John and Sue . . .)

(41) a. I need two students for my project on Spanish bilingualism. Who can speak Spanish fluently?
b. Bill and Sue can. (So can John and Tom).

What we can gather from the discussion so far is that while it is more common to use a mono-morphemic wh in *mention-some* contexts and that the expected response usually names a single individual, neither of these are absolute requirements. Let us now see whether this also holds in embedded contexts. The following is due to Gennaro Chierchia (p.c.):

(42) a. Context: Harry knows that Bill and Mary are patients with AB type blood and therefore can be approached for the test. He doesn't know that Sue and John have the same blood type and could also be approached.
b. #Harry knows/found out which patients we can approach for the test.
c. Harry knows/found out who we can approach for the test.

The contrast between (39) and (42) leads to the conclusion that the reliance of *mention-some answers* on mono-morphemic wh expressions is only a propensity as far as direct question–answer paradigms go, but a hard fact when it comes to embedded contexts. It would appear that even after putting aside *choice questions*, we are still left with a multi-faceted phenomenon within the class of non-exhaustive answers.

This has important implications for the semantics of mono-morphemic wh expressions. In Chapter 2 we had noted the possibility that such expressions could either have a null N_{SING}/N_{PL} or that its restriction could be implicit and hence neither singular nor plural. We now have some evidence in favor of the latter. If there were a null N_{SING}, we would predict that a *mention-some* answer would not be discernible, on a par with overtly singular wh expressions. If there were a null N_{PL}, we would predict that a *mention-some* answer would only be possible in contexts that support the expectation of pluralities being named in the answer. That mono-morphemic wh expressions do not have either of these properties suggests that their restriction is implicit, neither singular nor plural, but simply neutral. Of course, the facts are also compatible with there being a null N that is under-determined with respect to number. What is ruled out is the possibility that mono-morphemic wh phrases are ambiguous between singular and plural terms.

3.2.3 Priority modals

When we look at examples of *mention-some questions* in the literature we notice that they typically have what Portner (2009) calls priority modals: bouletic, deontic, teleological modals. In fact, non-modal questions only admit such answers in goal-driven contexts.[20] It makes sense, then, to probe the extent to which this particular flavor of modality determines the availability of *mention-some answers*. Non-modal questions and questions with epistemic modality provide relevant comparisons.

At first glance, epistemic possibility seems resistant to *mention-some answers*. If the context does not favor Bill over John as a possibility, (43b) does not seem to be a possible answer. If the premise for asking the question is changed, as in (44a), the judgment changes:[21]

(43) a. I see a light on in the office. Who might be in at this time?
b. #Bill may be in. Or John.

(44) a. I need help. Who might be in the office at this time?
b. Bill may be in. Or John. Either of them could help you.

Using this insight, we can probe non-modal questions to see if they also admit *mention-some answers* with appropriate contextual support:[22]

(45) a. I need a ride to the party tonight. Do you know who's driving?
b. Bill is. He could give you a ride. Or John, he's driving too.

In fact, if the goal is to get a ride, the exhaustive answer in (46b) seems to overreach. The appropriate answer is (46c), and it does not, by any means, imply that

[20] The only non-modal case considered so far is (36a), but the context highlights its teleological aspect.

[21] Thanks to Gennaro Chierchia for (44).

[22] In a context where the questioner is the boss and it is obvious that she is only interested in facts about people who work for her, (ii) does not rule out the possibility of people outside the office being at the party. However, this is not a *mention-some* answer but rather a *mention-all* answer to a question with implicit domain restriction. See Schulz and van Rooij (2006) and George (2011) for relevant discussion:

i. Who was at the party?
ii. John and Mary.

the addressee is the only one going. Most likely, the answer in (46c) would be followed by *I'll give you a ride*:

(46) a. I need a ride. Who's going to the party?
b. Bill, Mary, Sue, Harry ... and me.
c. I am.

Further support for the role of goal-driven modality comes from an observation in Gr&S (1984: 544–5). *Mention-some* interpretations in embedded contexts are not possible if the matrix subject is non-human. Examples (47a)–(47b) only allow *mention-all* construals:

(47) a. What the average grade is depends on what grade each student got.
b. Where you can get gas depends on what day it is.

Let us see if there is a difference between priority and epistemic or non-modal embedded questions:

(48) a. John knows/found out where to get gas.
b. We needed help and there was a light on in the office. We asked John. He knew who might be in the office at that time.
c. I needed a ride to the party. John told me who was driving to the party.

The facts about priority modals are clear. John does not need to know all the places to get gas for (48a) to be true. Is the same true of (48b)–(48c)? The data are not so clear, I believe. What we can say with some confidence is that the priority existential definitely survives embedding. We can conclude that a priority existential is a sufficient condition for non-exhaustive construals of questions. To the extent that epistemic/non-modal questions in embedded contexts allow for such construals, it is so only with explicit contextual support.

Strong corroboration for this comes from infinitival questions, analyzed by Bhatt (1999) as encoding covert modality. The following examples, which he notes as having non-exhaustive interpretations, are analyzed as having a covert priority existential (Bhatt 1999: 133–4):

(49) a. Magnus knows where to get gas $\approx$ Magnus knows where he/one can get gas.
b. Magnus knows how to solve this problem $\approx$ Magnus knows how one can solve this problem.

Infinitival questions about manner have a particular propensity for *mention-some* construals. In the following, based on Pavese (2013), the addressee need not know every way of cooking rice, just one will suffice:[23]

[23] Pavese points out that Quantificational Variability (to be discussed in Chapter 5) in such questions, *partly knowing how to cook rice*, does not involve knowing some of the many ways of cooking it. Rather, it involves knowing some part of one of the ways of cooking rice.

(50) a. Do you know how to cook rice?
b. Sure, you can pressure cook it for 5 minutes.

I should add that neither Bhatt nor Pavese claim that infinitival questions are exclusively non-exhaustive.

To sum up, we have determined that questions with existential priority modals readily admit *mention-some* answers in direct as well as embedded contexts. Non-modal questions and questions with existential epistemic modals also allow them if the (teleological) conversational goals are made explicit. This is clear in the case of direct questions but may also hold for embedded questions.[24]

If the facts discussed here and in the previous subsection are any indication, the phenomenon of *mention-some answers* is still in need of empirical shoring up. The framing of the issues surrounding this phenomenon will have to be refined once all the facts are in place.

3.2.4 Theoretical implications

The accounts of *mention-some questions* that have been proposed in the literature so far fall broadly into three classes: simple ambiguity approaches, scope-based approaches, and approaches based on partial answers. This classification is obviously a rough one and actual analyses typically involve a more nuanced combination of semantic and pragmatic considerations than these descriptions convey.

The following are representative of each of these three types of proposal. Beck and Rullmann (1999: 292) posit a special answerhood operator to capture *mention-some answers* (51a). George (2011) suggests that such answers arise when a scopal element interacts with the exhaustification operator (51b). Lahiri (2002a: 162) includes a contextually sensitive operator over questions, shown somewhat schematically in (51c):[25]

(51) a. $\mathrm{Ans}_3(w)(Q) = \lambda P_{<s<st>>} [\exists p\, [P(w)(p) \wedge Q(w)(p) \wedge p(w)]]$
b. $[Q\, [\exists_i\, [X\, [\ldots t_i \ldots]]]]$
c. $[x\ V\ [\textit{ENOUGH}\ Q]] = 1$ iff $\exists S\ S \subseteq Q, |S| > n$, for some contextually specified large n that satisfies the speaker's purposes, and $[x\ V \cap S] = 1$, where x stands for the matrix subject and V for the matrix verb.

Let us briefly discuss the approaches these proposals represent, keeping in mind the empirical desiderata we have identified.

The possibility of *mention-all* and *mention-some answers* has sometimes been taken to be a simple ambiguity in questions (Hintikka 1976; Berman 1991, 1994; Beck and Rullmann 1999, for example). Beck and Rullmann's Ans_3, a third answerhood operator in addition to those for weak and strong exhaustiveness,

[24] The connection between necessity priority modals and non-exhaustive answers also needs careful investigation.

[25] Lahiri's actual rule is couched within a theory that will be discussed in Chapter 5.

takes a Hamblin set and creates subquestions, each of which has at least one true proposition in it. Knowing or answering a question using Ans_3 involves picking out one of these subquestions, and consequently one of the true propositions from the basic question denotation. A recent variant of the ambiguity approach is George (2011), whose question denotations, we saw in Section 3.1.4, vary between sets of mutually exclusive exhaustified propositions and basic Hamblin sets.[26] His answerhood operator imposes simple existential quantification over these sets. When applied to exhaustified sets, the *mention-all* answer is obtained; when applied to non-exhaustified sets, the *mention-some* answer is obtained. Recall that for George, weak exhaustiveness is subsumed under the *mention-some reading* of the question and that he excludes the truth condition from his answer sets. He therefore needs to add the truth requirement specifically for *mention-some answers*.[27] All these proposals run the risk of over-generation, a problem the authors are well aware of. Berman tries to address the problem by positing *mention-all* as a default. Beck and Rullmann acknowledge that they do not have anything to say about pragmatic constraints on their answerhood operators. Given the nature of the differences we have noted, this seems a non-trivial gap in this general approach to non-exhaustive answers.

The second approach treats the *mention-all* and *mention-some* distinction as a structural ambiguity in questions, arising from two distinct LFs. The proposals in George (2011), Fox (2012), Chierchia and Caponigro (2013), Mayr (2013) and Nicolae (2013) fall under this category. Here I will demonstrate the approach with George's account. I should note that he includes questions with indefinites in his account of *mention-some answers* but for reasons stated in Section 3.2.1, I set those aside and focus on the modal case here. George (2011: 219) considers the possibility of deriving *mention-some* answers by optionally scoping an existential term above exhaustification but below question formation:

(52) a. Who can fix the printer?

b. [Q [can [X [who fixes the printer]]]]

c. $\lambda p\ \exists r[p = \lambda w'\ \exists w''[\text{can}(w',w'') \wedge \lambda x\ [\text{person}(w'')(x) \wedge \text{fixes}(w'')(\text{the-printer}(x)] = r]]$

d. {^john is someone who in some possible world is the one who can fix the printer, ^bill is someone who in some possible world is the one who can fix the printer, ^john and bill are people who in some possible world are the ones who can fix the printer}

The propositions name sets of individuals who in some accessible world are the individuals who fix the printer, leading again to a choice between several *mention-some* answers. With the modal having scope under exhaustification, we would get

[26] This is distinct from the scope account he proposes later in the dissertation. It is the latter which is given in (51b).

[27] Gr&S (1984: 461–2), who otherwise allow negative answers to questions (*no one*), do not admit them in such cases. George follows their lead on this.

the single proposition naming the set of individuals who in some world or other fix the printer, leading to the *mention-all* answer.

Note that this way of deriving *mention-some* answers requires a shift from George's baseline theory summarized in Section 3.1.4. Now, the exhaustification operation X becomes obligatory, with the distinction between strong exhaustiveness and *mention-some* readings obtained by the optionality of a term's ability to scope out. As a consequence, an existential modal is necessary and sufficient for *mention-some* readings. This has the obvious advantage of predicting their availability in direct and indirect questions with priority modals. Cases where such readings are available because the context makes conversational goals salient, could presumably be handled by positing covert modals. The details, however, would have to be worked out.[28]

The third approach takes the view that a *mention-some answer* is a partial answer that counts as complete for purposes of the conversation at hand, an idea that goes back to Gr&S (1984). Partial answers are of course ubiquitous in question–answer paradigms, so this approach has the parsimony argument going for it. If one needs a way to derive partial answers and if one needs a way to handle conversational dynamics, putting them together seems like a reasonable option. Informally, a semantic answer to the question would be the *mention-all* answer but a cooperative interlocutor would follow the maxims of quantity and relevance in giving a partial answer, without using intonation or hedges to mark it as such. A criticism of this general approach, also going back to Gr&S and reiterated by George (2011), is that *mention-some* answers with embedded questions is problematic for such pragmatic accounts. Attempts to offset such objections can be found in Lahiri (2002a), presented in (51c), Ginzburg (1995) and van Rooij and Schulz (2004). They build contextual parameters into question denotations to encode sensitivity to the goals behind asking a question. Given that not all types of *mention-some* answers survive in indirect contexts, embedding remains an open problem for this approach until the selectiveness of embedded contexts in supporting such contextual parameters can be made precise.

To sum up, it appears that both a scope-based account and an approach in terms of partial answers, augmented by pragmatic principles, are needed to fully account for the phenomenon of *mention-some* answers.

3.2.5 Section summary

This section tried to determine which factors are necessary and/or sufficient for non-exhaustive/*mention-some* answers to count as complete. Somewhat different results were discovered in direct vs. indirect question contexts. In particular, mono-morphemic wh phrases are not a requirement for direct questions but are needed in embedded contexts. A priority possibility modal readily allows for a non-exhaustive construal in direct as well as embedded contexts. A non-modal or

[28] To the extent that weak exhaustiveness is a special case of *mention-some readings*, this seems to lead to an unwelcome correlation between modality and weak exhaustiveness. In fairness to George, of course, we should note that he is inclined to deny the very existence of weak exhaustiveness.

even an epistemic possibility modal requires overt contextual support, and to that extent is more evident in direct question contexts. Some of the work that has been done or is being done in this domain was reviewed, leaving it up to the reader to determine to what extent the particular approaches studied fit the modified empirical picture of *mention-some answers* presented here.

3.3 Selecting for weak, strong, or non-exhaustiveness

The proposals for dealing with strong, weak, and non-exhaustive answers to questions that we have looked at vary in the range of ambiguity they ascribe to questions and, consequently, the formal status they accord to the different types of answers. We will now approach this issue from the perspective of embedding predicates and determine the extent to which these distinctions matter in complement selection. Negative polarity items in questions will also be considered as they provide a strong argument in favor of a grammatical distinction between strong exhaustiveness and weak/non-exhaustiveness.

3.3.1 Embedding predicates

We have looked at embedded questions but we have not paid much attention to the grammatical properties of embedding predicates so far. We can start with the classification of interrogative selecting predicates from Lahiri (2002a: 287). We will restrict ourselves here to issues related to the selection of strong vs. weak exhaustiveness, deferring a broader discussion to Chapter 5:[29]

(53) Predicates that take interrogative complements

- Rogative
  - *wonder, ask, depend on, investigate, examine etc.*
- Responsive
  - Veridical Responsive
    - *know, remember, forget, be aware, tell, communicate, be surprised.*
  - Non-veridical Responsive
    - *be certain (about), conjecture agree (on)*

Heim (1994) noted that the existence of predicates selecting for weak exhaustiveness would be an argument in favor of theories that allow for weak exhaustiveness, such as Karttunen. The absence of such predicates would be an argument for

[29] This classification subsumes the one in Karttunen (1977) and incorporates the distinction between intensional/extensional predicates from Gr&S (1982). We do not include infinitival complements (see Bhatt 1999).

theories that rule out this possibility, such as Gr&S. Most current theories that we have considered allow for both weak and strong readings. This is partly due to the discovery of a class of embedding predicates that do not take strongly exhaustive interrogative complements. This is the class of factive/veridical predicates to which *be surprised* and *be amazed* belong. Let us review some of the relevant arguments.

Heim, drawing on Berman (1991), uses the following scenario to establish that *be surprised* does not embed strongly exhaustive questions (see also Lahiri 1991, 2000, 2002a; Beck and Rullmann 1999; Sharvit 2002; Guerzoni and Sharvit 2007):

(54)

individuals:	John	Bill	Sue
my prior expectations:	Y	Y	Y
callers in *w*:	Y	Y	N

a. It surprised me who called.
b. It surprised me who didn't call.

Assume that John and Bill called as I had expected them to but Sue, who I had also expected would call, did not. According to Berman, (54a) would be judged false and (54b) true in this situation. Let us ignore plural individuals here to keep things simple:

(55) a. ⟦who called⟧ = {^john called, ^bill called, ^sue called}
b. ⟦who didn't call⟧ = {^john didn't call, ^bill didn't call, ^sue didn't call}

Under weak exhaustiveness, (55a) denotes the set of worlds in which both John and Bill called, and this includes some worlds in which Sue also called and some in which she did not. Under the weakly exhaustive reading of (55b), we would have the set of worlds in which Sue didn't call, some of which would include Bill and John as callers/non-callers. In contrast, under the strongly exhaustive interpretation, both would denote the same set of worlds, those in which there are two callers, John and Bill, and one non-caller, Sue.

In order for (54a) to be true, the lexical semantics of *be surprised* requires that the answer to the question *who called* must be a proposition that goes counter to expectations. Since I expected both John and Bill to call, the weakly exhaustive answer *John and Bill called* does not run counter to expectation, so the judgment that (54a) is false is predicted. The weakly exhaustive answer to (54b), instead, *Sue didn't call* does go counter to expectations, and is therefore predicted to be true. Since the strongly exhaustive answer to both (54a) and (54b) is *John and Bill called but Sue didn't*, the answers to both run counter to expectation. Both are predicted to be true, contrary to fact. This establishes that predicates of this class take weakly exhaustive readings of questions.

A second argument for *be surprised* to select weak exhaustiveness is based on Heim's (1994) observation that *de dicto* readings of the wh restrictor are only possible under strong exhaustiveness. Recall from Section 2.2 Beck and Rullmann's (1999) account of the *de dicto/de re* ambiguity. In embedded questions, the common noun is interpreted inside the nucleus, with the world variable varying across worlds or being anchored to the world of evaluation:

(56) a. John knows which students called.
b. know_w (j, $\text{Ans}_{W/S}$(λp $\exists$x [p = λw′[student (**w**) (x) $\wedge$ $\text{called}_{(w')}$ (x)]]))
c. know_w (j, $\text{Ans}_{W/S}$(λp $\exists$x [p = λw′[student (**w′**) (x) $\wedge$ $\text{called}_{(w')}$ (x)]]))

In principle, (56a) can be interpreted in four ways, weak *de re*, strong *de re*, weak *de dicto* and strong *de dicto*. However, Heim observes that *de dicto* readings correlate with strong readings. That is, there is no weak *de dicto* reading.

Sharvit (2002) elaborates on this, adopting Beck and Rullmann's account of *de dicto/de re* ambiguities.[30] She compares predicates like *know*, which show the relevant ambiguity, to predicates like *be surprised*, which do not:

(57) a. Scenario 1. Student Mary and student Sally left. John knows that they are students and that they left. Fred, a non-student, also left. John knows that he left and thinks he is a student.
b. John doesn't REALLY know which students left. Indeed, he knows that Mary and Sally are students who left, but he also thinks that Fred is a student who left.

(58) a. Scenario 2. Student Mary and student Sally left. Student Bill didn't leave. John believes that Mary and Sally are the students who left. John doesn't know that Bill didn't leave.
b. John doesn't REALLY know which students left, because Bill is one student who didn't leave and John doesn't know that Bill didn't leave.

Let us see under what readings *John knows which students left* can be false in scenario (57a). Since John can correctly identify the members of the set of students *{Mary, Sally}* that left, the *de re* readings are true. The weak *de dicto* reading is true as well, since he correctly knows of the two student leavers that they are students and they left. Crucially, it is false under the strong *de dicto* reading since he incorrectly includes Fred as a student who left.[31] Turning to the scenario in (58a), we find that *John knows which students left* is false on the strong *de re* reading because he can't separate the leavers and the non-leavers in the set of students *{Mary, Sally, Bill}*. It is true on the strong *de dicto* reading: John can correctly divide the student-leavers *{Mary, Sally}* from the set of individuals who are non-leavers or non-students *{Bill}*. The acceptability of (58b) is based on the strong *de*

[30] See Section 2.2 on this. Crucially, here we are talking of a *de dicto/de re* ambiguity with reference to the wh phrase. In Section 3.1 we discussed *de dicto/de re* ambiguity with respect to the whole interrogative clause.

[31] The weak *de re* reading merely requires John to have an attitude to the proposition: *Mary and Sally left.* Their status as students is not relevant, neither is the student-hood of Fred or his leaving. The strong *de dicto* reading requires him to have an attitude to the proposition: *the students who left are Mary and Sally.*

re reading of the embedded question. To sum up, we have evidence for a three-way distinction with predicates selecting for strong exhaustiveness: weak *de re*, strong *de re*, and strong *de dicto* readings. We do not have evidence of weak *de dicto* readings.

Returning to *be surprised*, if it can be shown not to have *de dicto* readings, there will be added support to its status as selecting exclusively for weak exhaustivity:

(59) a. It surprised John which students left.
b. <u>Scenario 3</u>. Student Mary and student Sally, the only students, left. John is surprised that Mary and Sally left, but he doesn't know that they are students.
c. #It didn't REALLY surprise John which students left. Indeed, he didn't expect Mary and Sally—the only students who left—to leave, but he wasn't aware that they are students.

The scenario in (59b) shows that (59a) is true on its *de re* reading. John would admit to not expecting Mary and Sally to leave, but their status as students wouldn't enter into it. Sharvit presents the oddity of (59c) as evidence that (59a) doesn't have a *de dicto* reading. She further shows that it is impossible to construct a scenario in which a *de dicto* reading would be true and a *de re* reading false. This is consistent with the predicate selecting exclusively for weak exhaustiveness, on the view that there is a single source for strong exhaustivity and *de dicto* readings. Sharvit's discussion of the *de dicto/de re* ambiguities is incisive but ends on an intriguing note. The absence of non-veridical weakly exhaustive verbs is noted as an accidental gap, not predicted by any theory.[32]

Our concern in the rest of this section will be on predicates that exclusively select for weak exhaustiveness but I would like to touch upon one non-veridical predicate *agree on*, and its relation to exhaustiveness and *de dicto/ de re* ambiguities. Sharvit (2002: 114) adopts Beck and Rullmann's (1999) semantics for *agree on* but not their contention that the weak/strong distinction is only relevant for veridical predicates (see also Klinedinst and Rothschild 2011):

(60) a. $[\![\text{agree-on}^{B\&R}]\!](Q)(w)(A) = 1$ iff
(a) for all x in A and all p in Q(w), if x believes in w that p is true, then for any y in A, y believes in w that p is true; and
(b) for all x in A and all p in Q(w), if x believes in w that p is false, then for any y in A, y believes in w that p is false;

b.

individuals:	John	Bill	Sue	*Harry*
Mary's beliefs:	Y	Y	N	*N*
Jane's beliefs:	Y	Y	N	—

c. Jane and Mary agree on who called.
d. Q = {john called, bill called, sue called, *harry called*}; A = mary+jane

[32] See Nicolae (2013) for discussion. Thanks also to Andreea Nicolae (p.c.) for helpful comments.

The lexical semantics of the verb requires that the only propositions that matter are those that the agents have views about. In the scenario (60b), ignoring Harry for now, (60c) would be true because Jane and Mary's beliefs coincide for all the individuals that they have beliefs about. The predicate being non-veridical, the facts are irrelevant. *Agree on* passes muster as selecting for strong exhaustiveness.

Now, throwing Harry into the mix, we find that Mary has a belief about Harry but Jane does not. If *agree on* optionally allows for a weak reading, then its semantics, under this reading, would only consider the first clause in (60a). Example (60c) would still be judged true under its weak reading, though false under its strong reading. Sharvit (2002: 112–15) presents the following to argue against this possibility:

(61) a. Bill and Mary do not REALLY agree on who cheated on the exam. For example, Mary thinks that Bob didn't cheat and Bill has no opinion about Bob.

b. John doesn't REALLY know who left. For example, he doesn't know that Sally didn't leave.

c. It didn't REALLY surprise Bill who cheated on the exam. # For example, it didn't surprise him that Mary didn't cheat.

Sharvit concludes that *agree on* can select strong or weak exhaustiveness, analogously to *know* and distinct from *be surprised.*

Guerzoni and Sharvit (2007: 387) round off the discussion by considering rogative predicates. They treat verbs like *wonder* as internal counterparts of direct questions and provide the following semantics for them (Guerzoni and Sharvit 2007: 387):

(62) $[\![\text{wonder-strong}]\!]^{w}(Q)(x)$ is defined only if it is not the case that for all $p \in Q$ s.t. $p(w)$, x believes p in w.
When defined, $[\![\text{wonder-strong}]\!]^{w}(Q)(x)$ = True iff for every p in Q, x wants to know whether p is true or not.

We will see below that their characterization is related to their views on NPI licensing.

3.3.2 NPI licensing and exhaustiveness

We have seen evidence from embedding predicates that both strong and weak exhaustiveness need to be recognized in the semantics of questions. But if such a distinction exists, we may rightly expect it to be manifested elsewhere in the grammar. Guerzoni and Sharvit (2007) argue for precisely this. The fact that questions allow negative polarity items (NPI) poses a challenge. NPIs are licensed in contexts that are (Strawson) downward entailing:

(63) a. John bought a car / *any car.
b. John didn't buy a car / any car.
c. Only John bought a car / any car.

Affirmative sentences are upward rather than downward entailing: *buying a car* entails *buying something* but not *buying a red car*. Consequently, they do not allow NPIs like *any N* (63a). Negative sentences reverse entailments and create hospitable contexts for NPIs. More interesting is the case of *only*, which is not downward entailing (*only John bought a car* does not entail *only John bought a red car*) and yet licenses *any*. von Fintel (1999) accounts for this by arguing that the entailment pattern has to be tested in contexts in which the presuppositions of the sentences tested are satisfied. If we confine ourselves, for example, to contexts in which John bought a red car, then it does follow from *only John bought a car* (63c) that *only John bought a red car*. This makes the proposition in the scope of *only* a Strawson downward entailing context and predicts the acceptability of *any*.

Turning to questions, it is hard to apply the notion of entailment to them (see Ladusaw 1979). We might, for example, want to say that a question A entails a question B if answering A completely answers B. But by this measure, questions do not appear to be downward entailing. Answering *did John buy a car?* does not provide an answer to *did John by a red car?* And yet, NPIs are possible in questions. Setting that aside, Guerzoni and Sharvit (2007) observe a correlation that ties in with the concerns of this chapter:

(64) a. Did you eat anything?
b. Who cooked anything?

(65) a. Claire wonders whether Frank has any books on Negative Polarity.
b. Claire knows whether Frank has any books on Negative Polarity.

(66) a. *It surprised Bill which students had ever been to Paris.
b. Claire wonders which students have any books on Negative Polarity.
c. %Claire knows which students have any books on Negative Polarity.

They argue that NPI licensing goes hand in hand with strong exhaustiveness. Polar questions are patently strongly exhaustive since the two propositions in their denotation represent a binary partition of the space of possibilities. To know one proposition in the Hamblin set to be true is to know that it can be the only true proposition in the set, or equivalently, to know the other to be false. Uncontroversially, NPIs in direct as well as indirect polar questions are grammatical, (64a) and (65). In the case of constituent questions as well, direct questions admit NPI (64b). Indirect questions, however, do so depending on the embedding predicate. Predicates that have been argued to select for weak exhaustiveness, such as *be surprised*, do not license NPIs (66a), while predicates like *wonder*, which arguably select for strong exhaustiveness, do so readily (66b). With *know* (66c), Guerzoni and Sharvit report cross-speaker variation. The diacritic % indicates that for some speakers it is fully acceptable, while for others it is not.

Speakers who accept NPIs, they contend, draw on the strongly exhaustive nature of *know*, while those who do not, display sensitivity to its weakly exhaustive nature.

Explanations for Guerzoni and Sharvit's generalization have been provided by Mayr (2013) and Nicolae (2013). Working independently, they both develop accounts that fall broadly within the alternatives and exhaustification approach to polarity (Chierchia 2013). Nicolae's proposal was summarized briefly in Section 3.1.4. The essential idea is that questions have an optional exhaustification operator, analogous to *only* inside the nucleus, which accounts for strong exhaustiveness. Given that *only* creates a Strawson downward entailing environment, the correlation of NPI licensing with strong exhaustiveness is expected:[33]

(67) a. *Who wrote anything?
b. *Weak Exhaustiveness: [Who$_i$ [t$_i$ wrote anything]] = {^a wrote anything, ^b wrote anything}

(68) a. Who wrote anything?
b. Strong Exhaustiveness: [Who$_i$ [**Only** t$_i$ wrote something]] = {^only a wrote anything, ^only b wrote anything}

Mayr (2013) addresses this problem somewhat differently. He draws on the account of polarity licensing in Chierchia (2013) and combines a Karttunen-question semantics, alternatives introduced by NPIs, and a strong exhaustive answer operator. The resulting answers to questions are shown to be downward entailing. Due to constraints of space, however, I leave the details for the reader to pursue on their own.

Both Nicolae and Mayr predict not only that predicates like *be surprised* should not allow NPI, as observed by Guerzoni and Sharvit, but also that *mention-some answers* should not allow them. Mayr makes this explicit:

(69) a. Where can I buy the New York Times?
b. *Where can I buy any newspaper?

We can draw two conclusions from these analyses. The first is that questions are ambiguous between a strongly exhaustive and a weakly exhaustive or non-exhaustive reading. The second is that there are predicates that do not select for strongly exhaustive readings of questions. The issue that remains open is whether the predicates that do not select for strongly exhaustive questions select for weakly exhaustive questions or for *mention-some* questions or both. George (2011) suggests that they take *mention-some* complements and Nicolae that they take both weakly exhaustive and *mention-some* complements. Mayr seems to be neutral on this. A potential diagnostic to test this issue may be the possibility of *wh*-ALL in the complement of such predicates: *John was surprised*

[33] Note that there is a disconnect between question denotations and possible answers. Covert *only* licenses NPI in questions but a possible answer cannot have an NPI unless overt *only* is used. See Nicolae (2013: 39–41) for discussion.

at who all showed up. Beck and Rullmann (1999) have argued convincingly that *wh-ALL* is incompatible with a *mention-some* answer. If *be surprised* cannot take strongly exhaustive answers, the acceptability of *wh-ALL* in the complement of this predicate shows that it takes weakly exhaustive answers and suggests a grammatical distinction between *weakly exhaustive* and *mention-some* readings.

3.3.3 Problematic NPIs

The accounts presented above represent real advances in our understanding of NPI licensing in questions. At the same time, I believe the data they seek to capture is more nuanced than what we have seen. Consider the following contrasts (Lahiri 1991: 67–8):

(70) a. *I know how he ever did it.
 b. I wonder how he ever did it.
 c. I don't know how he ever did it.

(71) a. *I know why anyone bothers to listen to him.
 b. I wonder why anyone bothers to listen to him.
 c. I don't know why anyone bothers to listen to him.

The shift in judgments between positive and negative versions of the same predicate, here *know*, raises non-trivial questions for accounts based on selectional properties of embedding predicates.

The alignment of the negative responsive predicate like *not know* with rogative predicates like *wonder*, seen above, has also been noted to affect the possibility of inversion in certain dialects of English (McCloskey 2006). That is, they manifest the syntax of matrix questions:

(72) a. *They know/discovered who was she dancing with at the party.
 b. They wondered/were asking who was she dancing with at the party.
 c. They wanted to know who was she dancing with at the party.
 d. They don't know who was she dancing with at the party.

If embedded clauses can lose their normal subordinate status under negation or modality, NPI licensing is predicted to follow the pattern of direct questions. Some preliminary discussion on this topic can be found in Dayal and Grimshaw (2009) and is briefly addressed in Chapter 5. As things stand, however, these data do not fall in line with the view that *know* can license NPIs because it can embed strongly exhaustive questions.[34]

[34] NPIs are not acceptable in subject position in constituent questions but the problem with (71a) remains even when this is controlled for, especially if a generic interpretation is factored out: **I know why John bothered to listen to anyone* or **I know why John bothered anyone.*

Another cautionary note comes from NPI in *mention-some* answers. While it is true that they are not perfect, they are not ruled out either. I note the following, based on very preliminary investigation. The contexts are set up to highlight the teleological conversational goals, making the expectation of a *mention-some answer* prominent:

(73) a. Context: A teacher planning a project wants to include a student who has visited Asia, even if it was a long time back.
b. Who has ever been to Asia? I need a volunteer for my project.
c. Bill has been to Asia. His parents were posted there.
(or John, I know he traveled to several countries in Asia last summer).

(74) a. Context: I am cooking something for which I need some exotic spices. I don't have a high expectation that the stores in my small town will carry such specialty items. But I'm willing to settle for some substitutes.
b. Where do they sell any spices in this town?
c. At Shoprite. Or even at Pathmark.

Speakers find the NPI in (73b) and (74b) either redundant or somewhat awkward but not entirely unacceptable. The resistance is certainly not of the order one finds in simple affirmative statements with NPI, even when they are uttered in response to questions with NPI:

(75) a. *Bill has ever been to Asia.
b. *They sell any spices at Shoprite.

While one cannot disregard the substantive results of the analyses discussed earlier, the facts listed here are worth keeping in mind as we move forward. They point to factors other than strong exhaustiveness as also being significant for NPI licensing in questions.

3.3.4 Section summary

Here we looked at embedding predicates to determine if they show sensitivity to strong vs. weak exhaustiveness. We looked at arguments from rogative and responsive predicates whose selectional properties suggest that such a distinction between predicates is needed. We also noted that the distinction correlates with the differential behavior of predicates with respect to NPI licensing. Though there remain several interesting strands for further investigation, our present understanding of the phenomenon supports the view that some distinction along the lines of strong and weak/non-exhaustiveness is called for. And there may even be an argument for a three-way distinction from particles that require exhaustiveness occurring in combination with predicates that do not select for strong exhaustiveness.

3.4 Exhaustiveness in the baseline theory

This chapter expanded the range of direct answers that questions admit to include *strongly exhaustive*, *weakly exhaustive*, and *non-exhaustive answers* and explored the implications of this for the semantics of questions. Several different proposals, as well as the empirical considerations behind those proposals, were discussed. I will now highlight the most significant ideas that emerged from our discussion, without attempting to integrate them into a uniform theory of questions.

We began with the difference between weak and strong exhaustiveness and proposed that there is only a single answerhood operator that delivers weak exhaustiveness: Ans-D_W. A structure like [x V Q] has a weakly exhaustive reading when the agent has an attitude to a proposition that the speaker recognizes as *Ans-D_W(Q)* but not the agent; it has a strongly exhaustive reading when the agent recognizes the connection. In direct question–answer paradigms, the answer has a strongly exhaustive reading because the speaker asserts not just the proposition *simpliciter* but rather the proposition as being identical to *Ans-D_W(Q)*. Keeping to weak exhaustiveness as the basic building block for mediating between questions and answers makes it possible to maintain a distinction between positive and negative versions of questions. Other proposals in the literature take the question itself to be ambiguous, encoding an optional exhaustification operation inside the question nucleus. Depending on the answerhood operators assumed, such proposals yield an ambiguity between strong exhaustiveness on the one hand and weak and/or non-exhaustiveness on the other.

We then considered the role of contextual as well as structural properties in making available a non-exhaustive construal of questions. Here we identified a difference between direct questions and indirect questions. Mono-morphemic wh phrases combined with priority existential modals always allow for them, while complex wh phrases and non-modal/epistemic modal questions only do so with explicit contextual support, one where a positive answer to the question addresses the conversational goals. Such contextual support is easier to integrate into direct questions, so *mention-some* construals of non-modal or epistemic modal questions tend to be restricted to direct questions. We discussed three current approaches to *mention-some* answers but none of them capture the duality within the phenomenon. A combination of structural and pragmatic approaches appears to be best positioned to capture the facts. The discussion also addressed the issue of number implicatures. Complex noun phrases, which obligatorily come with number restrictions, seem resistant to *mention-some* construals. This is because the uniqueness presupposition of singular wh phrases blurs the distinction between *mention-all*/*mention-some*. Plural wh expressions, instead, require special contexts to make salient a non-exhaustive plural answer as meeting the conversational goals. Mono-morphemic wh expressions, we concluded, are underspecified with respect to number since they show the behavior of neither type of complex wh phrase.

The final section of the chapter approached the issue of exhaustiveness from the perspective of embedding predicates. The fact that some predicates do not force strong exhaustiveness and that some predicates explicitly reject strong exhaustiveness is an argument for maintaining the distinction between strong exhaustiveness and weak/non-exhaustiveness. This divide is further supported by the differential behavior of negative polarity items in questions. While there is no evidence directly from embedding predicates for a three-way distinction between strongly exhaustive, weakly exhaustive, and non-exhaustive readings, there may be one in combination with the possibility of *wh*-ALL type phrases in the complement of predicates that reject strong exhaustiveness.

4

Single-pair, pair-list, and functional answers

Multiple constituent questions and questions with quantifiers admit answers expressing relations between individuals, either with a description or with a list. This means that there are now three types of answers that a theory of questions must account for: individual answers, which we have been studying, relational/functional answers, and pair-list answers. To add to the complexity, functional and list answers turn out to be a heterogenous class. This chapter presents diagnostics for distinguishing between different types of list and functional answers, clearly identifying the factors responsible for shifts in interpretation. It also introduces readers to technical details of specific proposals.

Pair-list answers to multiple wh questions and questions with universal quantifiers seem to involve a functional dependency between two sets. Answers exhaustively pair all the members of one set in a one–one or many–one relation to members of the other set. Questions with quantifiers also allow functional answers. We explore possible connections between these two types of answers. Questions with plural definites seem to allow functional and list answers as well but they do not align with questions with quantifiers in crucial ways, suggesting distinct accounts for the two types of questions.

Functional answers to questions with quantifiers require quantification over Skolem functions, functions from individuals to individuals. Do Skolem functions leave complex traces that can explain syntactic restrictions on the availability of functional answers? What determines whether a quantifier can admit pair-list answers? Can an account of questions with quantifiers apply to multiple wh questions? Do questions with indefinites belong in this set? These are among the issues probed here.

The functional approach is shown to fall short of capturing the functionality of pair-list answers: the need to list every member of the domain set and the requirement of unique pairing for each such individual. Two solutions are considered, one which modifies the functional approach and one which uses higher order questions. Empirical and theoretical considerations are weighed in relation to both. The derivation of higher order questions is discussed in the context of pair-list answers, echo questions, and scope marking.

The last section considers three responses in the literature to the proposals for list answers. The first touches upon differences between matrix and embedded questions with respect to their availability. The second looks at the differential

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behavior of *every N* and *each N* with respect to structural sensitivity. The third treats pair-list readings as quantification at the level of speech acts.

4.1 Pair-list and functional answers

This section explores challenges posed by constituent questions that have, in addition to a wh phrase, another quantificational expression: a second wh phrase or a universal quantifier. The first type of question admits individual and pair-list answers. The second type of question admits individual, pair-list, and functional answers. The discussion seeks to establish points of overlap between pair-list and functional answers as well as their relation to individual answers. These distinctions are particularly important in separating questions with plural definites from questions with universal quantifiers.

4.1.1 Lists and multiple constituent questions

Limiting the discussion to questions with two wh phrases, a question like (1a) can be answered with (1b) or (1c). Within our baseline theory it is analyzed as (2). If there are two students, Alice and Bill, and two professors, Prof. Carl and Prof. Dan, we get the denotation in (2b):[1]

(1) a. Which student met which professor?
    b. Bill met Professor Carl.
    c. Bill met Professor Carl and Alice met Professor Dan.

(2) a. $\lambda p\ \exists x\ \exists y\ [\text{student}_w(x) \wedge \text{professor}_w(y) \wedge p = \lambda w'\ \text{met}_{w'}\ (x,y)]$
    b. $\{\underline{\lambda w\ \text{Bill met}_w\ \text{Prof. Carl}}, \lambda w\ \text{Bill met}_w\ \text{Prof. Dan},$
    $\lambda w\ \text{Alice met}_w\ \text{Prof. Carl}, \lambda w\ \text{Alice met}_w\ \text{Prof. Dan}\}$
    c. $\text{Ans-D} = \lambda Q\ \lambda w\ \iota p\ [Q(p) \wedge p(w) \wedge \forall p'[[Q(p') \wedge p'(w)] \rightarrow p \subseteq p']]$

The two wh phrases are interpreted as existential quantifiers binding two argument positions inside the nucleus. The question thus denotes a Hamblin set with propositions varying on values for both variables. If only Bill met Prof. Carl, the only true proposition in the set will be the one underlined in (2b) and the answerhood operator (2c) will pick it out.[2] This is the single-pair answer to the multiple constituent question: (1b) is the analog of the individual answer to single constituent questions.

If, however, Bill met Prof. Carl and Alice Prof. Dan, Ans-D(2b) will be undefined. There will be two true propositions in the set, neither of which will entail the other. The absence of uniqueness will lead to infelicity. This theoretical

[1] A related construction has conjoined wh phrases: *where and when did you see him?* See Comorovski (1996) and Ratiu (2011a).

[2] I suppress reference to weak and strong versions of Ans-D when the distinction is not relevant to the point under discussion. (2c) captures weak exhaustiveness (see Chapter 3).

prediction flies in the face of ground reality: the pair-list answer (1c) is not only acceptable, it is possibly a more natural answer than the single-pair answer (1b).

Historically, it is the single-pair answer that has had to be defended at the empirical level. Pope (1976), who dubs them REF-QS, shows that single-pair answers are appropriate in contexts that establish the existence of a unique pair of individuals, but not their identity:[3]

(3) a. Speaker A: That student couldn't solve the problem.
Speaker B: Which student couldn't solve which problem?
b. Mother breaking up a fight between her two children: OK, who hit who first?

The possibility of (1b) and (1c) as possible answers raises the issue of a potential ambiguity. Even though Ans-D delivers only one of the possible answers, suggesting the need for a second account, it does not settle the question. One could argue that there is no restriction on the number of propositions in the set that can be true in a given world. It is in contexts that do not favor the possibility of multiple pairs that the single-pair answer becomes visible.

Recall from Chapter 2, however, the reason for building uniqueness into Ans-D via the use of *iota*:

(4) a. Which student/which students/who called?
b. {λw Bill called$_w$, λw Alice called$_w$}
c. { λw Bill called$_w$, λw Alice called$_w$, λw Bill+Alice called$_w$}

The choice of the singular term presupposes that only a single individual will be named in the answer, the choice of the plural term implies that a plurality will be named, while the choice of the neutral term leaves both options open. Adopting standard assumptions about interpreting number, (4a) with *which student* denotes propositional sets like (4b), naming atomic individuals, while (4a) with *which students* or *who* denotes propositional sets like (4c), naming both atomic and plural individuals. Ans-D applied to (4b) picks out a single true proposition if there is one, delivering uniqueness in the case of *which student*. The choice of an overtly plural wh phrase, due to the existential presupposition of the question: *some students called*, requires the proposition picked by Ans-D to name a plurality. Returning to multiple constituent questions, I submit that since Ans-D is needed for single constituent questions, the single-pair answer to multiple constituent questions comes at no extra cost to the theory. The challenge is to extend the system to derive pair-list answers.

The problem under discussion is not a consequence of the particular theory we have chosen but holds of any account that takes the shift from uniqueness in single constituent questions to multiple pairs in multiple constituent questions to

[3] Wachowicz (1974, 1975) classifies them with echo questions, but Pope shows that REF-QS and echo questions are intonationally distinct. See also Bolinger (1978), Bartels (1997), and Truckenbrodt (2013). Also, both mono-morphemic and complex wh phrases admit such answers, contrary to what has been claimed for English by Boškovic (2001).

be a semantic phenomenon. Higginbotham and May (1981), the first to address this problem, argues that pair-list answers represent one-to-one bijective relations (see also Dayal 1991a, 1991b).[4] If there are strict restrictions on pairings, a semantic rather than a pragmatic solution is called for. Engdahl (1986: 154), however, questions the basis for the semantic operation of *absorption* proposed by them, noting cases that violate bijection:

(5) a. Which table ordered which wine?
  b. Table A ordered the Ridge Zinfandel, Table B ordered the Chardonay and Table C ordered the Rose and the Bordeaux.

Dayal (1996: 105–8) resurrects the argument for a semantic account based on a different set of facts. The relevant constraints are identifiable when quantification is restricted to a very small domain:

(6) a. Which student talked to which professor?
  b. Alice and Bill both talked to Professor Carl.
  c. #Alice talked to Professors Carl and Dan.

(7) a. $a \rightarrow c$ b. $a \rightarrow c$ c. $*a \rightarrow c$
  $b \rightarrow d$ $b \nearrow d$ $b \searrow d$

Example (6) establishes that the relations at issue are really functions. Pair-list answers exhibit *domain-cover*: every member of the set denoted by the first wh phrase must be connected to some member in the set denoted by the second wh phrase.[5] And, they admit pairings that are one-to-one (7a) or many-to-one (7b) but not one-to-many (7c). Such clear constraints show that a semantic explanation for the shift from uniqueness to pair-lists is, after all, needed. Dayal suggests that counterexamples like (5) are only felicitous when most of the pairs are expected to fall in line with functions, with the deviations being exceptions rather than the norm. Although pair-lists are a semantic phenomenon, pragmatics comes into play in accounting for such semantically deviant cooperative responses.

The notion of *domain cover* has a natural connection with universal quantification. Multiple wh questions had been linked to questions with universal quantifiers by Groenendijk and Stokhof (1984, henceforth Gr&S), Comorovski (1989, 1996), and É Kiss (1993). However these authors either explicitly allow, or remain agnostic on whether an individual in the first set can be freely paired with any number of individuals in the second set, in contrast to what we have observed. Here we will take pair-list answers to multiple constituent questions to obey not only *domain cover* but also functional pairing and use *functionality* as a cover term

[4] See Partee et al. (1990) and Chierchia and McConnell-Ginet (2000) on relations and functions.

[5] Dayal uses the term *exhaustivity* to express this property, marking a distinction from *weak/strong exhaustiveness* of Gr&S (1982, 1984). However, *exhaustivity* is now used interchangeably with *exhaustiveness*, so I adopt the term *domain cover* from Bittner (1998).

for both properties. The challenge, then, is to formally capture functionality in multiple wh questions while preserving uniqueness in single constituent questions.

4.1.2 Lists and questions with quantifiers

Turning to single constituent questions with universal quantifiers and focusing on *every N* for now, we find functionality in pair-list answers to them as well. Karttunen (1977: 31–3), crediting Hull (1974), notes the existence of pair-list answers (8c) and Engdahl (1980, 1986) and Gr&S (1984) extend the paradigm to include functional answers (8d):[6]

(8) a. Which professor does every student like?
b. Every student likes Prof. Carl.
c. Bill likes Prof. Carl and Alice likes Prof. Dan.
d. Every student likes his/her advisor.

The theories considered so far only account for individual answers ((8b)). Let us see why:

(9) a. $\lambda p\ \exists x\ [\text{professor}_w\ (x) \wedge p = \lambda w'\ \forall y\ [\text{student}_w\ (y) \rightarrow \text{like}_{w'}\ (y,x)]]$
b. $\{\lambda w$ every student likes_w Professor Carl,
λw every student likes_w Prof. Dan$\}$
c. $\begin{tikzcd} a \arrow[r] & c \\ b \arrow[ur] & d \end{tikzcd}$ d. $\begin{tikzcd} a \arrow[dr] & c \\ b \arrow[r] & d \end{tikzcd}$

For some value of x, x = a professor, (9a) admits propositions where every student stands in the *like* relation to that x. That is, it describes the situations depicted in (9c)–(9d). The only pair-list answer possible would be an elaboration of one of the propositions in (9b), with all the students paired with the same professor. And the only functional answer would be one where all the students have the same advisor. But we know that professors can vary with students (8c)–(8d).

Intuitively, we want to give the universal scope over the wh, as in (10a). But Karttunen shows that this move is miguided. Consider the model in (10b) and the three propositions in (10c)–(10e). If (10a) is evaluated at *w1* we want Ans-D to pick out proposition (10e):

(10) a. $\lambda p\ \forall y\ [\text{student}_w\ (y) \rightarrow \exists x\ [\text{professor}_w\ (x) \wedge \boldsymbol{p = \lambda w'\ \text{like}_{w'}\ (y, x)}\ ]\ ]$
b.

	<B, Prof.C>	<A, Prof.D>	<B, Prof.D>	<A, Prof.C>
w1	Y	Y	N	N
w2	N	Y	Y	N
w3	Y	Y	Y	Y
w4	Y	N	N	Y

[6] Karttunen's example uses wh expressions of the form *what N*, which have special properties (see Chapter 6) that are orthogonal to our current concerns.

c. λw Bill likes$_w$ Prof. Carl = {w1, w3, w4}
d. λw Alice likes$_w$ Prof. Dan = {w1, w2, w3}
e. λw [Bill likes$_w$ Prof. Carl $\wedge$ Alice likes$_w$ Prof. Dan] = {w1, w3}

The proposed logical form in (10a) will let in a proposition *p* iff for every student *y* there is some professor *x*, and *p* denotes the same set of worlds as the nucleus proposition. But there is no proposition that meets these conditions if the domain has more than one student. This holds even if there are two students who both like the same professor. The set of worlds denoted by $\lambda w\ like_w(y,c)$ will not be the same when *y* is set to *a* and when *y* is set to *b*. Quantifying in a universal as in (10a) can only yield a meaningful non-empty set of propositions in worlds with just one student. However, a felicitous use of *every student* requires quite the opposite, a world with a plurality of students.[7] We need an alternative account of pair-list answers to questions with quantifiers.

Functional answers involve the same issues and thus raise the question of their relation to pair-list answers. Are they just alternative ways of expressing a situation in which there is variation or is there a deeper semantic connection? The early syntactic literature (May 1985) does not pay much attention to functional answers, treating them as succinct ways of expressing lists. Engdahl (1980, 1986) argues, however, that functional answers have a bona fide independent status (see also Gr&S 1984; Chierchia 1991, 1993). She extends Karttunen's semantics to allow wh expressions to range over Skolem functions, functions from individuals to individuals. Deferring formal details of the proposal to Section 4.2, let us see what we can establish on the basis of this informal characterization of Engdahl's position.

An important argument in favor of the independence of functional answers is that they are available with quantifiers that do not support pair-list answers:

(11) a. Who does no man like?
b. His mother-in-law.
c. #Bill doesn't like Alice and Bob doesn't like Sue.

Absent pair-lists as source, functional answers must represent a basic reading of the question.

In the reverse, one can ask if pair-list answers always derive from functional answers. Engdahl (1980, 1986) and Chierchia (1991, 1993) argue in favor of doing so, since pair-list answers are available in a subset of cases which allow functional answers. Gr&S (1984: 178), instead, treat the two as independent of each other:

(12) a.
$$\begin{array}{lcl} \textit{son} & & \textit{mother}\\ \text{John} & \rightarrow & \text{Mary}\\ & \nearrow & \\ \text{Bill} & \rightarrow & \text{Suzy}\\ \text{Peter} & \rightarrow & \text{Jane}\end{array}$$

[7] Karttunen also points out that in worlds with no students (10a) will let in any old proposition since they will all satisfy the conditions vacuously. But, of course, Ans-D predicts infelicity since it will be undefined if its existence/uniqueness presuppositions are not met.

b. Which woman does every man love?
c. His mother (John loves Mary, Bill loves Suzy, and Peter loves Jane).
d. John loves Mary, Bill loves Suzy and Mary, and Peter loves Jane.

Gr&S contend that in a situation like (12a), question (12b) can be satisfactorily and completely answered with the functional answer in (12c), with the elaboration given in parentheses. Their point is that there is a reading of (12b) that asks for a pair-list answer and in that case, the complete answer is (12d). This includes the pair *bill* and *mary*, a pair that would not be picked out by the *mother-of* function.

Note that (12d) is subject to the same caveats as example (5) from Section 4.1.1. The answer violates the presupposition of (12b) that each man loves exactly one woman. But Gr&S's general point can be made by substituting the neutral wh *who* in place of *which woman*. Under a pair list reading it would require all the pairs to be named but under a functional reading it would leave out the pair that does not fit the functional description *mother-of*. Arguably, though, even this pair list could be the extension of a function, since *who* would allow *bill* to be functionally related to a plural individual *mary+suzy*. It is just that such a function may not be a *natural* function that could be described by a canonical relational term like *mother-of* or *sister-of* (Engdahl 1986: 180). Once number morphology is controlled for, Gr&S's counterexample can be brought under the umbrella of list answers derived from functional answers.

Chierchia (1991, 1993) adds yet another argument linking list answers to functional answers. He observes that both pair list and functional answers become unavailable when the universal is in object rather than subject position. Again, deferring the explanation he provides until Section 4.2, it is the correlation itself that makes the case for a dependence between the two. It also establishes that functional answers are not derived from individual answers which are always available, regardless of the position of the quantifier:

(13) a. Which student likes every professor?
b. #Bill likes Prof. Smith and Alice likes Prof. Jones.
c. #His advisee likes every professor.

The evidence presented here overwhelmingly argues for an independent status for functional answers to questions with universal quantifiers, and for list answers to be derived from functional answers.

4.1.3 Lists and questions with plural definites

Gr&S (1984: 181) identify questions with plural definites as allowing pair-list answers as well (see also Pritchett 1990). On the face of it, this seems to be the case:

(14) a. Who do these men like?
b. These men like Sue and Jane.

c. John likes Sue, and Bill likes Jane.
d. These men like their mothers

Dayal (1992, 1996) and Krifka (1992) note two crucial differences that argue for a separate explanation, however. First, the subject–object asymmetry brought out by (13) does not hold for questions with plural definites:

(15) a. Who likes these men?
b. Sue likes John and Jane likes Bill.
c. Their mothers like these men.

Second, the pair list reading is not possible if the wh expression is singular:

(16) a. Which woman do these men like?
b. These men like Sue.
c. #John likes Sue, and Bill likes Jane.
d. These men like their mother.

Note that the functional answer in (16d) is only acceptable if the men are siblings. In other words, it is an individual answer. If pair-lists are derivative on functional answers, it is not surprising that there should be no pair-list answer. Substitution with a plural wh, *which women do these men like*, makes the point in a different way. The plural version still allows the same kind of pairing as the original. Its universal counterpart, *which women does every man like*, calls for a pairing of each man with more than one woman. Thus, functional and pair-list answers to questions with plural definites are distinct from functional and pair-list answers to questions with quantifiers.

Dayal and Krifka treat questions with plural definites as only allowing individual answers. Since definites denote individuals, whether singular or plural, the only kind of functional/list answers they can enter into are trivial. The domain set has only a single individual, making the functional answer equivalent to the individual answer. Individual answers, however, can be elaborated into list answers in the right circumstances. Scha (1981) shows that sentences like (17a) are true in situations where the total number of computers bought by a group of 200 Dutch firms is 600. Such cumulative readings require a relationship between every member of each group with some member of the other group ((17b)), but the pairings are otherwise unrestricted:

(17) a. 200 Dutch firms bought 600 computers.
b. $\forall x\ [\text{200-Dutch firms}(x) \rightarrow \exists y\ [\text{600-computers}(y) \wedge \text{bought}(x,y)]] \wedge$
$\forall y\ [\text{600-computers}(y) \rightarrow \exists x\ [\text{200-Dutch firms}(x) \wedge \text{bought}(x,y)]]$

Dayal and Krifka treat pair-list answers to questions with plural definites as instances of the cumulative reading of individual answers with two plural terms:

(18) a. Who do these men like?
b. These men like Sue and Jane
c. λw john+bill like$_w$ sue+jane

The individual answer (18b), with the logical representation (18c), can be expressed as a "functional" answer if the term *their mothers* can be used for the plural individual *sue+jane*. Or it can be expressed in a list which clarifies how the relation distributes down to the atomic individuals. This approach successfully captures the requirement for a plural or neutral wh expression in the question and the absence of structural sensitivity. It further implies a greater role for pragmatics in determining the nature of the pairings. *These men like their wives* is likely to lead to a one–one pairing in monogamous societies, while *these men like their sisters* need not. Dayal (1996: 143) formalizes the conditions under which a pair-list can be taken as a cooperative spell-out of the individual answer:

(19) *Cumulativity Constraint-1:* A list answer of the form $a_1R\ b_1,\ldots a_nR\ b_n$ to a question Q is acceptable at a world w iff $a_1+\ldots+a_n\ R\ b_1+\ldots+b_n = Ans\text{-}D\ (Q)(w)$.

The analysis of pair-list answers to questions with plural definites as the cooperatively spelt out cumulative reading of an individual answer is generally accepted in current literature and, as such, it will not be probed further in this chapter.

4.1.4 Section summary

This section has highlighted the striking parallelism between multiple constituent questions and questions with quantifiers. Both types of questions allow pair-list answers that call for an extension of our baseline theory of questions. List answers are grammatically constrained to spell out pairings that suggest a functional basis for them. This correlates in an interesting way with the fact that questions with quantifiers allow functional answers that cannot be reduced to individual or pair-list answers. Questions with plural definites do not have genuine pair-list or functional answers. Apparent pair-list answers are cooperative elaborations of an individual answer with two plural terms and apparent functional answers are individual answers that use a relational noun to refer to a plural individual.

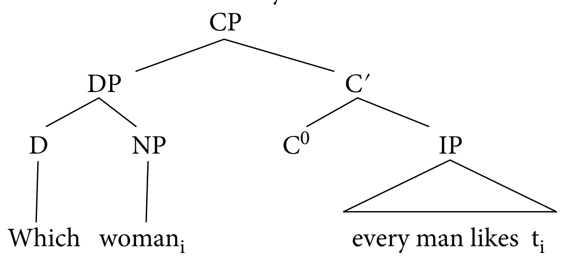
4.2 The function-based approach to pair-list answers

We now extend the baseline theory to include quantification over Skolem functions in questions with quantifiers and build structural sensitivity into the system to account for subject–object asymmetries in the availability of functional and pair-list answers. We note possible pragmatic and semantic factors that can constrain the set of quantifiers that allow list answers. This approach is also applied to multiple constituent questions. Questions with indefinite terms, which seem to offer a choice of questions to the addressee, are also discussed.

4.2.1 Quantifying over Skolem functions

Engdahl (1980, 1986) argues that functional answers provide evidence that wh expressions range over Skolem functions, functions from individuals to individuals, not just over individuals (see also Gr&S 1984).[8] Adapting Engdahl's syntax to our chosen model, we find that quantifying over functions involves the same principles of interpretation as quantifying over individuals:

(20) a. Which woman does every man like?
b.



There are two points in the derivation that we need to pay attention to. The trace of the wh phrase is interpreted as a variable over Skolem functions, functions whose argument can be bound by another term. In this case, the binder is *every man*:

$[\![\mathrm{IP}]\!] = {}^\wedge\forall x\ [\mathrm{man}\ (x) \rightarrow {}^\wedge\mathrm{like}\ (x,f_i(x))]$
$[\![\mathrm{C}^0]\!] = \lambda q\ [p = q]$
$[\![\mathrm{C}']\!] = [\![\mathrm{C}^0]\!]([\![\mathrm{IP}]\!]) \Rightarrow p = {}^\wedge\forall x\ [\mathrm{man}(x) \rightarrow \mathrm{like}(x,f_i(x))]$

The second point of note is that *which*, being an existential quantifier over Skolem functions, takes as its first argument the range of the function. The condition $\forall x$ *[woman(f(x))]* in the interpretation of the fronted DP restricts quantification to woman-valued functions. The universal here is not to be confused with the universal in the nucleus which is contributed by the subject term *every man*:

$[\![\mathrm{D}]\!] = \lambda Q\ \lambda\mathcal{F}\ \exists f\ [\forall x[Q(f(x))] \wedge \mathcal{F}(f)]$
$[\![\mathrm{NP}]\!] = \mathrm{woman}$
$[\![\mathrm{DP}]\!] = [\![\mathrm{D}]\!]([\![\mathrm{NP}]\!]) \Rightarrow \lambda\mathcal{F}\ \exists f\ [\forall x[\mathrm{woman}(f(x))] \wedge \mathcal{F}(f)]$

The final step in the derivation follows in the expected manner:

$$
\begin{aligned}
[\![\mathrm{CP}]\!] = \boldsymbol{\lambda\mathcal{F}}\ &\exists f\ [\forall x[\mathrm{woman}(f(x))] \wedge \boldsymbol{\mathcal{F}}\ (f)]\ (\boldsymbol{\lambda f_i\ [p = {}^\wedge\forall x\ [\mathrm{man}(x) \rightarrow \mathrm{like}(x,f_i(x)}))]]) \\
&\Rightarrow \exists f\ [\forall x[\mathrm{woman}(f(x))] \wedge \boldsymbol{\lambda f_i}\ [p = {}^\wedge\forall x\ [\mathrm{man}(x) \rightarrow \mathrm{like}(x,\boldsymbol{f_i}(x))]](\boldsymbol{f})] \\
&\Rightarrow \exists f\ [\forall x[\mathrm{woman}(f(x))] \wedge p = {}^\wedge\forall x\ [\mathrm{man}(x) \rightarrow \mathrm{like}(x,f(x))]] \\
&\quad \lambda p \exists f\ [\forall x[\mathrm{woman}(f(x))] \wedge p = {}^\wedge\forall x\ [\mathrm{man}(x) \rightarrow \mathrm{like}(x,f(x))]]
\end{aligned}
$$

[8] The functions quantified over are, in fact, of type *<s,<e,e>>* but the ideas presented here can be demonstrated at the extensional level.

The interpretation of (20a) in a specific case is illustrated below:

(21) a. Functions: *man wife-of* *man mother-of*
John → Mary John → Jane
Bill → Sue Bill → Rose
b. $\{\underline{{}^\wedge\forall x[\text{man}(x) \rightarrow \text{loves}(x,f_{\text{wife}}(x))]}, {}^\wedge\forall x[\text{man}(x) \rightarrow \text{loves}\ (x,f_{\text{mother}}(x))]\}$
c. Every man loves his wife.

In a world where every man loves his wife but not all men love their mothers, we would get (21c) as the functional answer. This demonstration showcases the advantage of using Skolem functions. Variation in the choice of women is captured without the universal taking syntactic scope over the fronted wh-expression. This is because the functional trace is interpreted not as an individual variable *x* but as a Skolemized function variable *f(x)*, with *x* bound by the universal. As discussed in Section 4.1, Engdahl takes pair-list answers to be a pragmatically derived graph of the function at a world, where a graph spells out the pairs in the function. She therefore posits nothing further for list answers.[9]

An aspect of Endahl's theory that does not bear directly on list answers but is still worth mentioning is that it allows for a local interpretation of pronouns and anaphors within the wh phrase:

(22) a. Which picture of $\text{himself}_i/\text{him}_j$ does every man_i like?
b. $\lambda p\ \exists f\ [\forall x[\text{picture-of-}\mathbf{x}(f(x))] \wedge p = {}^\wedge\forall x[\text{man}(x) \rightarrow \text{like}(x, f(x))]]$
c. $\lambda p\ \exists f\ [\forall x[\text{picture-of-}\mathbf{y}(f(x))] \wedge p = {}^\wedge\forall x[\text{man}(x) \rightarrow \text{like}(x, f(x))]]$

Binding principles determine whether the pronoun must be bound or remain free but the binding itself is effected locally within the interpretation of the wh expression. In (22b), the anaphor *himself* requires quantification over functions from individuals *x* to pictures of *x*, while in (22c), the pronoun *him* requires quantification over functions from individuals *x* to pictures of some contextually determined individual *y*. These effects are obtained without appealing to syntactic reconstruction at LF to the base position where the pronoun/anaphor is c-commanded by the quantifier.

Engdahl extends the functional account to multiple constituent questions. She allows, but does not require, Skolem functions in interpreting them (Engdahl 1986: 220–34). The two options are shown in (23):

(23) a. Which man saw which woman?
$\lambda p\ \exists f_1\ \exists f_2\ [\text{man}(f_1) \wedge \text{woman}(f_2) \wedge p = \lambda w\ \text{saw}_w\ (f_1,f_2)]$
$\{{}^\wedge$john saw mary, $^\wedge$john saw sue, $^\wedge$bill saw mary, $^\wedge$bill saw sue$\}$

[9] Engdahl takes quantifiers like *no N* to disallow pair-list answers for pragmatic reasons (cf. (11) above): members cannot be listed when there are no men in the *like* relation.

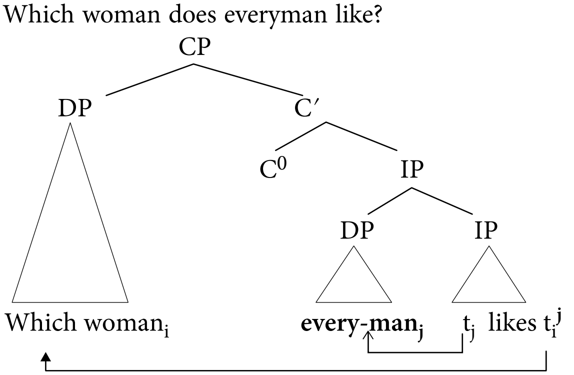
b. Which student suggested which of his paintings?
$\lambda p\ \exists f_1\ \exists f_2\ [\text{student}(f_1) \wedge \forall y[\text{painting-of-y/x}(f_2(y))] \wedge$
$p = \lambda w\ \text{suggest}_w\ (f_1, f_2(f_1))]$
{^John$_i$ suggested his$_{i/j}$ painting of Mary,
^Bill$_i$ suggested his$_{i/j}$ painting of Sue}

Quantifying over 0-place functions of type *e*, as in (23a), is tantamount to quantifying over individuals. If quantification is over 1-place functions of type <*e,e*>, as in (23b), we get the possibility of a wh-internal relational dependency. This is analogous to what we saw in (22).

Note that Engdahl's analysis of multiple wh questions does not capture the functionality discussed in Section 4.1.1, a result that accords with her view of list answers as pragmatically determined.

4.2.2 Incorporating structural sensitivity

Chierchia (1991, 1993) builds on the functional account but argues for a syntactic reflex of this semantic option. Wh-expressions, when they quantify over functions, leave behind traces that are doubly indexed. In (24a), for example, the subscripted i-index (for identity index) identifies the trace with the wh-operator *which woman*, which quantifies over Skolem functions. The superscripted a-index (for argument index) on the trace, which is bound by the c-commanding argument *every man*, is an individual variable. Intuitively, the a-index corresponds to the pronoun in functional answers, *every man likes his wife*, and may be taken as having a pronominal character. I use arrows to indicate the i-dependency and bold to indicate the a-dependency:

(24) a. Which woman does everyman like?
b.


Chierchia exploits the syntax of the functional variable to explain the absence of a functional reading when the wh is in subject position and the quantifier in object position:

(25) a. Which woman likes every man?

b. *[$_{CP}$ Which woman$_i$ [$_{IP}$ **every man**$_j$ [$_{IP}$ t_i^j likes t_j]]]

c. [$_{CP}$ Which woman$_i$ [$_{IP}$ t_i^j [$_{VP}$ every man$_j$ [$_{VP}$ likes t_j]]]

Example (25b) shows that the i-index of the wh-trace is bound by the wh-expression *which woman*. To bind the a-index of the trace, the universal must QR to a c-commanding position. This configuration, however, results in a weak cross-over (WCO) violation since the a-index is pronominal. There is, of course, the option of raising the quantifier to VP (25c), but it does not create the configuration needed for functional dependency. Thus, Chierchia successfully accounts for the structural asymmetry he notes with respect to functional answers. Since functional dependencies are the source of pair-list answers, the asymmetries transfer over to them (cf. (13)).

Chierchia's argument for the structure sensitivity of pair-list answers to questions with quantifiers was an alternative to the account prevalent at the time, due to May (1985). May provides structural analyses parallel to the ones in (24) and (25) for the cases under discussion. The difference is that his wh traces denote simple individual variables $t_{i/j}$ because he assumes quantification over individuals. The individual answer is derived in the expected way, through an LF with the scopal order in (24b). In order to derive the pair-list answer May proposes (26):

(26) *Scope Principle*: Mutually c-commanding quantifiers can take scope in either order.

Since QR pulls *every man* out of the inner IP, it comes structurally close enough to the wh phrase to allow scope permutation.[10] May does not provide a semantics for the pair-list reading. A simple-minded quantifying in of the universal into the question permitted by the Scope Principle would be open to the problems discussed in Section 4.1.2 in relation to (10). Setting that aside, May's syntactic assumptions derive the impossibility of pair-list readings with the quantifier in object position. In order to satisfy the Scope Principle, the quantifier has to raise to IP but this violates the ban on crossing dependencies (Pesetsky 1982), as evident from LF (25b). The only option is for the universal to QR to VP, as in LF (25c). But this does not meet the requirements of the Scope Principle and the resulting answer is the one where the wh has scope over the universal, that is, the individual answer. May does not give formal status to the functional answer.

An important difference between Chierchia's account of the asymmetry and May's is the locus of explanation, a difference that affects their applicability to multiple constituent questions (Hornstein 1995; Comorovski 1996; Dayal 1996).

[10] As von Stechow (1996) notes, May's LFs are not transparent as they do not disambiguate scope relations.

Chierchia's explanation rests on the relationship of the wh and the quantifier at their base positions while May's explanation relies on the relationship at their landing sites. We noted in Section 4.1 that pair-list answers to multiple wh questions are parallel to questions with quantifiers. In particular, the subject wh has universal-like properties. Consider the multiple constituent question in (27a) and its possible LFs in (27b)–(27d):

(27) a. Which man likes which woman?
b. $[_{CP}$ which woman$_j$ $[_{CP}$ which man$_i$ $[_{IP}$ t_i likes $t_j]]]$ *satisfies Scope Principle*
c. $[_{CP}$ which woman$_j$ $[_{CP}$ **which man$_i$** $[_{IP}$ $\mathbf{t_i}$ likes $t_j^{\,i}]]]$ *complies with WCO*
d. * $[_{CP}$ **which woman$_j$** $[_{CP}$ which man$_i$ $[_{IP}$ $t_i^{\,j}$ likes $\mathbf{t_j}]]]$ *violates WCO*

May's theory predicts that since both wh expressions take scope at the level of CP, they will satisfy the Scope Principle, as shown in (27b). This makes the incorrect prediction that either should be able to scope over the other, assuming that wide scope translates to domain cover. If we focus on their base positions, however, the source of the asymmetry is explained under Chierchia's functional account. In (27c) the object wh leaves behind a functional trace and the subject wh binds its a-index. In (27d) the subject leaves behind a functional trace but the object incurs a WCO violation if it tries to bind its a-index. This provides the formal grounding for the intuition that the higher wh in a multiple wh interrogative behaves like a universal quantifier.

4.2.3 Tapping into witness sets

Chierchia (1993), departing from Engdahl and his own earlier account, provides a semantics for pair-list readings which builds on functional LFs of the kind shown in (24b), but with a difference:[11]

(28) a. $[_{CP}$Which woman$_i$ $[_{C'}$ does $[_{IP\text{-}2}$ every man$_j$ $[_{IP\text{-}1}$ t_j like $t_i^{\,j}]]]]$
b. $\lambda P \exists A\, [W(\text{every man}, A) \wedge$
$P(\boldsymbol{\lambda p\ \exists f \in [A \rightarrow \text{woman}]\ \exists x \in A[p = {}^\wedge\text{like}(x, f(x))]})]$

The interpretation of the LF for the pair-list reading is identical to the interpretation of the LF for the functional reading up until IP-1. It differs with respect to where the quantifier is interpreted. In the case of functional readings of questions, the universal is interpreted inside the question nucleus, but here it has scope outside C^0, the point at which the nucleus is determined: $p = {}^\wedge like(x, f(x))$. The

[11] *P* is of type $<<<s,t>,t>,t>$, a set of sets of propositions, *W* stands for minimal witness sets. Barwise and Cooper (1981) define witness sets of a generalized quantifier as subsets of the common noun that are members of the quantifier. A minimal witness set is one that does not have a proper subset that is also a witness set.

accompanying semantics involves a shift in question denotations from a set of propositions to a set of sets of propositions/a family of questions.

Note though that this semantics involves a breach of strict compositionality. If we assume that quantifier raising can only be to IP and the nucleus is determined at C^0, pulling the semantic contribution of the universal outside the nucleus is non-trivial. Chierchia (1993: 210–11) describes it as a form of *absorption*, a restructuring option: *[wh NP$_i$ [DP$_j$ IP]]* $\Rightarrow$ *[[wh NP$_i$ DP$_j$] IP]*. He also entertains the possibility that the universal could raise above C^0, in a fashion analogous to wh movement.[12] The primary motivation for not allowing QR above C^0 in syntactic accounts such as May's is to account for subject–object asymmetries in pair-list answers on the basis of landing sites (see Pritchett 1990). Since the locus of explanation is the configuration inside IP in Chierchia's account, raising the universal above C^0 is a viable option. And it is an option that would be preferable from the perspective of compositionality.

Chierchia's approach to pair-list answers imports Gr&S's (1984) account of list answers into the functional approach. A question under its list reading, denotes a family of questions whose members are fixed by the number of witness sets *A* of the quantifier. In the case of the universal, there is only one witness set, namely the set denoted by the common noun, so the family of questions is a singleton:

(28) c. A = {John, Bill}

d. f_1 $\begin{tikzcd} j \arrow[r] & m \\ b \arrow[r] & s \end{tikzcd}$ f_2 $\begin{tikzcd} j \arrow[r] & m \\ b \arrow[ur] & s \end{tikzcd}$ f_3 $\begin{tikzcd} j \arrow[dr] & m \\ b \arrow[r] & s \end{tikzcd}$ f_4 $\begin{tikzcd} j \arrow[dr] & m \\ b \arrow[ur] & s \end{tikzcd}$

e. {{^John likes Mary, ^John likes Sue, ^Bill likes Mary, ^Bill likes Sue}}

To answer this question is to answer the only question in the set. The portion in bold in (28b), now creates a set of propositions such that for some function *f*, the proposition links some member of *A* to some member in the range of *f*. If John and Bill are all the men in the domain set, and Mary and Sue the women in the range set, we get the four functions in (28d). Existentially quantifying over functions and men yields the propositions inside the single member of (28e), with all the men being paired with all the women.

We noted in Section 4.1 that all quantifiers allow functional answers, but not all of them allow pair-list answers. A prime example is *no N*. This follows from Chierchia's *absorption* operation. Since the witness set of *no N* is the empty set, it cannot generate lists. In fact, reference to minimal witness sets predicts the absence of pair-list answers for all downward monotone quantifiers. A quantifier like *no more than three N/at most three N*, for example, will have

[12] Recall that *absorption* is a term due to Higginbotham and May (1981) and referred originally to their account of how two singular wh phrases can compose to allow for the shift from uniqueness to bijection. It is now used as a cover term for operations that interpret two or more quantifiers in a non-iterative manner.

witness sets with up to three members but the minimal witness set will be the empty set:

(29) a. Who do no more than three/at most three men like?
b. No more than three/at most three men like their mothers-in-law.
c. #John likes Mary and Bill likes Sue.

Chierchia notes *most N* as a problem since any subset of *N* larger than half qualifies as a minimal witness set.[13] Dayal (1996) appeals to unique witness sets, which accounts for upward monotone quantifiers like *most N*, in addition to quantifiers like *no N* whose unique witness set is empty, and downward monotone quantifiers like *no more than n N* which have more than one witness set. But this leads to a non-trivial difference between them on the status of list answers to questions with indefinites.

Indefinites have minimal witness sets but they do not typically have unique witness sets:

(30) a. Book = {Sense and Sensibility, Persuasion, Emma}
b. Two books = $\lambda P\ \exists X\ [\text{two}\ (X) \wedge \text{books}(X) \wedge P(X)]$
c. Minimal witness sets = {SS, P}, {SS, E}, {E, P}

Chierchia takes questions with indefinites to denote a family of questions, one for each minimal witness set. Dayal does not take them to allow pair-list answers, and the use of unique witness sets is meant to capture this fact. The choice of what type of witness set to use for pair-list answers, then, turns on the proper determination of the facts for questions with indefinites. We turn to this next.

4.2.4 Questions with indefinites

Questions with indefinites have two related but distinct properties, the potential for choice and the potential for pair-list readings. These two features are in evidence in the following example based on Gr&S (1984: 453–4), though the original discussion goes back to Belnap and Bennett (1977) and Belnap (1982):

(31) a. What did two of John's friends give him for Christmas?
b. Two of John's friends gave him a watch for Christmas.
c. $\lambda p\ \exists x\ [p = {}^\wedge\exists y\ [2(y) \wedge \text{friends-of-john}(y) \wedge \text{give}(y,j,x)]]$
$\Rightarrow \{{}^\wedge\underline{\text{two of John's friends gave him a watch}},$
${}^\wedge\text{two of john's friends gave him a book}\}$
d. {<bill → watch>, <peter → watch>, <fred → book>}

[13] With a three-member domain, {SS, P, E} *most N* has three minimal witness sets: {SS, P}, {SS, E}, and {E, P}. Chierchia also notes *both N* as a problem, but under the view that this is a plural definite (Brisson 2003), it should be amenable to the plurality-based account discussed in Section 4.1.3.

Response (31b) is the answer predicted by the baseline theory, in a world where the *give* relation is as shown in (31d). The question presupposes that there is exactly one thing that was given by two of John's friends and asks for its identity.

Gr&S point to another construal of the question that emerges in the situation depicted in (32a). There is now more than one possible true answer, (32b)–(32d):[14]

(32) a. Bill $\rightarrow$ {ball}
Peter $\rightarrow$ {pen}
Fred $\rightarrow$ {book}
b. ^Bill gave John a ball and Peter gave him a pen.
c. ^Bill gave John a ball and Fred gave him a book,
d. ^Peter gave John a pen and Fred gave him a book,

The choice of friends seems to be left up to the addressee. Once this choice is made, a pair-list answer seems appropriate since the two friends chosen give different presents. This is derived in Chierchia's account in the following way:

(33) a. What did two of John's friends give him?
b. $\lambda P\ \exists A$ [Witness-Set(two of John's friends, A) $\wedge$
$P(\lambda p\ \exists f\ \exists x \in A[p = {}^\wedge like(x, f(x))])]$
c. {{^Bill gave John a ball, ^Peter gave John a pen, ^Bill gave John a pen,...},
{^Bill gave John a ball, ^Fred gave John a book, ^Bill gave John a book,...},
{^Peter gave John a pen, ^Fred gave John a book, ^Fred gave John a pen,...}}

Assuming Bill, Peter, and Fred are John's friends, the miminal witness sets of *two of John's friends* are *{Bill, Peter}*, *{Bill, Fred}*, and *{Peter, Fred}*. The question, therefore, denotes a family of three questions, one for each minimal witness set. While there is no choice in the case of questions with universals which have only one witness set, questions with indefinites typically present a choice of questions to answer.

Szabolcsi (1997a: 320–2), building on Moltman and Szabolcsi (1994) and Szabolcsi (1997b), makes some important observations about the availability of pair-list readings, focusing on questions with singular wh expressions. She finds that questions with universal quantifiers such as (34a) admit pair-list answers, as we have been assuming so far, though not as readily as suggested in the literature. Questions with indefinites such as (34b), instead, are marginal at best in English. She cites Gr&S (1984: 555–6) for the clear inadmissibility of its Dutch counterparts:[15]

[14] Perhaps, the judgment is clearer if instead of the partitive, a simple indefinite is used: *What did two guests give John for his wedding?*

[15] Szabolcsi's concern is with a range of quantifiers, including indefinites like *more than n N* and *at least n N* which disallow lists. Note that % stands for variation among speakers with respect to acceptability, ? for a general assessment of marginality.

(34) a. Which boy did every dog bite? *%PL*
b. Which boy did two dogs bite? *?PL*

However, to the extent that pair-list answers to questions with indefinites are at all possible, they call for an explanation. Szabolcsi (1997a: 322–3, fn. 6) speculates that they may be instances of cumulative readings of individual answers, as in Dayal's and krifka's accounts of questions with plural definites (see also Dayal 1996: 120, fn. 31):

(35) a. Who did two dogs bite?
b. Fido and Spotty bit Harry and John. In particular, Fido bit Harry and Spotty bit John.

This could explain the marginality of the pair-list answer for (34b) since the wh expression rules out the possibility for the two dogs to be related to a plurality of boys.

A problem with this line of approach, though, is that plurality-based cumulative answers are typically structure insensitive (cf. Section 4.1.3) but (36a), with the indefinite in object position, does not seem to admit the pair-list answer in (36b), even with *who* instead of *which* N_{SING}. Example (37) is further evidence of structure sensitivity:

(36) a. Who bit two boys?
b. Fido bit Harry and Spotty bit John.

(37) a. What did two boys read? *PL*
b. Who has read two novels? **PL*

If this structural sensitivity is a stable fact, then it remains a problem for an analysis in terms of cumulativity, but the contrast in (34) makes it implausible to consider extending the explanation for pair-list answers to questions with quantifiers to those with indefinties.

Regardless of what the final picture for questions with indefinites turns out to be, we must address the fact that these questions always seem to leave it up to the addressee to choose the individuals the question is about. This brings it suspiciously close to the *mention-some* phenomenon in questions, which also gives the addressee free rein in choosing an answer. In Section 3.3.1, however, we argued to keep the two apart. One reason was that they place different restrictions on the wh phrase:

(38) a. Where (all) can you buy gas around here?
b. What (all) are two of your students working on?

A *mention-some* question turns into a *mention-all* question with the addition of particles like *wh-ALL* in languages/dialects that have them (cf. (38a)) but a similar move in questions with indefinites does not affect the dimension of choice. The addressee is still free to answer (38b) with respect to any two students. If we do not account for choice readings through the family of questions approach and we do not treat them as *mention-some* questions, an explanation remains to be given.

A possible line of inquiry, one that has not been explored at any length as far as I am aware, is that choice questions arise under a specific indefinite reading of the term. Compare the well-known case of a declarative with a specific indefinite with the kind of question we are considering:

(39) a. If two of my relatives die, I will inherit a fortune.
$\exists f_i$ [die(f_i(2-relatives-of-mine)) $\rightarrow$ inherit(I, a fortune)]
b. What topic are two of your students working on?
$\lambda p\ \exists x$ [topic(x) $\wedge$ p = $^\wedge$work-on(f_i (2-of-your-students), x)]

Specific indefinites in examples like (39a) have been the subject of much investigation and an influential approach to them uses Skolemized choice functions to capture their special referential-like properties (Reinhart 1997, 1998, among others). Here we represent the choice function variable as existentially bound from outside the island, as in Reinhart's account but for present purposes it could also remain free. Importantly, f_i is a choice function of type <<*e,t*>,*e*>. It selects an individual out of a set whose members are sums of two individual relatives of mine. In this case, we take the index on this function to be cued to the speaker. A straightforward application of this idea to (39b) would capture the effect of choice if the index on the choice function variable is cued to the addressee instead of the speaker. This would be analogous to the interrogative flip observed in languages where evidentials have a speaker-based interpretation in declaratives but an addressee-based interpretation in questions (Speas and Tenny 2003; Murray 2010). The significant point for present purposes is that by tapping into a well-established aspect of specific indefinites, we may be able to account for the intuition that such questions involve choice. A further promising feature of an approach along these lines is the observation that specific indefinites are non-distributive (Ruys 2005).[16] If this is so, it may help us understand why such questions are resistant to list answers. Obviously, much work remains to be done, at the empirical as well as the analytical level.

4.2.5 Section summary

We have extended the semantics for questions to incorporate quantification over Skolem functions for functional and pair-list answers. Syntactic asymmetries in the availability of such answers were handled by interpreting traces as functional variables with a pronominal index, sensitive to WCO effects. Looking at questions with non-universal quantifiers, we noted the extent to which the use of minimal witness sets or unique (minimal) witness sets captures the set of quantifiers that admit pair-list answers. Questions with indefinites are not amenable to accounts in terms of witness sets or to plurality-based accounts. We suggested that the choice associated with such questions may depend on the terms being specific indefinites whose indexicality is cued to the addressee.

[16] The use of choice functions for the interpretation of wh phrases will be taken up in Chapter 7.

4.3 Functionality in pair-list answers

Here we show that the functional account presented above does not capture domain cover and the restriction to functional pairings. Two solutions are presented. One modifies the functional approach to allow each proposition in the question denotation to be the full graph of a function. It does so by positing an ambiguity in C^0_{+WH}. The other iterates the standard question formation operation, and distributes Ans-D over the members of the resulting family of questions. Echo questions provide direct empirical support for the existence of higher order questions in natural language. The need for higher order questions for pair-list answers is evaluated with reference to scope marking.

4.3.1 Functionality through functional absorption

Dayal (1996) points out that the same problems that were identified in Section 4.1 for the baseline theory resurface in the function-based account of pair-list readings. Chierchia's answerhood operator (Chierchia 1993: 192; Lahiri 1991: 147) says that an answer to a question is any proposition that is the conjunction of some subset of the propositions in the question denotation. This allows (40a) to be answered with (40c), in a situation like (40b), violating both components of functionality:

(40) a. Which man likes which woman? / Which woman does every man like?
b. {^John likes Mary, ^John likes Sue, ^Bill likes Mary, ^Bill likes Sue}
c. John likes Mary and Sue.

It is worth emphasizing though that the fundamental problem is not the particular answerhood operator adopted. Rather, it is the fact that these question denotations are standard Hamblin–Karttunen sets. That is, the functional dependency that Engdahl and Chierchia advocate is not reflected in their final question denotations.

To capture domain-cover and point-wise uniqueness Dayal posits, in addition to an individual C^0_{+WH}, a functional C^0_{+WH} whereby each proposition spells out the graph of a function. I will call this *functional absorption*, distinguishing it from earlier proposals about absorption. Consider the results schematically, first with a multiple wh question and the set of four functions in (29d):

(41) a. Which man likes which woman?
b. $[_{CP\text{-}2}$ which woman$_i$ $[_{CP\text{-}1}$ Which man$_j$ $[_{IP}$ t_j likes t_i / $t_i^j]]]$?
c. ⟦CP-2⟧ with $C^0_{+WH\text{-individual}}$ =
{^John likes Mary, ^John likes, Sue, ^Bill likes Mary, ^Bill likes Sue}
d. ⟦CP-2⟧ with $C^0_{+WH\text{-functional}}$ =
{^John likes Mary and Bill likes Sue, *graph of* f_1
^John likes Mary and Bill likes Mary, *graph of* f_2
^John likes Sue and Bill likes Sue, *graph of* f_3
^John likes Sue and Bill likes Mary} *graph of* f_4

Depending on which denotation Ans-D applies to, the individual or the pair-list answer is derived. Applied to (41c), it gives the single-pair answer, applied to (41d) the pair-list answer. Note that in both cases, the propositions in the set are not in an entailment relation. Thus, Ans-D is defined only in worlds where exactly one proposition is true. Let us now go through the crucial steps.

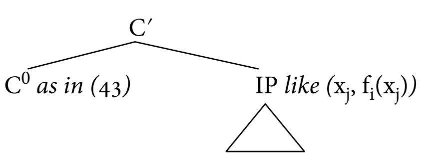
Dayal posits (42) as the meaning of the functional C^0 (Dayal 1996: 117–18). There are three distinct aspects to the proposed meaning: introduction of ∃ quantification over functions, restrictions on the domain and range of the function, the creation of graphs for each such function. The final denotation is the standard one, a set of propositions:

(42) $[\![C^0]\!] = \lambda Q\ \lambda D\ \lambda R\ \exists f\ [Dom(f) = D \wedge \forall y\ [R(f(y))] \wedge p = \cap\ \underline{\lambda p'\ \exists y \in D[p' = Q(y)(f)]}]$

C^0 introduces, first and foremost, quantification over functions of type <*e,e*>, with ∃*f* binding a function variable *f* inside the nucleus. The type of quantification is exactly as in the Engdahl–Chierchia theory, but here it enters the computation independently of the wh phrase. The second contribution of C^0 is to introduce the restriction on ∃*f*. Since the quantification is over functions from individuals to individuals, there are two restrictions in place, a condition on the domain of the function *dom(f) = D* and a condition on the range of the function *∀y[R(f(y))]*. The third contribution is the creation of propositions that are graphs of functions. This is done by taking for each function, the intersection of the set of propositions obtained by quantifying over the members of the domain set. C^0, because it introduces two new variables, needs to combine not just with the nucleus *Q* of type <<*e,e*>,<*e*, <*s,t*>>>, but also with two other arguments *D* and *R*, of type <*e,t*>.

Let us now see how the set of propositions in (41c) is derived from an LF encoding a functional dependency. The first step, in (43), saturates the first argument of functional C^0 with the IP meaning:

(43) a. $[_{CP\text{-}2}$ which woman$_i$ $[_{CP\text{-}1}$ Which man$_j$ $[_{C'}\ C^0_{+WH\text{-functional}}\ [_{IP}\ t_j$ likes $t_i^j]]]]$?

b. 

$[\![C']\!] = [\![C^0]\!]\ ([\![IP]\!])$

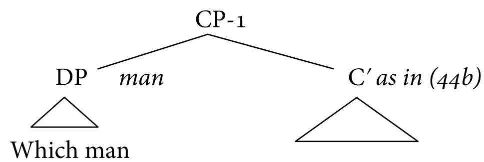
$\Rightarrow \boldsymbol{\lambda Q}\ \lambda D\ \lambda R\ \exists f\ [Dom(f) = D \wedge \forall y\ [R(f(y))] \wedge$
$p = \cap\ \underline{\lambda p'\ \exists y \in D\ [p' = \mathbf{Q}(y)(f)]]}\ (\boldsymbol{\lambda f_i}\ \mathbf{{}^\wedge like\ (x_j, f_i(x_j))})$

$\Rightarrow \lambda D\ \lambda R\ \exists f\ [Dom(f) = D \wedge \forall y\ [R(f(y))] \wedge p =$
$\cap\ \lambda p'\ \exists y \in D\ [p' = \boldsymbol{\lambda f_i\ \lambda x_i}\ like\ (x_j, \mathbf{f_i(x_j)})\ \mathbf{(y)(f)}]]$

$\Rightarrow \lambda D\ \lambda R\ \exists f\ [Dom(f) = D \wedge \forall y\ [R(f(y))] \wedge p =$
$\cap\ \lambda p'\ \exists y \in D\ [p' = like(y, f(y))]]$

Now we saturate the domain and range arguments. Wh phrases, as restrictions on the function, have to denote sets of individuals. This can be obtained from their basic meaning as existential generalized quantifiers by applying the BE operator (Partee 1986). Alternatively, wh phrases can be treated uniformly as set denoting terms, and their generalized quantifier meaning in other contexts can be obtained through Partee's ∃ type shift (Bittner 1994). We follow the latter option:

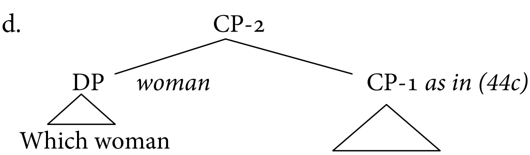
(43) c.



$$[\![\text{CP-1}]\!] = \boldsymbol{\lambda D}\, \lambda R\, \exists f\, [\text{Dom}(f) = \mathbf{D} \wedge \forall y\, [R(f(y))] \wedge p = \cap\, \lambda p'\, \exists y \in \mathbf{D}\, [p' = \text{like}\,(y, f(y))]]\ (\mathbf{man})$$

$$\Rightarrow \lambda R\, \exists f\, [\text{Dom}(f) = \text{man} \wedge \forall y\, [R(f(y))] \wedge p = \cap\, \lambda p'\, \exists y \in \text{man}\, [p' = \text{like}(y, f(y))]]$$

d.



$$[\![\text{CP-2}]\!] = \lambda \mathbf{R}\, \exists f\, [\text{Dom}(f) = \text{man} \wedge \forall y\, [\mathbf{R}(f(y))] \wedge p = \cap\, \lambda p'\, \exists y \in \text{man}\, [p' = \text{like}\,(y, f(y))]]\ (\mathbf{woman}) \Rightarrow$$

$$\exists f\, [\text{Dom}(f) = \text{man} \wedge \forall y\, [\text{woman}(f(y))] \wedge p = \cap\, \lambda p'\, \exists y \in \text{man}(y)\, [p' = \text{like}\,(y, f(y))]]$$

$$\lambda p \exists f\, [\text{Dom}(f) = \text{man} \wedge \forall y\, [\text{woman}(f(y))] \wedge p = \cap\, \lambda p'\, \exists y\, \text{man}(y)\, [p' = \text{like}\,(y, f(y))]]$$

Note that the wh in-situ adjoins above the fronted wh. Another option would be to tuck it below the fronted wh, following Richards (1997). If the latter were adopted, the order in which the restrictions are fed in would have to be reversed but the essential results would be maintained. What is required to maintain compositionality is a match between syntactic hierarchy and semantic saturation.

The two meanings for C^0 apply straightforwardly to Chierchia's LFs for list, functional, and individual readings of questions with quantifiers. Crucially, there are two variables to be bound at C^0 in (44a), an individual and a functional variable. There is only one in (44b), either an individual variable or a functional variable:

(44) a. $[_{\text{CP-1}}$ which woman$_i$ $[_{\text{CP-2}}$ every man $[_{C'}$ $C^0_{\text{+WH-functional}}$ $[_{\text{IP}}$ t_j likes $t_i^j]]]]$
b. $[_{\text{CP-1}}$ which woman$_i$ $[_{C'}$ $C^0_{\text{+WH-individual}}$ $[_{\text{IP-2}}$ every man $[_{\text{IP}}$ t_j likes $t_i/t_i^j]]]]$

Assuming high QR for the universal and the extraction of a unique witness set from it in (44a), we get a question denotation that is the same as for multiple wh questions. Thus, when Ans-D applies to it we get a proposition that encodes functionality. An LF like (44b) composes with an ordinary C^0 and is interpreted exactly as in the Engdahl–Chierchia account of functional answers. That is, we get an individual or a functional answer, depending on whether the wh chain involves individuals or functions.

Building ambiguity into the C^0 node, then, is a way of accounting for the perceived ambiguity of multiple constituent questions and questions with quantifiers under the functional approach to pair-list answers.[17] It derives the functionality of list answers, which otherwise remains elusive even with quantification over functions. The individual pieces in the complicated looking $C^0_{\text{+WH-functional}}$ are all familiar and independently motivated. Packaging them under one node, however, has not always been looked upon with favor. It is, therefore, worth emphasizing its chief merit. Functional absorption allows a single answerhood operator, Ans-D, to derive number-based effects in individual answers as well as the functionality of pair-list answers.

4.3.2 Higher order echo questions

An alternative way of capturing functionality appeals to higher order interpretations. Before we discuss this approach, however, let us try to understand the role of higher order questions in grammar by looking at an uncontroversial case. Karttunen (1977: 12) notes that constituent and polar questions cannot combine unless the wh phrase has echo intonation:

(45) a. Did Mary read WHICH BOOK/*which book?
 b. Mary isn't sure whether to read WHICH BOOK/*which book?

He furthermore notes that direct questions like (45a) call for answers that are themselves questions. Echo questions raise interesting issues in their own right and will be taken up in Chapter 9. Here we present the account in Dayal (1996: 123–7), which draws on the discussion in Comorovski (1989, 1996) and in some ways anticipates the iterated $C^0_{\text{+WH}}$ approach to be discussed in Section 4.3.3.

Consider the following question–answer paradigms involving at least one wh phrase with echo intonation:

(46)	a. Bill cooked WHAT?	Bill cooked $[\text{meat}]_F$.
	b. WHO cooked WHAT?	$[\text{Bill}]_F$ cooked $[\text{meat}]_F$.
	c. Who cooked WHAT?	Who cooked $[\text{meat}]_F$?

[17] Pesetsky (2000) and Cable (2007, 2010) also posit ambiguity in C^0 to account for superiority and intervention, but the terms of the ambiguity are not quite the same.

Dayal makes the non-controversial assumption that an echo question responds to a previous utterance, at least some part of which was inaudible to the questioner. It elicits as response an utterance with focus on the inaudible part(s) of the original utterance. A single wh question like (46a), or a multiple wh question with echo intonation on both wh expressions like (46b), elicits a declarative as answer. However, a multiple wh like (46c) with echo intonation on just one wh, elicits an answer which is itself a question.

Dayal posits a null operator for echo questions that can combine with CPs that denote functions from (tuples of) individuals to propositions, as well as with CPs that denote functions from (tuples of) individuals to questions. In other words, it can combine with a –WH complement as well as a +WH complement, as long as there are variables associated with echo wh phrases inside the CP for it to bind. An answerhood operator, similar to the one for ordinary questions accommodates the fact that echo questions relate to previous utterances, not truth (see Chapter 9 for details):

(47) CP-2

$OP_{ECHO} = \lambda Z\, \lambda Q\, \exists x_1 \ldots \exists x_n\, [Q = Z(x_1, \ldots x_n)]$ CP-1

The application of the echo operator in (46) now yields the following first and second order sets:

(48) a. $OP_{ECHO}([\![\text{bill cooked WHAT}]\!]) = OP_{ECHO}(^\wedge\text{bill cooked x})$
$\Rightarrow \{^\wedge\text{Bill cooked meat}, {}^\wedge\text{Bill cooked pasta}\}$

b. $OP_{ECHO}([\![\text{WHO cooked WHAT}]\!]) = OP_{ECHO}(^\wedge\text{y cooked x})$
$\Rightarrow \{^\wedge\text{Bill cooked meat}, {}^\wedge\text{Bill cooked pasta}, {}^\wedge\text{John cooked meat}, {}^\wedge\text{John cooked pasta}\}$

c. $OP_{ECHO}([\![\text{who cooked WHAT}]\!]) = OP_{ECHO}(\lambda p\, \exists y\, [\text{person}(y) \wedge p = {}^\wedge\text{y cooked x}])$
$\Rightarrow \{\{^\wedge\text{Bill cooked meat}, {}^\wedge\text{John cooked meat}\}$
$\{^\wedge\text{Bill cooked pasta}, {}^\wedge\text{John cooked pasta}\}\}$
Equivalently: {Who cooked meat? Who cooked pasta?}

At CP-1, (46a) and (46b) denote propositions. Since the non-echo wh in (46c) is interpreted in the normal way, CP-1 in this case denotes a question: *who cooked x?* Binding the free variable by OP_{ECHO} always shifts the denotation one level up. With this background, we turn now to the use of higher order questions to derive functionality in pair-list answers.

4.3.3 Functionality through higher order questions

Hagstrom (1998: 148) makes the same assumptions as the baseline theory for single wh questions: questions denote Hamblin sets, only one proposition counts as an answer, a negative answer denies the uniqueness/existential presuppositions of the question. He differs on multiple wh questions. A multiple constituent question can denote a family of questions. To answer such a question is to answer each member of the family, with the uniqueness/existence presuppositions distributing over the subquestions. The pair-list answer is the conjunction of the individual answers to subquestions.

Hagstrom's ideas have been developed further and given a fully compositional implementation in Fox (2012).[18] The key insight is to allow iteration of a type flexible version of C^0_{+WH} $\lambda p\, \lambda q\, [q = p]$. The LF in (49b) positions the wh in-situ below the fronted one, following Richards (1997), but places them in distinct projections of C:

(49)

a. Which student bought which book?

b. $[_{CP\text{-}2}$ which student$_i$ $[_{C'}$ C^0_{+WH} $[_{CP\text{-}1}$ which book$_j$ $[_{C'}$ C^0_{+WH} $[$ t_i bought $t_j]]]]]$

c.

CP-2 $\lambda \mathbf{Q}\, \exists y\, [\text{student}(y) \wedge \mathbf{Q}(y)]$ $(\boldsymbol{\lambda x_i Q = \lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge x_i\ \text{bought}\ x]})$

$\Rightarrow \exists y\, [\text{student}(y) \wedge \boldsymbol{\lambda x_i}\, Q = \lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge x_i\ \text{bought}\ x](y)]$

$\Rightarrow \exists y\, [\text{student}(y) \wedge Q = \lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge y\ \text{bought}\ x]]$

$\lambda Q\, \exists y\, [\text{student}(y) \wedge Q = \lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge y\ \text{bought}\ x]]$

DP $\lambda Q\, \exists y\, [\text{student}(y) \wedge Q(y)]$ C′ $Q = \lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge x_i\ \text{bought}\ x]$

C^0 $\lambda Q'\, \lambda Q\, [Q = Q']$ CP-1 $\lambda p\, \exists x\, [\text{book}(x) \wedge p = {}^\wedge x_i\ \text{bought}\ x]$

Which student$_i$ which book$_j$ t_i bought t_j

CP-1 denotes a set of propositions, though the set depends on the value assigned to the variable in subject position: *which book did x_i buy?* or equivalently: *{^x_i bought E, ^x_i bought P}*. The higher C^0_{+WH} combines with CP-1 and the higher wh phrase existentially binds the free variable inside it. The abstraction over *Q* in the final line, the analog of abstraction over *p* in ordinary questions, yields a family of questions:

(50) a. {{^John bought P, ^John bought E}, *which book did John buy?*
{^Bill bought P, ^Bill bought E}} *which book did Bill buy?*

b. ∩{Ans-D({^John bought P, ^John bought E}),
Ans-D({^Bill bought P, ^Bill bought E})}

[18] See Nicolae (2013) for an accessible presentation of Fox's account, along with details of the syntax that have been omitted here.

Domain cover is derived by requiring that every subquestion be answered, and functional pairing by a point-wise application of Ans-D.[19] The pair-list answer is the conjunction of these individual answers. The family of questions is, in effect, a plural term that has the answerhood operator distributed over it.

This approach has considerable appeal as it captures a challenging paradigm, applying independently motivated principles and basic tools of interpretation. Dayal (2016b), however, questions whether its theoretical elegance can be maintained against a wider set of facts. By eliminating functional dependencies from consideration, it leaves unaddressed the overlap between functional and pair-list readings emphasized by Engdahl and Chierchia. Of course, adding a functional core is not incompatible with building higher order questions through iterated C^0_{+WH} (Gennaro Chierchia p.c.). Questions with quantifiers also present some complications (see Nicolae 2013), but one may argue that they do so for all theories. Note that this use of higher order questions differs from Chierchia's in requiring every member of the family of questions to be answered, not just one. As it stands, then, the approach does not extend to questions with indefinites. One may argue, as we have done in Section 4.2, that list answers to such questions are a distinct phenomenon. However, those who want to bring them under the same umbrella have to make some non-trvial accommodations (see Nicolae 2013, for example). Furthermore, questions with more than two wh expressions may require some modification of the system as it is not clear if the truth requirement built into Ans-D should be applied at each iteration.

Dayal (2016b) also draws out the implications of this approach for the scope marking construction introduced in Section 2.2. Recall that the second CP in such constructions must denote a Hamblin rather than a Karttunen set. That is, for (51c) to be an acceptable answer to (51a), it is not necessary that Bill actually read *Emma* and John *Persuasion*. This is accomplished in the indirect dependency approach of Dayal (1994) by interpreting the two questions as in (51b) and identifying the restriction *T* in CP-1 with the denotation of CP-2. If list readings denote a family of questions, however, CP-2 would have to be shifted to a set of propositions. Ans-D cannot be used for this purpose, as in the Hagstrom–Fox approach, since it would import the truth requirement and incorrectly predict that (51c), as an answer to (51a), should entail *Bill read Emma and John read Persuasion*. Addressing the problem thus requires some adjustments in the theory.

(51) a. What does Mary say/think/believe? Who read what?
b. $[\![\text{CP-1}]\!] = \lambda p\ \exists q_{<s,t>}\ [T_{<<s,t>,t>}\ (q) \wedge p = \lambda w\ \text{say}_w\ /\ \text{think}_w\ /\ \text{believe}_w\ (m, q)]$
$[\![\text{CP-2}]\!] = \{\text{\^{}b read E and j read E},\ \text{\^{}b read P and j read P},$
$\text{\^{}b read E and j read P},\ \text{\^{}b read P and j read E}\}$
c. Mary thinks Bill read Emma and John read Persuasion.

A second problem noted for the Hagstrom–Fox approach is the fact that the predicate in CP-1 of a scope marking construction must select for propositions:

[19] Fox attributes this idea to Heim (2010).

(52) a. *What does Mary ask/wonder? Who read what?
b. $[\![\text{CP-1}]\!] = \lambda p\ \exists Q_{<<s,t>,t>}\ [\mathcal{T}_{<<<s,t>,t>,t>}\ (Q) \wedge p = \lambda w\ \text{ask}_w\ /\ \text{wonder}_w\ (m, Q)]$

Dayal (1994) gives a type-theoretic account for this. With verbs that select propositions, the quantification can be restricted by single or multiple constituent questions, interpreted as sets of propositions, as seen in the types of *q* and *T* in (51b). Example (52a) is ruled out because CP-2, a set of propositions, cannot be identified with the restriction $\mathcal{T}$. If, on the other hand, pair-list readings could denote families of questions, one might well expect (52a) to be acceptable: *Which question Q in {What did Bill read?, What did John read} did Mary ask?*

Dayal (2016b) draws on echo questions to further articulate this problem. Dayal (2000) shows that the only way to have predicates like *ask/wonder* in CP-1 of a scope marking construction is to interpret one of the two wh expressions in CP-2 with echo intonation (see also Lahiri 2002b). As discussed in Section 4.3.2, possible answers to such questions are themselves questions. Thus they are of the right type to serve as the restriction $\mathcal{T}$. Example (53a) allows for answers drawn from (53c):

(53) a. What did Mary ask? Who bought WHAT?
b. [[who bought WHAT]] = {Who bought Emma?, Who bought Persuasion?}
c. {^Mary asked who bought Persuasion, ^Mary asked who bought Emma}

Bringing echo questions into consideration has an interesting consequence for accounts of functionality when we look at questions with quantifiers. They are acceptable in scope marking under a pair-list reading with predicates like *think*:

(54) a. What does Mary think? What did everyone buy?
b. Mary thinks everyone bought Emma.
c. Mary thinks John bought Emma and Bill bought Persuasion.

However, they are never acceptable with predicates like *ask*, even when the wh carries echo intonation:

(55) a. *What did Mary ask? WHAT did everyone buy?
b. $[\![[_{CP}$ everyone bought WHAT$]]\!]$ = ^everyone bought x
c. $[\![[_{CP}\ OP_{ECHO}\ [_{CP}$ everyone bought WHAT$]]]\!]$ =
{^Everyone bought Emma, ^Everyone bought Persuasion}

This is because CP-2 in (55a) cannot denote a family of questions. Absent a normal wh expression inside the lower CP projection, we get something of type *<s,t>* as its meaning (55b). When OP_{ECHO} binds the echo wh phrase, we get a set of propositions. If list readings were derived from families of questions, one might well expect (55a) to be acceptable, given (51a), (53a), and (54a).

These data, therefore, suggest that it may be worth keeping to the lower type *<<s, t>,t>* for pair-list readings of questions and reserve the higher type *<<<s,t>,t>,t>*

for multiple wh echo questions.[20] To sum up, Dayal's and Hagstrom and Fox's approaches do not disagree on the existence of higher order questions or even about their derivation but rather on their role in capturing functionality in pair-list answers.

4.3.4 Section summary

It was shown that functional approaches to pair-list answers fail to capture their functionality. Functionality can be enforced through functional absorption, whereby each proposition in the set spells out the graph of a function. An alternative is to iterate question formation and build higher order questions. Functionality can then be captured by distributing Ans-D over subquestions and intersecting the resulting propositions. Higher order questions are manifested most clearly in echo questions with more than one wh phrase. The scope marking construction was presented as a possible empirical test for their relevance in deriving functionality in pair-list answers.

4.4 Further issues

The functional approach to pair-list answers has been extremely influential, especially Chierchia's version of it as it brought together insights from the syntactic as well as the semantic literature. There have been many responses to it, some of which we have already explored. Here we will present a few other studies that focus on the need for interpreting questions above their normal type as sets of propositions, on explanations for the structure sensitivity in pair-list readings of questions with quantifiers, and on the possibility of deriving pair-list answers by quantifying over speech acts.

4.4.1 The proper place of lifted questions

Gr&S (1984) and Chierchia (1993), we saw, both argue for lifting the meaning of questions from its basic type in order to account for pair-list and choice readings of questions. Szabolcsi (1997a) argues that lifted meanings are only justified in the complement position of extensional verbs like *know* or *find out*.

Abstracting away from the issue of functions, the pair-list reading of a matrix question with a universal quantifier can be represented with or without lifting (Szabolcsi 1997a: 312):

(56) a. Which man did every dog bite?
b. $\lambda P\ \exists W$ [W a witness of $[\![$every dog$]\!]$ $\wedge$ P (which x $\in$ W bit which man)]
c. $\lambda p\ \exists x\ \exists y$ [x $\in$ W the unique witness of $[\![$every dog$]\!]$ $\wedge$ man (y) $\wedge$ p = x bit y]

[20] Chapter 7 will discuss the role of higher order questions in deriving list answers across islands.

Analysis (56c) treats (56a) essentially as a multiple wh question, with the witness set of the quantifier playing the role of the common noun in a wh phrase. We saw in Section 4.3 that this does not, in fact, capture functionality in pair-list answers, but let us set that aside here. Szabolcsi notes that lifted meanings are only required for choice questions. Recall from Section 4.2.4 that she does not find pair-list answers to questions with indefinites acceptable, a point that is even clearer when modified numerals like *more than n N* are used. This is evidence for staying with the normal denotation for matrix questions.

In contrast, Szabolcsi argues that lifted interpretations are needed in complements of extensional verbs. Both versions of the embedded question in (57) allow for a pair-list construal. Intuitively, *P* in (56b) can be instantiated by properties associated with embedding such as *being found out by John, being known by John*:

(57) John knows/found out which man *every dog/more than six dogs* bit.

Szabolcsi (1997a: 331–2) further notes that a universal, which is otherwise clause bounded ((58a)), seems to show wide scope effects in embedded pair-list contexts ((58b)). She interprets (58b) with the whole complement, interpreted at the lifted level, taking scope over the matrix clause. A possible derivation for (58c) is in (58d):

(58) a. Some librarian found out that every student needed help. $*\forall_{ST} > \exists_L$

b. Some librarian (or other) found out which book every student needed. $\forall_{ST} > \exists_L$

c. [[which book every student needed]$_i$ [some librarian found out t_i]]

d. $\boldsymbol{\lambda P}\ \exists A$ [non-ø witness(A, ⟦every student⟧) $\wedge$
$\forall x$ [**P**(which book x needs) iff x $\in$A]]
(λp ∃z [librarian (z) ∧ found-out(z, p)])
$\Rightarrow \exists A$ [non-ø witness(A, ⟦every student⟧) $\wedge$
$\forall x$ **λp** ∃z [librarian (z) ∧ found-out(z, **p**)] (**which book x needs**)] iff x ∈ A]]
$\Rightarrow \exists A$ [non-ø witness(A, ⟦every student⟧) $\wedge$
$\forall x\ \exists z$ [librarian (z) ∧ found-out(z, which book x needs)] iff x ∈ A]]

Szabolcsi notes that modified numerals, even though they allow for pair-list readings in embedded questions, do not show scope interaction with matrix arguments: *some librarian found out which book more than six students needed* does not allow librarians to vary with students. She attributes this to an independent difference between the two quantifiers: *every* allows inverse scope while *more than n N* does not.

There is another significant point related to these examples that Szabocsi makes. Gr&S (1984) argue that quantifying in approaches cannot capture the *de dicto* readings of the common noun in pair-list construals of embedded questions. Szabolcsi, aware that her version of “quantifying in” the embedded question may also be open to this charge, challenges the generalization. She argues that there is a subtle distinction between genuine *de dicto* readings and presupposed information that is discernible with predicates like *discover* (Szabolcsi 1997a: 339):

(59) John has just discovered what candy every criminal craves.

Sentence (59) may be true if what John has just discovered are the candy preferences of particular individuals without discovering their criminal status. He may already be aware of their criminality. This distinction, she claims, is masked in examples with predicates like *know*.

The intuitions at play are subtle and worth probing further but constraints of space prevent me from doing so here. Let me simply note that our current understanding of the *de dicto/de re* ambiguities balance the possibilities for scope taking inside and outside opaque contexts as well as the flexibility in interpreting the world variable on the descriptive term. When it comes to pair-list readings in embedded contexts, the interactions between these two dimensions become quite complex, as we have just seen.

4.4.2 Presuppositionality and lists

Previous sections have established the relevance of Skolem functions in the grammar of natural language on the basis of questions with the quantifier *every*. We now expand our inquiry to include the quantifier *each*:

(60) a. Which woman does every man/each man love?
b. His mother-in-law.
c. $\lambda p\ \exists f\ [\forall x\ [man(f(x))] \wedge p = {}^\wedge like(x,f(x))]$

(61) a. Which woman loves every man?
b. #His mother-in-law.

Recall that Chierchia used data like these to argue that the a-index of the Skolem function is pronominal and subject to WCO. His account of structure sensitivity has been challenged on the grounds that the correlation between WCO and pair-lists is not reliable. A particularly compelling instance of this is the quantifier *each*, which aligns with *every* with respect to WCO but not with respect to structural restrictions. Karttunen and Peters (1980) discuss the pair-list reading of (62) with *each* in object position. Williams (1986) explicitly notes the lack of the expected subject–object asymmetry with respect to pair-list readings:

(62) Which clerk is now serving each customer?

We will consider two alternatives to Chierchia's account of structure sensitivity which provide some explanation of the differential behavior of the two universal quantifiers.

Comorovski (1989, 1996) argues in connection with multiple constituent questions that pair-list answers are only possible with D-linked wh phrases, phrases that denote contextually salient sets. This is consistent with the view that pair-list answers list members of the quantifier's witness set. Corroboration of this claim is also presented by the quantifier *any*, which like *every N*, and *each N*, allows functional answers. Unlike them, however, it does not allow pair-list answers (Dayal 1996: 121):

(63) a. Which woman does any man / each man / every man like?
b. His mother.
c. Bill likes Mary and John likes Sue.

All three versions of the question in (63a) have universal force but the interpretation of the answer in (63b) varies.[21] *Any man likes his mother* only has a generic reading, *each man likes his mother* is about a particular set of men, while *every man likes his mother* is ambiguous between the two readings. Only *each* and *every*, namely those with contextually salient domains, allow the pair-list answer (63c). But if pair-list answers always draw on terms that presuppose their domain, the difference in structure sensitivity between *each N* and *every N* cannot simply rest on that. Something more is needed.

Agüero-Bautista (2001) also pays attention to the presuppositional profile of the two universal terms but augments it with other independently motivated factors.[22] The first difference has to do with their scope potential in declaratives. In (64) *every N* is trapped below negation and the indefinite, while *each N* can scope over them:

(64) a. Someone did not meet every candidate. $\exists > \neg > \forall$; $*\forall > \exists > \neg$
b. Someone did not meet each candidate. $\exists > \neg > \forall$; $\forall > \exists > \neg$

From this he concludes that *every N* remains below negation and the subject of the clause at LF. The second difference is between different wh phrases with respect to *there-insertion* contexts (Heim 1987):

(65) a. *Which items are there in the fridge?
b. What is there in the fridge?

Putting these pieces together, he proposes a constraint on the reconstruction of wh phrases (Agüero-Bautista 2001: 55) and posits the LFs in (67b)–(67c) for the questions in (67a):

(66) Do not reconstruct a presuppositional phrase into a theta position.

[21] The point here is independent of whether *any* is analyzed as a universal or as an existential.

[22] Further support for the contrast under discussion comes from (i)–(ii) from Agüero-Bautista (2001: 82):

i. Which boy resembles every man in your class? *PL
ii. Which boy resembles each man in your class? PL

(67) a. Which woman loves each man/every man?
b. [$_{CP}$ which woman [$_{XP}$ **each man** [$_{IP}$ $\boldsymbol{t_{which}}$ [$_{vP}$ t_{each} [$_{vP}$ t_{which} likes t_{each}]]]]]
c. [$_{CP}$ which woman [$_{IP}$ $\boldsymbol{t_{which}}$ [$_{vP}$ **every man** [$_{vP}$ t_{which} likes t_{every}]]]]

Because *each N* raises higher than *every N*, (67b) has three positions associated with *each*, while (67c) has only two positions associated with *every*. Meanwhile, *which boy* being presuppositional, can only reconstruct down until the subject, not its base position inside vP. So, *each man* c-commands the reconstructed wh phrase while *every man* does not. This according to Agüero-Bautista is why one allows pair-list readings from object position while the other does not. The explanantion would extend to monomorphemic wh phrases *who loves each man?* on the view that wh phrases that support list answers are always presuppositional.

Beghelli and Stowell (1997), building on Liu (1990) and Szabolcsi (1997b), also provide an account that separates these two universal quantifiers (and others) by their potential scope sites. Unfortunately, I must leave it to the reader to consult these and other articles in Szabolcsi (1997c) on their own.

4.4.3 Quantifying into question acts

A very different view of structure sensitivity emerges from the account of pair-list readings in Krifka (2001). Krifka takes the relevant configuration to involve a topic structure. This is shown schematically in (68):

(68) a. As for x, which dish did x make?
b. *Topic* [x], λt_1 [*Quest* [which dish$_2$ [he$_1$ make t_2]]]
c. Which dish did x_1 (x_1 in x) make? And which dish did x_2 (x_2 in x) make? And…

Without going into the technical details, the point to note is that the question keeps its normal meaning and the topic is quantified into the speech act rather than into the standard question meaning (Krifka 2001: 22–3). We get, in effect, a conjunction of questions of the kind shown in (68c).

Krifka points out that when the universal term is focused, *which dish did* EVERYONE *make*, pair-list answers are ruled out. This follows on the view that focus must be interpreted inside the nucleus and cannot therefore be the topic. This is certainly compatible with Krifka's account where topics quantify over speech acts but it is also compatible with other theories that we have discussed in Sections 4.2 and 4.3. Chierchia (1993), Dayal (1996), and Fox (2012) all interpret the universal outside C^0, that is, outside the domain where focused *every* must remain.

Let us probe, instead, the restriction of pair-list answers to certain quantifiers, as the explanation for it is specific to Krifka's account in terms of conjoined speech acts. Krifka agrees wtih Szabolcsi (1997a: 324–5) that conjunction and disjunction of questions are qualitatively different, contra Gr&S (1984). Example (69a) can be answered with a pair-list answer satisfying both requests, as in (69b). In (69c), instead, the questioner cancels the first question in posing the second. There is no choice presented to the addressee. This is another argument against lifted meanings for matrix questions:

(69) a. What did Mary read? And what did Judy read?
b. Mary read Emma and Judy read Persuasion.
c. What did Mary read? Or, what did Judy read?

Krifka concludes that quantifiers that align with conjunction (universal terms, plural definites, and conjoined proper names) are good topics while those that align with disjunction (indefinites, *most*, etc.) are not, because only conjunction is properly defined on speech acts.

Intriguing though this approach is, there are several issues that remain unresolved. One problem that Krifka himself notes is that quantifiers typically do not make good topics, and yet they lend themselves to pair-list answers. Another is the difference between *every* and *each* with respect to structure sensitivity. Krifka suggests that subjects tend to make better topics than objects, a tendency that *each* can override because it presupposes a given set of entities. We saw in Section 4.4.2, however, that presuppositionality cannot be the determining factor since even *every* participates in pair-list construals only when its domain is presupposed. Finally, using topichood to derive structural restrictions implies a separate explanation for similar asymmetries with functional readings of questions with quantifiers.

There are other aspects of Krifka's proposal worth probing,[23] which we cannot go into here (see Chapter 5 for a brief discussion in relation to embedded question acts). I will simply mention that this line of explanation would find interesting confirmation if list readings in languages that overtly mark topics were only available with topic-marked quantifiers. I am not aware of literature testing this prediction.

4.4.4 Section summary

The proposals discussed in this section focus primarily on pair-list readings of questions with quantifiers, independent of their functional readings. The first argued for distinctions between a matrix and a subset of embedded questions with respect to interpreting them at a higher level. The other two proposals addressed the differential behavior of the two universal terms *every* and *each* with respect to syntactic restrictions. One appealed to differences in their presuppositional profile to posit distinct LFs. The other also appealed to presuppositional differences, as they relate to the ability to function as topics that must be quantified in at the level of the speech act of questioning. Admittedly, we were

[23] For example, Krifka suggests that *which* N_{SING} is more topical than *who/which* N_{PL} and may lead to *every N* being less favored as a topic (cf. (34a)). He also differentiates how conjoined noun phrases and plural definites differ in quantifying into speech acts to account for the differences in their behavior with respect to list answers.

barely able to scratch the surface of the rich empirical and theoretical picture revealed in these and other studies in this domain.

4.5 Functions and lists in the baseline theory

We extended the semantics of questions to include quantification over Skolem functions in order to admit functional readings of questions with quantifiers. Deriving pair-list answers from functional answers explains the fact that the quantifiers that admit pair-list answers are a subset of the ones that admit functional answers. It involves extracting a set from the quantifier and merging it with the wh expression through an *absorption* operation. Quantifiers that can participate in absorption are restricted to those that have minimal and/or unique witness sets.

The use of minimal witness sets brings list answers to questions with indefinites under the same fold as pair-list answers to questions with quantifiers, while the use of unique witness sets keeps the two apart. The latter move treats the choice represented by such questions in terms of a specific indefinite whose indexicality is cued to the addressee. List answers to questions with plural definites were shown to be a distinct phenomenon, amenable to a pragmatic explanation as elaborations of individual answers with plural arguments.

Another property of functional questions that was discussed are apparent subject–object asymmetries. This is captured in the functional approach by positing a complex wh trace, with a pronominal element which is subject to the weak cross-over constraint. It applies to functional as well as list readings of questions with quantifiers. Multiple wh questions, which seem to privilege the subject wh term, are also interpreted using the same principles.

It was shown that the functionality of pair-list answers remains elusive in theories that posit standard Hamblin–Karttunen sets, even if the wh is interpreted functionally. One way of ensuring functionality posits *functional absorption* in C^0. Here each proposition in the question denotation is the graph of a function. Applying Ans-D to the resulting set delivers a pair-list answer with the right properties. Applying Ans-D to denotations resulting from the ordinary meaning of C^0 derives single-pair answers to multiple wh questions, and individual and functional answers to questions with quantifiers.

An alternative account of functionality iterates C^0 and allows question formation to apply to questions, leading to higher order questions. Functionality is captured by intersecting the propositions obtained by distributing Ans-D over all the subquestions. Multiple wh echo questions provide empirical justification for higher order questions but evidence from scope marking calls into question their usefulness in deriving pair-list answers.

We also considered scope interaction between an embedded wh expression and quantifiers in matrix clauses. Such interaction can be explained by treating the complement as a set of questions and allowing it to permute scopally with quantifiers in the matrix clause. Comparing questions with *every N* and those with *each N*, we found that both allow pair-list answers but only the former shows structural sensitivity. This led to proposals that posit syntactic differences between the two universal quantifiers and argue for a greater role for these syntactic differences in deriving list readings. Finally, we looked at a proposal that treats list readings of questions as conjunctions of speech acts. Quantifiers that lend themselves to list readings are treated as topics, though the quantifiers that support pair-list readings do not align with those that participate in topicalization. Differences between the two universal quantifiers are imputed to differences between them with respect to presuppositionality, but it needs to be kept in mind that presuppositionality may be a necessary condition for all quantifiers that admit list readings.

To sum up, functional and list answers are a heterogenous class. There are differences among researchers on which quantifiers allow such answers as well as on the proper account for those facts. Here we tried to make explicit where the empirical and theoretical fault lines lie. This is particularly important for list answers since they are a powerful diagnostic tool widely used to study wh scope.

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