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QUESTIONS WITH QUANTIFIERS*

This paper studies the distribution of 'list readings' in questions like *who does everyone like?* vs. *who likes everyone?*. More generally, it focuses on the interaction between *wh*-words and quantified NPs. It is argued that, contrary to widespread belief, the pattern of available readings of constituent questions can be explained as a consequence of Weak Crossover, a well-known property of grammar. In particular, list readings are claimed to be a special case of 'functional readings', rather than arising from quantifying into questions. Functional readings are argued to be encoded in the syntax as doubly indexed traces, which straightforwardly leads to a Crossover account of the absence of list readings in *who likes everyone?*. Empirical and theoretical consequences of this idea for the syntax and semantics of questions are considered.

1. INTRODUCTION

Questions and quantifiers interact in complex ways. In this paper, I will make some proposals as to the nature of such interactions. The main empirical fact that I will address is the distribution of so-called "list" readings, and in particular, the asymmetry in (1):

(1) a. Who_i does everyone like t_i?
   b. Who_i t_i likes everyone?

These types of questions are widely discussed in the literature,[1] where it has been observed that (1a) admits (at least) two kinds of answers, while (1b) does not. The first kind of answer that (1a) admits is the "single constituent" or "individual" answer, exemplified in (2a). The second kind, the list answer, is illustrated in (2b).

(2) a. Singular Constituent Answer: Professor Smith
   b. List Answer: Bill likes Smith, Sue Jones, ...

An answer such as (2b) seems inappropriate for questions like (1b).

Let us assume that quantified NPs are assigned scope at Logical Form

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[1] The most extensive and influential proposals on this are May (1985, 1988). Other relevant discussions and proposals can be found in Williams (1988), Lasnik and Saito (1991), and Sloan (1990), among others.

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(LF) by adjunction to IP (= S). The main descriptive generalization concerning contrasts such as the one in (1) appears to be that at LF, the trace of the NP has to c-command the trace of the *wh*-word for a list reading to be possible. Equivalently, we could say that the NP cannot "cross over" the *wh*-trace. The dominant view of this phenomenon is based on the assumption that list readings derive from quantifying an NP into a question[2] and that there is some constraint that prevents this from happening in structures like (1b). The relevant constraint is the object of considerable debate in the literature. Above, we used the notion of "crossing over" to describe the phenomenon. It is tempting, then, to try to relate the phenomenon at hand to other crossover phenomena. But it is not obvious how to go about this. Strong crossover (which in the Principles and Parameters framework is subsumed under principle C of the binding theory)[3] is clearly irrelevant: the contrast in (1) arises in spite of the fact that *wh*-word and NP are not coindexed. And weak crossover involves binding of a pronoun, as in the following paradigmatic cases:

(3) a. Who$_i$ does $[_{NP_j}$ his$_i$ mother$]$ love t$_i$?
a′. For which x, x's mother loves x?
b. His$_i$ mother loves everybody$_i$
b′. For every x, x's mother loves x

The question in (3a), under the indexing given there, should be interpreted as shown in (3a′). This interpretation, however, is unavailable. Similarly, (3b) doesn't have the interpretation (3b′). In both cases, we have (descriptively) a binder (the *wh*-word in (3a) and the quantified NP in (3b)) that "crosses over" (at S-structure in (3a) and at LF in (3b)) its intended bindee, viz. a pronominal element. However, in (1b) above, there is no overt pronominal element that the quantifier binds: what the quantifier crosses over is just the *wh*-trace.

In spite of this, I will argue that the contrast in (1) can indeed be viewed as a case of weak crossover, once the semantics of questions is brought into the picture in a proper way. I will not take a stand on how weak

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2 List readings are also associated with multiple *wh*-questions, such as *Which professor taught which course?*, a topic that will have to be left for another occasion.

3 A classical reference on crossover phenomena is Postal (1971). Typical examples of strong crossover are:

(i)* he$_i$ likes every man$_i$
(ii)* he$_i$ thinks that every man$_i$ is a genius

Here we have an NP coindexed with a pronoun that c-commands it. In contrast, weak crossover (which induces less severe ungrammaticality) concerns NPs coindexed with a *non*-c-commanding pronoun to their left. Standard examples are provided in (3) in the text.

crossover is to be analyzed. My point is simply that the contrast in (1) is just a special case of this well-known property of grammar. The appeal of such a thesis lies, I submit, in the fact that if it is correct, no construction-specific constraint is called for, in contrast with what arguably happens in other proposals. While developing this main claim, I will make several other points concerning the interplay of the syntax and semantics of questions and quantifiers.

In the rest of this introduction I intend to do three things. First, since the empirical soundness of the generalization exemplified in (1) has been challenged, I would like to consider the data that have been brought forth in this connection and argue that the generalization in question does hold up to closer scrutiny. Second, I will outline one of the most influential approaches to the distribution of list readings, namely R. May's, and indicate what I take to be its major shortcomings. Third, I will present in its barest outline the main argument to be developed in this paper.

1.1. *Factoring Plurality Out*

It has often been noted that in some examples fully parallel to (1b), the unavailable interpretation appears to be possible. Suppose there is a party to which each student has brought a different dish. In such context, I ask:

(4) a. Who put everything on the platter?
 b. Bill, the chicken salad; Frank, the chow mein; . . .

A pair-list answer such as (4b) seems to be felicitous in this case, which casts doubts on the soundness of our empirical generalization. Yet, as several researchers have pointed out,[4] it can be argued that once plurality is taken into account, the relevant generalization does hold up. The point is that *who*, while morphologically singular, appears to be semantically unmarked for singularity vs. plurality in the sense that, for example, (5c) and (5d) appear to be felicitous as answers to (5a) but not as answers to (5b).[5]

(5) a. Who came to the party?
 b. Which boy came to the party?
 c. John, Bill and Fred
 d. Those boys

[4] Cf. May (1985), among others.

[5] Groenendijk and Stokhof (1984) claim that singular *which*-phrases do not carry uniqueness presuppositions. On this issue, I side with Higginbotham and May (1981), Srivastav (1990a) and many others who argue that they do.

Now the relevant observation is that if we replace *who* in (4a) with *which student*, the list answer becomes unavailable:

(6) a. Which student put everything on the platter?
b.* Bill, the chicken salad; Frank, the chow mein; . . .

But crucially, pair-list answers remain available with singular *which*-phrases if the quantifier c-commands the *wh*-trace:

(7) a. Which dish did every student bring t?
b. Bill brought the chicken salad; Frank brought the chow mein;. . .

Thus we still have a sharp contrast here. The fact that a list interpretation of (7a) (but not of (6a)) remains available, in spite of the strong singularity (i.e., uniqueness) presupposition of singular *which*-phrases, is remarkable and calls for an explanation.

There is an independent way to disambiguate a sentence like (5a), namely by letting *who* antecede a singular pronoun. If our hypothesis is correct, once we do this, the availability of list answers should disappear in (4a) but not in sentences with the same structure as (7a). Indeed, this seems to be so:

(8) a. Who_i put everything on his_i platter?
a′.* John, the chicken salad; Bill, the chow mein; . . .
b. What did everyone return to its owner?
b′. Bill returned the screwdriver to its owner; John returned the cat to its owner; . . .

So the availability of a list reading in structures like (5a) seems to be related to the tolerance of *who*/*what* for plurality. The interpretation of (5a) appears to be parallel to the interpretation of the following sentence:

(9) The kids brought everything for the party. Bill brought the paper cups, John the beer, . . .

The phenomenon exemplified by (9) has to do with the possibility of distributing a property or relation over a group. This and related problems are discussed at more length in Krifka (1992) and Srivastav (1992). What is relevant for our purposes is that even once the effects of plurality are factored out, a noticeable asymmetry does remain in constituent questions, a fact that needs to be accounted for.

1.2. *A Previous Approach*

An interesting attempt to explain the asymmetry in (1) is due to May (1985, 1988). May's main assumptions are the following. He adopts a definition of dominance in terms of segments (cf. also Chomsky 1986) and a definition of c-command in terms of maximal projections (m-command) according to which *wh*-phrases in Spec of CP and quantified NPs adjoined to IP govern each other, thereby forming what May calls a Σ-sequence. May proposes an interpretive principle according to which the elements of a Σ-sequence can be interpreted in any order. This principle, which May dubs the "scope principle," is summarized (in simplified terms) in (10):

(10) *The Scope Principle*
Elements of a Σ-sequence can be interpreted freely with respect to scope relative to each other.

So for example, a sentence like (11a) can be assigned the LF in (11b), where the two quantifiers can be interpreted in either order.

(11) a. Every man loves a woman

b. [a woman$_j$ every man$_i$ [t$_i$ loves t$_j$]] < ∀ ∃ / ∃ ∀

This entails that the LF in (11b) is interpretively ambiguous and that, consequently, LF no longer disambiguates scope.

Similar considerations apply to sequences of *wh*-words and quantified NPs. For example, (1a), repeated here as (12a), has the LF in (12b), which allows for free scoping of the *wh*-operator and the universal quantifier, resulting in the two readings in (12c) and (12d):

(12) a. Who does everyone love?

b. [who$_i$ everyone$_j$ [t$_j$ loves t$_i$]] < *wh* ∀ / ∀ *wh*

c. for which x: everyone loves x (singular reading)

d. for every x, which y is such that x loves y (list reading, via quantifying in)

May adopts, further, the Path Containment Condition from Pesetsky (1982):

(13) *Path Containment Condition* (PCC)
If two paths overlap, one must contain the other.

An LF is well-formed iff it meets the PCC. This establishes the desired subject-object asymmetry, as the following example illustrates:

(14) a. who does everyone love $\Rightarrow$ [who$_i$ everyone$_j$ [t$_j$ loves t$_i$]]

b. who loves everyone $\Rightarrow$ [who$_i$ everyone$_j$ [t$_i$ loves t$_j$]]

In (14a), but not in (14b), the paths of the *wh*-phrase and of the quantifier satisfy the PCC. Thus the LF in (14a) is well-formed. In contrast, the LF in (14b) is ill-formed. The only possibility for a sentence like the one in (14b) is to adjoin the quantified NP to VP, yielding:

(15) [who$_i$ [$_S$ t$_i$ [everyone$_j$[$_{VP}$loves t$_j$]]]] *wh* $\forall$

Here the PCC is satisfied, but the *wh*-operator and the quantifier are too far apart to form a Σ-sequence. Consequently, the scope principle doesn't apply and the only possible reading is the one where the *wh*-word has scope over the universal quantifier, which results in the singular reading. There is one final crucial assumption one needs for this story to go through, as Williams (1988) points out. Quantifier raising (QR) must not adjoin NPs to CP. This is stated in (16):

(16) a. NPs can adjoin to IP, VP, NP, but not to CP

b. [everyone$_j$ [$_{CP}$who$_i$ [$_{IP}$ t$_i$ loves t$_j$]]]

If CP-adjunction were possible, there would be a structure for (1b) not ruled out by the PCC, namely (16b), where *everyone* and the *wh*-word would be part of the same Σ-sequence, thereby allowing for both scope options.

Thus on May's story, the unavailability of the list answers for sentences like (1b) follows from (10), (13), and (16).[6] Notice that this approach is compatible with the fact that structures like (1b) can receive a kind of a list reading when the *wh*-word has a group interpretation, as discussed in the previous section. In other words, (multiple *wh*-questions aside) list readings can have two sources. One is the situation where a universal quantifier is quantified into a question. This is subject to a structural restriction: the *wh*-word and the quantified NP must form a Σ-sequence at LF. The other is a purely interpretive phenomenon that comes about (in

[6] May also considers, and ultimately rejects, an approach that uses the ECP instead of the PCC.

as of yet poorly understood ways) as a by-product of the singular constituent reading when groups are involved.

Several empirical problems have been argued to arise in connection with May's proposal.[7] For us, however, it is important to emphasize two theoretical aspects of the proposal. First, it is clear that May's account relies crucially on the possibility of making semantic sense of quantifying into a question, an assumption that, as we shall see, is not unproblematic. Second, May's assumptions (in particular (10) and (16)) are largely construction specific. In fact, the asymmetry in (1) appears to be virtually the only empirical evidence in favor of the Scope Principle. It would be a priori desirable to relate the pattern in (1) to other independently observable properties of grammar.

I believe that the same general points can be raised in objection to other attempts to deal with quantifier-*wh* interaction (cf. the references in fn. 1), but I will refrain from arguing against these attempts in detail. May's approach is indicative of our current level of understanding of the asymmetry in (1). The purpose of this paper is to argue that a deeper understanding can be achieved by linking this asymmetry to weak crossover, an independently observable property of grammar.

1.3. *The Relevance of Weak Crossover*

My main point can be formulated in schematic terms along the following lines. There is a family of questions that calls for a "functional" answer (studied especially in Engdahl 1986, which is based on her 1981 dissertation, and Groenendijk and Stokhof 1984, ch. 3). For example:

(17) a. Who/which person does everyone like?
b. His mother

From an intuitive standpoint, the answer in (17b) specifies a function from individuals into their mothers. It can be argued (sec. 2.3 below) that the logical form of questions of this kind is roughly as follows:

(18) a. Which function f is such that everyone x loves $f(x)$
b. For which f: everyone$_x$ loves $f(x)$

The main characteristic of this logical form is that in the *wh*-trace position we find a function f applied to an argument x. The individual variable x is bound, by the subject NP in this case, while the functional variable f is

[7] See, e.g., Williams (1988), Jones (1990), and Sloan (1990) for discussion.

bound by the *wh*-operator (i.e., the question is about f). Now, Engdahl (1986) has argued that list readings can be viewed as a special case of functional readings. Her reasoning proceeds as follows. Consider what lists are. They are pairs of individuals. But functions taken extensionally are just sets of ordered pairs. So lists can be viewed as functions. This seems to entail that logical forms such as (18) suffice to represent the list reading of questions as well as the functional one. In other words, in answering (17a) under the interpretation represented by (18), we can either specify a function by giving its intension, as in (17b), or specify a function by giving its extension, as in, e.g. {⟨Paolo, Maria⟩, ⟨Sandra, Filippo⟩, . . . }. The latter is, of course, a list.

If this hypothesis is correct, list readings do not come about by quantifying an NP into a question, as assumed by May and others. In fact, there might be independent reasons for being skeptical of the quantifying- in strategy. After all, quantifying in is defined over sentences. What guarantees that it can be extended to questions? Perhaps questions are objects that are incompatible with quantifying in. At the very least, it has to be shown that there is a natural extension of the standard techniques for quantifying in NPs that works for questions. But why would one want to engage in such an enterprise? After all, we do need logical forms such as (18) to deal with functional questions. And they seem to cover list readings automatically.

Consider, in this light, a sentence like (1b), which lacks a list reading. Since under the present hypothesis, list readings are special cases of functional readings, the derivation of (1b) ought to proceed roughly as follows:

(19) a. Which f [$f(x)$ loves everyone$_x$]
b. For which f: everyone$_x$ [$f(x)$ loves x]

The structure in (19a) constitutes the S-structure of (1b), while (19b) represents its LF, obtained by scoping *everyone* out. By comparing it with the well-formed (18), we immediately see that there is something wrong with (19). In (18) the quantifier *everyone* c-commands $f(x)$. In (19a) it does not: in order for *everyone* to bind the occurrence of x in the functional complex $f(x)$ it has to cross over it. The parallelism with canonical cases of weak crossover such as those in (3) becomes evident now.

It follows, then, that structures like (19b) will be ruled out by whatever principle takes care of weak crossover phenomena in general. And since the one in (19) is the only way in which list readings may be derived, it also follows that sentences like (1b) will fail to have such readings. Nothing whatsoever needs to be done to handle the distribution of list readings.

Earlier in this introduction, in noticing the parallelism in the distribution of list readings and that of crossover phenomena, I observed that the difficulty in capitalizing on this intuition was the following: the only thing that the quantifier seemed to cross over in sentences like (1b) was the *wh*-trace. Apparently, there was no pronominal or anaphoric element that the quantifier would bind in doing so. Now we see that on independent grounds, the analysis of functional questions requires the presence of precisely such an element (i.e., the x in $f(x)$). So a principled reduction to a pure case of weak crossover becomes not just possible, but virtually unavoidable.[8]

The present paper tries to articulate and defend in some detail the view just sketched. We will see, in particular, that the argument does not quite hold in the form I have given. There is, however, a well-motivated variant of it that will go through and, in fact, covers several other cases. The paper is organized as follows. In section 2, some background assumptions are provided. In section 3, I discuss in detail the semantics of list readings of questions and point out some problems that various current proposals face. In section 4, I present and articulate my proposal on the semantics of list readings, and in section 5, I address its empirical consequences.

2. Background

In the discussion that follows, I will adopt a version of the Principles and Parameters framework for syntax. I assume that semantic interpretation takes the form of a compositional map of the relevant level of syntax (namely LF) into a logic (namely Montague's IL). Within this setting, I will discuss certain relevant aspects of the syntax and semantics of questions. Obviously, given the size of the literature on this topic, many important points will have to be left out or touched upon only briefly.

2.1. *On the Semantics of Questions*

To understand a question is to understand what constitutes a possible answer to it, i.e., its "answerhood" conditions. Here is one well-known way of spelling this out. Consider a constituent question such as (20a) and the set of propositions in (20b):

(20) a. Who does John love?
b. {John loves a_1, John loves a_2, ...}
where a_1, a_2, ... are all the people in the domain.

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[8] An argument along these lines was presented in Chierchia (1991).

The set in (20b) can be viewed as the logical space from which answers to (20a) can be constructed. Typically, an answer to (20a) in a specific circumstance will be constituted by a subset of (20b). To put this in slightly different terms, to ask (20a) is to ask which of the propositions in (20b) are true. A complete answer to (20a) in a world w is a list of all the members of (20b) which are true in w. The set in (20b) can also be characterized as in (21a), or equivalently, using Montague's IL, as in (21b):

(21) a. $\{p$: for some person a, $p =$ that John loves $a\}$
b. $\lambda p \exists x[\text{person}(x) \wedge p = {}^\wedge\text{loves}(j, x)]$

Throughout this paper, it will be useful to switch back and forth between the notations in (21) as convenient. To make things easier, I will stick to IL, but I will assume that it is enriched with standard set-theoretic notation (namely $\{a: \phi\}$, $\cup$, $\cap$, etc.)[9]

I will call sets such as those in (18) an "answer space." Hamblin (1958, 1973) was the first to analyze answerhood conditions in terms of answer spaces. Karttunen (1977) has advocated a slight modification of Hamblin's approach. According to him, a question Q determines for each world w the set of propositions that taken jointly constitute a complete answer to Q in w. So the value of (21a) at a world w is to be represented as follows:

(22) $\lambda p \exists x[{}^\vee p \wedge \text{person}(x) \wedge p = {}^\wedge\text{love}(j, a)]$

I will refer to these approaches jointly as the H/K approach.

A second family of proposals regards questions as partitions of possible states of affairs. Two important approaches that develop this idea are Higginbotham and May (1981) and Groenendijk and Stokhof (1984) — G&S henceforth.[10] On this view, one way to picture the value of a question like (17a) (close to Higginbotham and May's proposal) is the following:

(23) Cell 1 [that John loves a_1, that John doesn't love a_2, that John doesn't love $a_3, \ldots$]
Cell 2 [that John loves a_1, that John loves a_2, that John doesn't love $a_3, \ldots$]
Cell 3 [that John loves a_1, that John doesn't love a_2, that John loves $a_3, \ldots$]
.....
for all the people in the domain

[9] These symbols are (somewhat pedantically) defined in IL in Appendix I.

[10] Cf. also Higginbotham (1991) and Groenendijk and Stokhof (1989). It should be borne in mind that G&S (1984) is a collection of papers written at various times. The earliest one to appear in print was chapter 2, first published in 1982 in *Linguistics and Philosophy*, pp.

G&S set things up somewhat differently. Instead of regarding each cell in (23) as a set of propositions, they would regard it as the proposition which is the conjunction of the propositions in it (more on G&S's approach in sec. 3). The cells in (23) partition the logical space of possible worlds into mutually exclusive and jointly exhaustive sets. Such a partition represents a state of total ignorance relative to who John loves. What one wants to know in asking who John loves is which of the cells in (20) the actual world belongs to. So an answer to this question is something that reduces the ignorance as to who John loves. A partial answer rules out some of the cells in (20). A complete one rules out all but one cell. One of the claims of advocates of partitionism is that their approach makes it easy to define the notion of partial answer. Such a notion cannot be as smoothly defined on the H/K approach (but cf. the next paragraph).

There are various trades-offs between these two approaches. In this paper, I will adopt a version of the H/K approach, for essentially three reasons. First, Lahiri (1991) has shown that there is an elegant, compositional procedure to turn H/K denotations into partitions, at least for one interesting class of cases. This means that whatever advantages the partitional semantics affords are not lost on the H/K approach. Second, Rooth (1992) has pointed out that there is a very simple connection between H/K's theory and the highly constrained approach to focus he has developed, which explains, for example, why (24b) is appropriate as answer to (20a) (repeated here as (24a)), while (24c) is not.

(24) a. Who does John like?
b. John likes $[_F$ Mary$]$
c.* $[_F$ John$]$ likes Mary
(where $[_F\ ]$ indicates focal stress)

I am not sure whether an equally direct link between the semantics of questions and focus theory can be established on the partitional view. Third, there is at least one phenomenon that at present I do not know how to treat within a partitional semantics, namely "quantificational variability" (to be discussed shortly). Lahiri (1991), building on work by Berman (1991), has developed a quite convincing treatment of it, based on the H/K approach.[11] Having said that, however, I should also add that I

175—233. Other important early proposals related to those mentioned in the text are Belnap and Bennett (1977) and Hintikka (1976). For a discussion of these and other approaches not explicitly addressed here I especially refer to G&S (1984) and Lahiri (1991).

[11] The interesting proposals on multiple *wh*-questions developed in Srivastav (1991a, 1991b) do not appear to be smoothly compatible either with a partitional view. Hence her approach, if correct, provides us with another reason for sticking to the H/K line.

believe my main point to be fully compatible with a partitional view. If an interesting way can be found to deal with focus and quantificational variability within a partitional approach, then it will be easy to translate my proposals into that approach, as I hope the reader will be able to see.

To be more specific, I will assume that interrogative sentences, whether embedded or not, denote answer spaces. From now on, I will use the terms 'question' in this technical sense. Given a question Q, a possible answer to Q is any proposition p which is the conjunction of a subset of Q. In symbols:

(25) $A_Q(p) = \exists S[S \subseteq Q \wedge p = \bigcap S]$ (from Lahiri 1991, p. 147)

As Lahiri shows in detail, A_Q forms a complete atomic Boolean algebra, where the atoms are the members of Q and answers are ordered by a relation $\leqslant_Q$ relative to their informativeness. The general interpretive procedure for a simple constituent question is as follows:

(26) a. $[wh\ \mathrm{N}]_i\ \mathrm{S} \Rightarrow \lambda p \exists x_i [\mathrm{N}(x_i) \wedge p = {}^\wedge\mathrm{S}]$

b. Example:

$[\text{which boy}]_i\ [t_i \text{ is Italian}] \Rightarrow \lambda p \exists x_i[\text{boy}(x_i) \wedge p = {}^\wedge\text{Italian}(x_i)]$

Who and *what* are interpreted as *which person or people* and *which thing or things*, respectively. Notice that the semantics in (26) does not reflect the uniqueness condition which I take to be associated with *which*-phrases. This is done only to keep things simple. Since we are not dealing with issues that crucially hinge on uniqueness, this won't affect our main point. Notice also that (22a) delivers what G&S (1984) call the "de re" readings of constituent questions. Again, this choice (to which I will stick throughout this paper) is only made for simplicity's sake.[12]

I will now turn to a discussion of question-embedding verbs. On this issue I will closely follow Lahiri (1991), to which I refer for arguments and technical details. The following subsection is basically a summary of those aspects of his work that are directly relevant to our goals.

2.2. *The Interpretation of Embedded Questions*

As argued by many, there are two fundamental classes of verbs that take *wh*-complements. Verbs like *wonder* are essentially relations between individuals and questions. The type and interpretation of *wonder* are as follows:

[12] However, since it might be less clear whether our proposals can in principle be compatible with a treatment of de dicto readings, I will discuss this issue in Appendix III.

(27) a. Mary wonders who John likes
b. Type of *wonder*: $\langle q, \langle e, t\rangle\rangle$
c. wonder $(m, \lambda p \exists x[\text{person}(x) \wedge p = {}^\wedge\text{love}(j, x)])$

Verbs like *know*, on the other hand, express relations between individuals and answers to the question expressed by the verb's complement. This can be set up in the following way. It is plausible to assume that *know* (like other verbs that take *that*-complements) is a relation between individuals and propositions; i.e., its logical type is $\langle p, \langle e, t\rangle\rangle$, where $p = \langle s, t\rangle$. This creates a type mismatch between the type of *know* and the type of questions that needs to be resolved. We need to go from q to p, i.e., from a question to one of its possible answers. Of all the possible answers to Q, which one should we choose? Clearly, we want the most informative answer that is relevant in the context. What counts as relevant may of course vary from case to case. But minimally, an answer to an embedded question must satisfy the presuppositions of the embedding verb. Since *know* is a factive, we will consider, in the case at hand, only those possible answers that satisfy the factivity presupposition of the verb *know*, i.e., we will want to consider only true members of A_Q. This can be put in the following terms:

(28) a. Mary knows who John likes ≈ Mary knows the most informative relevant answer to the question "who John likes"
b. Type of *know*: $\langle p, \langle e, t\rangle\rangle$
c. know $(m, \sigma p[A_Q(p) \wedge C(p)])$,
where $Q = \lambda q \exists x[\text{person}(x) \wedge q = {}^\wedge\text{love}(j, x))]$

Here, 'σ' is a "supremum" operator which picks out the most informative relevant answer in A_Q. This operator is well defined because, as Lahiri shows, A_Q forms a complete, atomic Boolean algebra. C in (28c) is a variable whose value is to be specified by the context and must minimally accommodate the presuppositions of the embedding predicate.[13]

Predicates like *know* display quantificational variability in the presence

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[13] See Lahiri for a precise definition of 'σ'. The answer we obtain with this approach corresponds to the "weakly exhaustive" reading of G&S (1984). For a discussion of the various options available in connection with exhaustiveness within the present approach, I refer once more to Lahiri's work. The use of a supremum operator in this context is a generalization of the treatment of plurals developed by Link (1983). See also Partee (1987) for a discussion of supremum operators as a type-shifting device — I think, moreover, that the variable C can be used to account for the variable "strength" that an answer to a question can have, a fact often noted in the literature (cf., e.g., Hintikka 1976, Belnap and Bennett 1977, and the "mention-some" vs. "mention-all" readings of G&S 1984). However, I will not elaborate on this here.

of adverbs of quantification of the appropriate kind. This phenomenon is illustrated in (29):

(29) a. For the most part, Mary knows who John likes ≈ for most propositions p which are part of the most informative relevant answer to "who John likes," Mary knows that p

b. Mary is certain, in part, about who will come to the party ≈ for some propositions p which are part of the most informative relevant answer to "who will come to the party," Mary is certain that p

With Lewis (1975), Kamp (1981), Heim (1982), and many others, I assume that adverbs of quantification split the clause into a restriction and a nuclear scope. Here the restriction is provided by the (relevant answers to the) embedded question. So for example, (29a) is spelled out as in (30), where (30a) is the LF of (29a) and (30b) its interpretation:

(30) a. For the most part [who John likes]$_i$ [Mary knows t_i]

b. most $q[q \leqslant_Q \sigma p[A_Q(p) \wedge C(p)]]$ [know (m, q)]

Following Lahiri again, I assume that in these cases, the embedded question undergoes QR and "lands" in the restriction of the quantificational adverb, serving the task of providing some content for the restriction. This fits well with current assumptions on how quantificational adverbs work in general, but I will not elaborate further on it.[14]

2.3. *Functional Readings*

In section 1.3, I briefly discussed the phenomenon of functional readings. Here I will lay out the details of their syntax and semantics. The phenomenon in question is illustrated by question–answer pairs such as (17), repeated here:

(17) a. Who/which person does everyone love?

b. His mother

Here the short answer in (17b) does not refer to an individual. Consequently, it cannot be viewed as a special case of the individual answer.

[14] For a discussion on how adverbs of quantification split the clause, see especially Diesing (1992) and references therein. The proposal presented here differs slightly from Lahiri's. He assumes that embedded questions always undergo QR, while I assume that they do so only in the presence of a quantificational adverb. For some discussion of the "splitting algorithm" I prefer, see Chierchia (1992).

An advocate of the independence of pair-list readings might argue that answers like (17b) are just a special case of list readings.[15] After all, (17b) is just a short way of providing a list, such as the following:

(31) Giovanni, Maria; Paolo, Francesca; . . .
where the first member of each pair is a person and the second his mother.

This is untenable, however, for several reasons. I will mention three, adapted from G&S (1984, ch. 3). First, an answer like (31) just doesn't provide the same information as (17b). If one is after the type of information exemplified by (17b), providing a list won't do: it would be too extensional, so to speak. Second, and conversely, if one is after a list, such list ought to be a complete specification of who each relevant individual loves. But an answer like (31) wouldn't necessarily provide such a specification. Finally, there are questions that do not admit pair-list answers, but do admit functional answers. A case in point is (32):

(32) a. Who does no Italian married man like?
b. His mother-in-law
c.* Giovanni, Maria; Paolo, Francesca; . . .
d. What do at most three students like?
e. Their exotic language requirement
f.* Paul the semantics requirement, Mary the phonology requirement, and Bill the exotic language requirement

(32b) constitutes a possible answer to (32a), but a list like (32c) does not; similarly for the triplet in (32d–f). The quantifiers that disallow list readings most strongly are the downward monotone ones.[16] This suggests that functional readings cannot be viewed as an instance of list readings, for the latter have a narrower distribution.

On the semantics of questions we are adopting, functional readings can be represented more formally as follows:

(33) $\lambda p \exists f[p = {}^\wedge \forall x[\text{Italian}(x) \rightarrow \text{love}(x, f(x))]$
where f is a variable of type $\langle e, e \rangle$

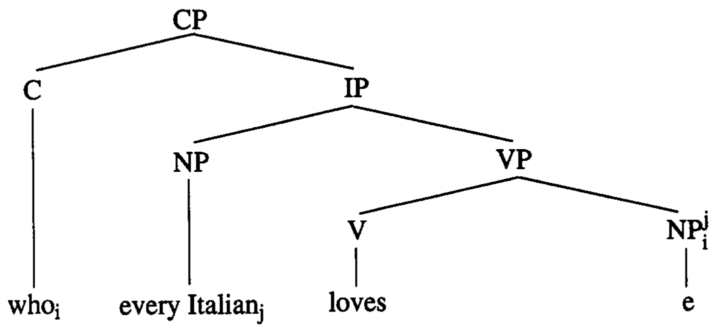
[15] In sec. 1.3 I made the opposite proposal, following Engdahl, namely that list readings are a special case of the functional readings.

[16] Here and throughout I adopt the standard view that NPs denote generalized quantifiers (of type $\langle\langle e, t\rangle, t\rangle$ — cf., e.g., Barwise and Cooper 1981). A quantifier $\mathcal{P}$ is downward monotone iff whenever $A \in \mathcal{P}$ and $B \subseteq A$, it follows that $B \in \mathcal{P}$. So, for example, if no man smokes, it follows that no man smokes cigars. Thus *no man* denotes a downward monotone generalized quantifier.

The semantics in (31) involves quantifying over functions from individuals to individuals, also known as Skolem functions.

An interesting question arising in this connection is how to get this reading compositionally. We evidently must assume that *wh*-words can be associated with two things: a function and an argument. The function is bound by the (existential quantifier that corresponds to the) *wh*-operator. The argument is bound locally by some suitable NP. As the function and the argument constitute two semantically distinct elements, it seems plausible to maintain that they are associated in the syntax with two distinct indices. This requires a slight modification of the standard view of *wh*-traces. We need something along the following lines:

(34)



In (32) the *wh*-word leaves behind a complex trace.[17] I will call *wh*-phrases of this kind "functional *wh*-complexes," and I will call the traces they leave behind "functional traces". Let us assume, for convenience, that the subscript corresponds to the function and is bound by the *wh*-phrase in Comp. The superscript corresponds to the argument. Its value is determined by coindexing it with a c-commanding NP: in the case at hand, the subject NP. The structure in (34) maps in a direct and obvious way onto the meaning in (33). I will call the index corresponding to the function the f-index and the one corresponding to the argument the a-index.

Though strictly speaking not necessary, it is natural within the Principles and Parameters framework to assume that the two indices in (34) are actually projected as two distinct empty nodes.[18] So, for example, we might take the structure of a functional trace to be as in (35a):

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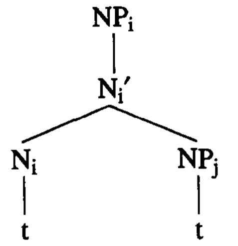
[17] The view that functional readings involve complex indices is also taken from G&S (who adopt a different syntactic framework, however).

[18] This could follow from some appropriate version of the Projection Principle, which governs how argument structure is syntactically projected. Functional traces differ from ordinary traces precisely in that they are articulated in a function and an argument.

(35) a.



b. $[_{NP}\, e^{j}_{i}]$

I will keep abbreviating (35a) as (35b). The empty nodes associated with both the f-index and the a-index in (35a) are subject, I assume, to the canonical syntactic conditions on licensing, namely the ECP. This is straightforward for the empty node associated with the f-index, which functions as a "standard" *wh*-trace. For the empty node associated with the a-index, the ECP requires that there be a head that licenses and θ-marks it. I assume that the [+wh] N^0 functions in this capacity. That is, I assume that the +wh feature has sufficient lexical content to license an empty element. In the spirit of, e.g., Rizzi (1990), the a-index is also subject to an identification requirement, which is satisfied by coindexing with a c-commanding antecedent.

Another thing to be noted is that in these structures the a-index is, as it were, left behind under *wh*-movement. We don't want to have the a-index in Comp, as such an index is not directly bound by the *wh*-operator. We must therefore assume that the moved *wh*-phrase only carries along the index associated with the head.

I should add that while the specific details of how functional *wh*-complexes are implemented might turn out to have interesting consequences, I don't think that such details will affect my main point. What is important here is that functional *wh*-complexes must be made up of two parts, one corresponding to the function and the other to the argument. In order to interpret functional questions, we must minimally assume the existence of more structured *wh*-traces, involving two indices. Of these, the f-index behaves like an ordinary *wh*-trace, while the a-index behaves like a bound pronominal.[19]

Before moving on, I should maybe say something more explicit as to how the domain and range of *wh*-functions are determined. The range

[19] Sloan (1990) presents data that, under the approach developed here, could perhaps be accommodated by regarding the a-index as an anaphor rather than a pronominal. Without meaning to be dismissive of her data, I do find them problematic enough to postpone their discussion to a different occasion.

appears to be completely determined by the (head of the) *wh*-phrase itself. This is particularly evident in the case of *which*-phrases. Consider (36a):

(36) a. Which woman$_i$ does every Italian love t$_i$?
b. $\lambda p \exists f[\forall x\, \text{woman}f(x)) \wedge p = {}^\wedge\forall x[\text{Italian}(x) \rightarrow \text{love}(x, f(x))]$
(cf. Engdahl 1986, pp. 174 ff)

In (36a) we are clearly looking for a woman-valued function. This can be make explicit as in (36b). The underlined part requires that the range of *f* be the set of women. The domain of *f* is determined by what we take the antecedent to be. The antecedent must be an NP c-commanding the *wh*-trace. In (36a) it is the local subject. But it could be another argument or a higher subject.

(37) a. To whom$_i$ did John return every paper$_j$ [e_i^j]?
a′. To its author
b. Who$_i$ does everyone$_j$ say [e_i^j shouldn't be invited to the party]?
b′. His little brother

Question (37a) asks for a person-valued function. The answer provides a function from papers into their respective authors. *Every paper* (i.e., the object NP) is construed as the binder of the a-index and, thereby, fixes the domain of the function. Question (36b) also asks for a person-valued function. Here the binder of the a-index is the higher subject *everyone* and the domain of the function is understood to be people. So in general, while the range of the function is fixed by the *wh*-phrase, the domain varies depending on what we take the binder of the a-index to be.

Another issue that is worth discussing briefly is the fact that functional readings may involve functions of more than one argument. Engdahl discusses examples of the following kind:

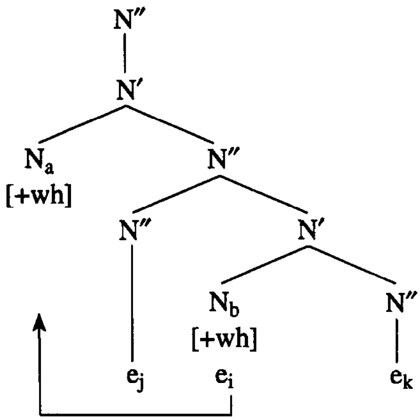
(38) a. To whom does every writer dedicate a book?
b. To the person that inspired her/him to write it

Here the relevant functions map pairs of writers and books into people. This entails, on the present account, that one must allow for more than one a-index. That is, the LF and semantic interpretation of (38a) must be along the following lines:

(39) a. [to whom$_i$ every writer$_j$ a book$_k$ [t$_j$ dedicates t$_k$ [$e_i^{j,k}$]]
b. $\lambda p \exists f[p = \forall x[\text{writer}(x) \rightarrow \exists y[\text{book}(y) \wedge \text{dedicate}(x, y, f(x, y))]]$

This raises the question of the exact syntactic structure of the functional complex that I have schematically indicated in (39a) as [$e_i^{j,k}$]. Since the function takes two arguments in this case, the structure must be rich enough to accommodate them. Under the binary-branching view, this virtually forces us to have a structure of roughly the following kind:

(40)



This structure is parallel to the structure of double object constructions in the theories of Jacobson (1987) and Larson (1988). The idea is that the lower [+wh] N^0 (i.e. N_b) first licenses e_k and assigns a θ-role to it. It then raises via head movement into the upper [+wh] N^0 (i.e. N_a) where it licenses and θ-marks e_j (which occupies the Spec position of the lower N″). The fact that I am using the category N across the board here should not be taken too seriously. Readers should feel free to substitute their favorite functional categories. The important point is that some recursion must be allowed, as there clearly is a need to accommodate functions of more than one place.

To summarize so far, I have adopted a specific version of the H/K approach to questions and indicated the line I take on embedded *wh*-complements, the quantificational variability phenomenon, and the syntax and semantics of functional readings. With this as background, we now turn to a discussion of our main topic, viz. list readings.

3. List Readings

It might be useful to begin by summarizing the data. Some *wh*-questions with quantified NPs have an interpretation that calls for a list answer. All those that do seem to be subject to a constraint requiring the trace of the NP to c-command the trace of the *wh*-word. So far we have illustrated this with universally quantified NPs, but the same point can be made with existentially quantified ones:

(41) a. What car do two students have?
John has a Subaru and Mary a VW.

b. Who has two cars?
 * John has a Subaru and Mary has a VW.

However, not every quantified NP in a *wh*-question allows for a list reading. Typically, downward monotone NPs do not (cf. (29) above).[20] In the literature, there are two families of approaches to list readings. The first one exploits functional readings, whereas the second develops a technique for quantifying NPs into questions and links list readings to quantifying in. I will discuss these approaches in turn and indicate what I take to be some of their shortcomings.

3.1. *Lists as Functions: First Try*

In section 1.3 I suggested, following Engdahl, that list readings might be regarded as a special case of functional readings. (In second 2.3, it was shown that the converse view is unviable). The main argument in favor of reducing lists to functional readings was essentially the following. Think of what lists are: pairings of individuals, i.e., sets of ordered pairs. But this is exactly what the graph of a function is. Now, let us see more concretely how this proposal would work. Consider:

(42) a. Who does everyone love?
 b. $\lambda p \exists f [p = {^\wedge}\forall x[\text{love}(x, f(x))]]$

The representation in (42b) is the standard semantics for the functional reading of (42a). In plain functional readings, we tacitly assume that the functions we are asking about are "natural" ones (such as those expressible by phrases like *his mother* or *her father*). But there is no a priori reason why arbitrary pairings of individuals should be left out of consideration. Formally, any pairing of a lover and a lovee, i.e., any list, forms a possible value for '*f*' in (42b) and hence provides a possible answer to (42a). In fact, it would seem that in order *not* to get a list as a possible answer to (42a) we would need a special stipulation (i.e., we would need to stipulate

[20] There are NPs that are not downward monotone and yet do not appear to license lists:

(i)	What do most students like?	*Mary phonology, John syntax, ...
(ii)	What do both students like?	*Mary phonology and John syntax.

I don't know why this is so. Another controversial case involves *each*. For some people, it shows the same asymmetries as other quantifiers (cf., e.g., examples (8)—(9) in Sloan 1990); for others (such as one of the reviewers), it does not. At any rate, *each* is known to be different from other quantifiers in several respects, and its properties are still not well understood at this point.

that in (42b) we are referring only to functions that are somehow "natural").

The appeal of this hypothesis is its extreme simplicity. According to it, no special device is needed to deal with list readings. They just fall out. However, there are problems that make this approach difficult to defend. I will mention three of them.

The first problem has to do with the definition of answerhood. Let me illustrate it with an example. Imagine a situation with three people *a*, *b*, *c*, where *a* loves *b*, *b* loves *c*, and *c* loves *a*. Now consider question (42a) against this background. The range of the function (which is specified by the *wh*-word itself) is the set of people, and the domain (which is determined by the binder) is also the set of people. Now, in the case at hand, there is a unique f that satisfies the formula in (42b) (and consequently a unique true proposition in (42b)). The relevant function is given in (43a) and the proposition in (43b):

(43) a. $f_1 = \begin{array}{l} a \rightarrow b \\ b \rightarrow c \\ c \rightarrow a \end{array}$

b. $\forall x[\text{love } x, f_1(x))] = \text{love}(a, b) \wedge \text{love}(b, c) \wedge \text{love}(c, a)$

Intuition tells us that a complete specification of this function would constitute the only true, complete, and appropriate answer to (42a) in the situation described. Now contrast this with:

(44) a. Who do two people love?

b. i. *a* loves *b* and *b* loves *c*

ii. *a* loves *b* and *c* loves *a*

iii. *b* loves *c* and *c* loves *a*

iv. *c* loves *a* and *a* loves *b*

c. $\lambda p \exists f[p = {}^\wedge \exists x \exists y[x \neq y \wedge \text{love}(x, f(x)) \wedge \text{love}(y, f(y))]$

Imagine that (44a) is asked against the same background. The answerhood conditions of (43a) are clearly very different from those of (42a). While (42a) has just one complete answer, any of the answers in (44b) (or any combination thereof) constitutes a true, complete, and appropriate answer to (44a). G&S (1984) call this phenomenon the "choice reading." Now the problem is that, at least under the assumptions developed so far, we still have only one relevant function from people to people in the situation at hand and consequently only one true proposition in (42c). How are we then going to define appropriate answerhood conditions for (44a)? In answering (42a), we have to run through the whole function. In answering (44a) it suffices to run through two values of the function. It seems that the number of values of the function we have to consider depends on the NP that constitutes the binder of the a-index. But in the semantics that I have developed so far, it is just not clear how this dependency can be captured. I have tried several ways of changing how functions are picked (e.g. by partializing them), but have been unable to come up with a satisfactory solution to this problem. Choice readings seem to call for a more elaborate notion of question.

The second problem has to do with quantificational variability. Consider again the situation described in the previous paragraph and imagine a situation where Mary knows that *a* loves *b*, and that *b* loves *a*, but not that *c* loves *a*. In this case (45a) is true:

(45) a. For the most part, Mary knows who everyone loves.
b. most true propositions in $\lambda p \exists f[p = {}^\wedge\forall x[\text{love}(x, f(x))]]$ are known to Mary

We are interpreting (45a) essentially as in (45b), following Lahiri. But as shown above, in this case there is only one true proposition in the question in (42b) and Mary does not know it. Hence, the sentence is predicted to be false. And it appears to be impossible to retrieve compositionally the "parts" (i.e., conjuncts) we need from the relevant propositions.

The third problem has to do with downward monotone quantifiers. Consider:

(46) a. Who do at most two people love?
b. $\lambda p \exists f[p = {}^\wedge\text{at most two people}(\lambda x[\text{love}(z, f(z))])]$

Under the view we are considering, (46b) is the interpretation for (46a). Imagine now a situation where the people are *a* and *b*, and where *a* loves *b* and *b* loves *a*. In such a situation, the following function makes the proposition in (46b) true:

(47) a. $f_2 = \begin{matrix} a \rightarrow b \\ b \rightarrow a \end{matrix}$
b. *a* loves *b* and *b* loves *a*

Yet (47b), which is just a spellout of f_2, is inappropriate as an answer to (45a). What is wrong with it? After all, f_2 is the function we are looking for. And there appears to be nothing wrong with the *form* of the answer in (47b). So the problem is that on the view that list readings are just a special case of functional readings, it is unclear why questions with downward monotone quantifiers do not admit list readings (while they do admit functional readings). One can try several moves here, too, but again I could find no fully convincing one.

So there appear to be some serious problems with this approach, stemming from the fact that the proposed semantics doesn't seem to have enough structure to represent certain phenomena. I now turn to approaches that try to solve these problems with some form of quantification into questions.

3.2. *Quantifying into Questions*

The basic idea that underlies these approaches is that lists come about by quantifying NPs into questions. This is at the basis of most syntactic approaches to asymmetries in the distribution of list readings, such as May (1985). Intuitively, a question like (48a) is to be interpreted as in (48b).

(48) a. Who do two people love?
b. For two people, tell me who they love.

So a question of this form really is a family of questions: who do these two people love? Or who do these other two people love? . . . This means that the type of (48a) will have to be richer than the type of the simple questions previously considered. It turns out that to develop this idea is technically complex. In what follows, I will briefly and informally consider two approaches due to Higginbotham (1991)[21] and G&S (1984).

In Higginbotham (1991), the list reading of (48a) is represented as in (49).

(49) [two x: x is a person] [*wh* y: y is a person] [? x loves y]

Let us give an idea of how (49) is to be unpacked. First, [? x loves y] denotes a yes/no question, the one that would be expressed by '*does x love y*?' The *wh*-operator '[*wh* y: y is a person]' turns this into a question about who x loves. For Higginbotham, such a question is a partition of the following form, as we saw:

(50) Cell 1: [x loves a_1, x doesn't love a_2, x loves a_3, . . .]
Cell 2: [x loves a_1, x loves a_2, x loves a_3, . . .]
Cell 3: . . .
. . . . .

At this point, the quantifier '[two x: x is a person]' turns (50) into something of the following form:

[21] Cf. also Higginbotham and May (1981) and May (1985, 1989).

(51) Block 1: let b_1 and b_2 be two people
Q_1 = who does b_1 love = {cell 1, cell 2, ...}
[replacing b_1 for x in (47)]
Q_2 = who does b_2 love = {cell 1, cell 2, ...}
[replacing b_2 for x in (47)]
Block 2: let b_3 and b_4 be two people
Q_1 = who does b_3 love = {cell 1, cell 2, ...}
[replacing b_3 for x in (47)]
Q_2 = who does b_4 love = {cell 1, cell 2, ...}
[replacing b_4 for x in (47)]

So the question in (47) denotes a family of questions, each member of which is a question about two people (i.e., the conjunction of a question about one person with the conjunction of a question about another person). The members of a family of questions are called "blocks." To answer a family of questions like (51) is to answer one of its blocks. The complex question in (51) is a question of degree 1 (since it is obtained by quantifying one NP into a question). In principle, one can have questions of degree n for any finite n.

Let me now turn to a brief description of G&S (1984), especially ch. 6. First, let us review their version of partitionism. For G&S, questions are associated with equivalence relations over the set of possible worlds (that partition the worlds into cells). Here are two informal examples of a yes/no question and a constituent question:

(52) a. Does John smoke? = $\lambda w' \lambda w''$ [John smokes$_{w'}$ = John smokes$_{w''}$]
where for any expression A, A_w is the value of A at w[22]
b. Who does John love? =
$\lambda w' \lambda w''$ [λx[John loves x]$_{w'}$ = λx[John loves x]$_{w''}$]

The relation in (52a) holds between w' and w'' just in case either both w' and w'' make the proposition that John smokes true or both make it false. So such a relation partitions the set of possible worlds into exactly two cells. This relation can also be viewed as a function from worlds into propositions. Intuitively, such a function maps a world w into the complete true answer to *does John smoke?* in w. More explicitly, one can say that a proposition p answers (52a) at world w iff it entails the proposition obtained by plugging w into (51a):

[22] These informal remarks are formalized by G&S (1984) using Gallin's (1975) *Ty2*, which affords direct quantification over worlds.

(53) $\lambda w' \lambda w''$ [John smokes $_{w'}$ = John smokes$_{w''}$] (w) =
$\lambda w''$ [John smokes$_w$ = John smokes$_{w''}$]

What proposition does (53) express? It depends on what w is like. If John smokes$_w$ = 1, then (53) maps w'' into true iff John smokes$_{w''}$ = 1, i.e. (53) is the proposition that John smokes. If John smokes$_w$ = 0, then (53) expresses the proposition that John doesn't smoke. So an answer to (52a) must either entail that John smokes or entail that he doesn't. The treatment of *wh*-questions is parallel, except that we get more cells. The relation in (52b) holds between w' and w'' iff the set of people loved by John is the same in w' as in w''. And an answer to (52b) in a world w where, say, John loves a, b, and nobody else must entail the proposition that John loves a, b, and nobody else.

It is also useful to briefly go over the way denotations such as those in (52) are compositionally obtained according to G&S. The value of a sentence like *John smokes* can be turned into the value of the corresponding yes/no question by an operation of the following kind: $\phi \Rightarrow \lambda w \lambda w' [\phi_w = \phi_{w'}]$. To build a *wh*-question instead, we first need to abstract over the position of the trace. The result is then turned into a question by a simple generalization of the question-forming operation just mentioned. The two relevant operations are given in (54):

(54) Abstract Formation: $\phi \Rightarrow \lambda x \phi$
Generalized Question Formation: $\alpha \Rightarrow \lambda w \lambda w' [\alpha_w = \alpha_{w'}]$, α an n-place relation
(formulae are identified with 0-place relations)

Also, abstract formulation can be generalized by letting it turn an n-place abstract into an n+1-place one. This is what G&S exploit to deal with multiple *wh*-questions, which I am ignoring in this paper, and with list readings, to which I now turn.

In the basic cases of quantifying into a sentence, the quantifying-in operation combines an NP meaning $\mathscr{P}$ and a formula ϕ relative to a variable x_n to yield a new formula. Such an operation can be formalized in IL as shown in (55a):

(55) a. $\mathbf{Q}_n(\mathscr{P}, \phi) = \mathscr{P}(\lambda x_n \phi)$, where ϕ is of type t (ignoring intensions)
b. $\mathbf{Q}_n(\mathscr{P}, \beta) = \lambda v[\mathbf{Q}_n(\mathscr{P}, \beta(v))]$, where β is of a type that ends in t

The operation $\mathbf{Q}_n$ can be extended in a natural way to expressions of any type that "ends in t," as illustrated in (55b). Partee and Rooth (1983) and many others discuss such extensions. Questions in G&S's theory are relations between worlds (of type $\langle s, \langle s, t\rangle\rangle$); thus the cross-categorial generalization of quantifying in applies to them. However, as G&S point out, this only gets us the right results for universally quantified NPs. For example, if we quantify *everyone* into the value of *who does x like*, we obtain a question that asks for every person x, which is the set of people that x likes. This gives us the list reading for *who does everyone like*, as desired. But if we quantify a non-universal NP into questions, we do not obtain partitions, i.e., we do not obtain proper question meanings (I refer to G&S for details). Thus, in order to obtain list readings involving, for example, an existentially quantified NP such as *two people*, we will need a different device.

The device that G&S develop bears some similarity to the one proposed by Higginbotham. I will discuss it here informally, adapting it somewhat to our needs and notation. As shown in Barwise and Cooper (1981), each natural language quantifier $\mathscr{P}$ "lives on" a set A.[23] Let $\mathscr{P}_A$ be a quantifier that lives on A. Moreover, each quantifier has one or more "minimal witness sets." A minimal witness set for $\mathscr{P}_A$ is a $B \subseteq A$ such that $B \in \mathscr{P}$ and for no $P' \subseteq B$, $B' \in \mathscr{P}$. For example, a minimal witness set for (the value of) *two men* is a set of exactly two men. *No man* has the empty set as its unique minimal witness set. In fact, downward monotone quantifiers all have $\varnothing$ as their minimal witness set. *Every man*, too, has a unique witness set, namely the set of men. In dealing with a question like *who do two people like*, we want to form a set of questions, one for each minimal witness set in *two people* (i.e., one per group of two people).[24] This can be accomplished as follows. Consider the abstract corresponding to *who x likes*, namely $\lambda y[x \text{ likes } y]$, and an NP like *two people*. For each minimal witness set A in the value of *two people* (i.e., for any set A of exactly two people), we can form a new abstract $\lambda x\lambda y[x\in A \wedge x \text{ likes } y]$. Each one of such abstracts can then be turned into a question about those two people. This can be expressed as follows:

(56) $\lambda Q \exists A\, [W(\text{two people}, A) \wedge Q = \lambda w \lambda w'\, [\lambda x \lambda y\, [x \in A \wedge x \text{ likes } y]_w = \lambda x \lambda y\, [x \in A \wedge x \text{ likes } y]_{w'}]]$
where 'W' stands for 'is a minimal witness of'

The formula in (56) denotes the desired family of questions, one per minimal witness set. As on Higginbotham's approach, we can say that to

[23] A generalized quantifier $\mathscr{P}$ lives on a set A iff for any set B, $B \in \mathscr{P} \Leftrightarrow B \cap A \in \mathscr{P}$.
[24] The use of *minimal* witness sets leads to problems in connection with quantifiers like *at least two men*. These problems can be solved by taking plurals seriously, which we cannot do, however, within the limits of this paper. I refer to G&S (1984, ch. 5) for discussion.

answer (56) is to answer any of its members. Formula (56) can equivalently be put as follows:

(57) $\lambda P \exists A\ [W\ (\text{two people}, A) \wedge P\ (\lambda w \lambda w'\ [\lambda x \lambda y\ [x \in A \wedge x \text{ likes } y]_w = \lambda x \lambda y\ [x \in A \wedge x \text{ likes } y]_{w'}])]$

Here, instead of taking sets of questions, we take sets of sets of questions. Notice that (56) can be obtained from (57) by simply taking the union of the singletons in (57).[25] G&S (1989) argue that by taking the type of (57) as the one at which questions are represented, an elegant treatment of disjunctive questions (like *who saw Bill or John?*) and related phenomena becomes available (see Appendix IV for discussion). I will call objects of the same type as (56) "families of questions" and objects of the same type as (57) "lifted questions." Lifted questions can be viewed as generalized quantifiers over questions.

Both of these treatments (Higginbotham's and G&S's) have appealing features. They overcome the difficulties that the functional approach to list readings runs into. They also provide the basis for an account of why list readings are bad with downward monotone quantifiers. If one works things out, what happens is that such questions can be answered by saying nothing at all. And one could conceive of a straightforward Gricean story as to why asking such questions would be self-defeating.

One thing that emerges quite clearly from the present discussion is that to deal with "choice readings" and related phenomena (such as disjunctive questions), we need to raise the type of interrogatives by using either families of questions or lifted questions. Then to maintain a uniform type for all questions, we must also treat the simple ones at the higher level. So for example, if Q is a simple question, then its official meaning could be one of the following:

(58) a. $\lambda Q'\ [Q' = Q]$
b. $\lambda P P(Q)$

(58a) is a family of questions that contains only one question. And (58b) is the set of all sets containing Q, which, as we know from Montague, encodes the same information as Q itself.

Even granting these points, there are reasons to be dissatisfied with the way denotations of this type are obtained according to the proposals of Higginbotham and G&S. I will discuss two, the first being empirical, the second conceptual.

[25] That is, (56) is to (57) what '$\lambda x[\text{man}(x)]$' is to '$\lambda P \exists x[\text{man}(x) \wedge P(x)]$'.

The empirical difficulty lies in the fact that neither approach has a principled way of preventing quantification into yes/no questions. So it is expected that, for example, (59a) has a reading on which it is equivalent to (59b):

(59) a. Does John love everybody?
b. Who does John love?

This appears to be false. One of its consequences is that in certain cases a proposition like *John doesn't love Bill* (which entails that he doesn't love everybody) should *not* count as a complete answer to (59a), contrary to fact.[26]

The conceptual difficulty is the following. It is a fact that the standard quantifying-in operation just doesn't give us list readings in their full generality (on any of the approaches currently available). Some other device is needed. Is it appropriate to regard such a device, whatever it may be, as a form of quantifying in? What do the operations proposed by Higginbotham or G&S have in common with $\mathbf{Q}_n$ as defined in (55)? Not much, it seems to me. Basically, what $\mathbf{Q}_n$ has in common with the operations described in the previous paragraph is the fact that they all involve NP meanings.[27] But this doesn't seem enough to warrant the conclusion that we are dealing with two facets of the same phenomenon — unless we are willing to regard *every* operation involving NP meanings (such as, e.g., passive) as a case of quantifying in.

So we have the following situation. Trying to reduce list readings to functional readings doesn't seem to work. Mechanisms such as the ones considered in this section do better but still don't overcome all of the problems. How is it possible to improve on this situation? Perhaps our first attempt to reduce lists to functions was a bit too simpleminded.

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[26] Belnap and Bennett (1977) try to construct examples where quantifying an NP into a yes/no question gives the right results, but I agree with Lahiri (1991, p. 113) that none of their examples is convincing. Also, one of the referees tries to make the case that answering *I don't* to a question like *Does everyone agree?* asked by the chairman of the board to the board members, may not count as a complete answer. It seems clear to me that if the question *Does everyone agree?* is taken literally, finding out that one person does not suffices to provide the information that was asked for.

[27] Another feature that the operation proposed by Higginbotham shares with quantifying in is that both operations are order dependent, i.e., different orders in which NPs are plugged in yield different readings. Interestingly, however, the order in which an NP is plugged in relative to a *wh*-operator does not make a difference. Thus Higginbotham points out that (modulo some special cases) the equivalence in (i) holds in his system:

(i) $[Qx{:}\, A]\,[wh\, y{:}\, B]\, \phi \Leftrightarrow [wh\, y{:}\, B]\,[Qx{:}\, A]\, \phi$

Similar considerations apply to G&S's system. Cf. Appendix II for details.

Perhaps we should give it a second try, capitalizing on what we have learned from the proposals discussed in this subsection. After all, a list *is* just the graph of a function, and what we want to say about lists ought to be sayable by using functions.

4. LIST AS FUNCTIONS: REPRISE

The intuition underlying the following proposal is that list readings are indeed functional readings of a special kind. The difference between plain functional readings and list readings is the following. In plain functional readings, the range of the function is semantically specified by the *wh*-word, but the domain is not. It is only indirectly specified by the antecedent of the a-index. In list readings, by contrast, the domain of the function is semantically determined as well, by extracting it from NPs. Moreover, the value of interrogatives has to be lifted in order to analyze choice readings properly. Consider:

(60) Which professor does every student like?

On the plain functional reading, we are looking for a natural professor-valued function. For example, a function that maps x into x's advisor would do. On the list reading, we are looking for a function that pairs a student x with a professor $f(x)$ in order to find out which propositions of the form 'x loves $f(x)$' are true.

A very simple modification of G&S's proposal affords us just what we want. First let us introduce a (fairly standard) piece of set-theoretic notation. Let U be a domain and let X, Y be nonempty subsets of U. Let $[Y \rightarrow X]$ be the set of all total functions from Y into X. That is, if $y \in Y$, then $f(y) \in X$; otherwise $f(y)$ is undefined. If Y or X are empty, $[Y \rightarrow X]$ is empty. With this in mind, let us now turn to list readings. I assume that list readings are obtained by means of an operation that (in the simplest cases) applies to three things (a *wh*-phrase, an NP, and an IP) and gives us as output a family of questions (or, equivalent, a lifted question). Such an operation is essentially a Skolemized variant of G&S's proposal. The point is that since quantification over Skolem functions is necessary anyhow, we might as well use it in these cases. I will first illustrate this operation by means of a few examples. Then I will provide its general formulation.

(61) Example A

a. who_i + everyone_j + t_j loves e_i^j $\Rightarrow$ $\{Q: \exists A[W(\text{everyone}, A) \wedge Q = \{p: \exists f \in [A \rightarrow X] \exists x \in A\ [p = {}^\wedge\text{loves}(x, f(x))]\}]\}$ where X is the set of people

b. $\{\{a \text{ loves } b, b \text{ loves } a, a \text{ loves } a, a \text{ loves } b\}\}$

The family of questions in (61a) will contain exactly one simple question, since *everyone* has exactly one witness set. In particular, the question will contain all the possible propositions of the form '*a* loves *b*', where *a* and *b* are people. In a situation where *a* and *b* are the only people, (61a) gives us (61b). To answer this question is to answer its only member, i.e., to specify which propositions in its only member are true.

(62) Example B

a. which book_i + two people_j + t_j love e_i^j ⇒
$\{Q: \exists A\ [W(\text{two people}, A) \wedge Q = \{p: \exists f \in [A \to \text{book}] \exists x \in A[p = {}^{\wedge}\text{loves}(x, f(x))]\}]\}$

b. {{*a* loves *l*, *b* loves *l*, *a* loves *m*, *b* loves *m*} {*a* loves *l*, *c* loves *l*, *a* loves *m*, *c* loves *m*} {*c* loves *l*, *b* loves *l*, *c* loves *m*, *b* loves *m*}}

In this case, the family of questions contains as many questions as there are groups of two people. To answer this family of questions is to answer any of its members. A typical answer to a question in the family will have the form '{*a* loves *a'*, *b* loves *b'*}'. In a situation where there are three people *a*, *b*, and *c* and two books *l* and *m*, (62a) yields (62b).

(63) Example C

who_i + at most two people_j + t_j loves e_i^j ⇒
$\{Q: \exists A[W(\text{at most two people}, A) \wedge Q = \{p: \exists f \in [A \to X] \exists x \in A\ [p = {}^{\wedge}\text{loves}(x, f_A(x))]\}]\} = \{\varnothing\}$

In this case, the minimal witness set of *at most two people* is the empty set. But then the family of questions in (63) will only contain the empty set, in reflection of the fact that list readings are unavailable in these cases.

Having worked through these examples, it is easy to see what the general rule is (I give the rule using lifted questions):

(64) $wh\ \text{N}_i + \text{NP}_j + \text{S} \Rightarrow \lambda P \exists X\ [W(\text{NP}_j, X) \wedge P(\lambda p[\exists f_i \in [X \to N]\ \exists x_j \in X[p = {}^{\wedge}\text{S}]])]$

As far as the syntax goes, I will make the following assumptions, building on a proposal put forth in Higginbotham and May (1981). A sequence of operators in sentence-initial position can undergo Absorption, which is a simple restructuring operation of the following kind:

(65) *Absorption*

$[wh\ \text{N}_i[\text{NP}_j\text{S}]] \Rightarrow [[wh\ \text{N}_i\ \text{NP}_j]\ \text{S}]$

I leave it open how absorption is to be formulated exactly. Maybe it is adjunction of an NP to Spec of CP (analogous to what happens with multiple *wh*-questions). Or maybe it brings about a virtual bracketing of the kind argued for in connection with reanalysis in Romance. Be that as it may, the result of Absorption is interpreted as in (64).[28]

Consider in this light a question like *Which professor does every student like?* It has three LFs that correspond to its individual, plain functional, and list readings, namely:

(66) a. [which professor$_j$ [every student$_i$ [t_i like t_j]]] ⇒ (individual reading)
$\lambda P\, P(\lambda p[\exists x \text{ professor}(x) \wedge p = {}^\wedge \forall y[\text{student}(y) \rightarrow \text{like}(x, y)])$

b. [which professor$_j$ [every student$_i$ [t_i like t_j^i]]] ⇒ (plain functional reading)
$\lambda P\, P(\lambda p[\exists f \forall x\, [\text{professor}(f(x)) \wedge p = {}^\wedge \forall y[\text{student}(y) \rightarrow \text{like}(y, f(y)])$

c. [[which professor$_j$ every student$_i$] [t_i like t_j^i]] ⇒ (list reading)
$\lambda P \exists A[W(\text{every student}, A) \wedge P(\lambda p[\exists f \in [A \rightarrow \text{professor}]\; \exists x \in A[p = {}^\wedge\text{loves}(x, f(x))]])]$

Since plain functional readings may involve functions of more than one argument, we would expect the same to be possible of list readings. This seems to be so indeed. For example, a question like (67a) admits (67b) as an answer:

(67) a. Every student has given several papers to his/her colleagues for them to comment on. I want to know to whom every student gave two of his papers.

b. John gave paper *a* to Bill and paper *b* to Mary; Sue gave paper *c* to Bill and paper *b* to John; ...

---

[28] May (1989) and Srivastav (1991a) propose to view Absorption as a purely interpretive phenomenon. We can follow their proposal and let the LF in (i) be ambiguous:

(i) [which professor$_i$ [every student$_j$ [t_j like t_i^j]]]

If we interpret '[every student$_j$ [t_j like t_i^j]] using the ordinary quantifying in (i.e. Q_n) and then form a question out of this, the result will be the plain functional reading. If instead we were to interpret the whole of (i) using (64), we would get the list reading. However, this would result in LF representations which do not disambiguate the different readings of questions. If we want an unambiguous LF for list readings, we need a representation where both the *wh*-phrase and NP meaning are simultaneously available. I use Absorption basically as a cover term for any way of constructing an LF of this kind — Higginbotham and May use Absorption to deal with multiple *wh*-questions, among other things, and the present approach could be extended along similar lines. But a discussion of how this could be done must await another occasion.

Notice that this clearly counts as a complete answer even if, for example, John has handed out more than two papers for comments. I will indicate here how examples of this kind are going to be treated. A fully explicit treatment can be found in Appendix II. The LF of the relevant question is as in (68a). It comes about, we assume, through iterated applications of Absorption. Its interpretation is shown in (68b):

(68) a. [to whom$_i$ every student$_j$ two of his$_j$ papers$_k$] [t$_j$ gave t$_k$ $t_i^{j,k}$]

b. $\lambda P \exists R[W(\text{every student, two of his papers}, R) \wedge P(\lambda p[\exists f \in [R \rightarrow \text{person}] \exists xy \in R\, [p = {}^\wedge\text{give}(x, y, f(x, y))]])]$

Here we have two NPs undergoing Absorption. They jointly determine the domain of the function. So instead of a minimal witness set, we must extract a minimal witness relation. Other than that, everything is the same. It is interesting to remark that while our semantics is heavily based on the proposal of G&S (1984, ch. 6), the approach they develop is unable to treat examples of this sort. First, it is unable to get the pronoun *his*$_j$ to be bound by the subject NP. And second, it doesn't yield the reading where each student gives out a different pair of papers. (This is shown in Appendix II.)

It is now time to take stock, before looking at the empirical consequences of the approach proposed here. In the system I am advocating, interrogatives denote lifted questions. A *wh*-trace can be functional or individual. Furthermore, functional readings come in two varieties: unrestricted ones and those restricted by one or more NPs (the latter case arising via Absorption). In case no restriction is semantically provided, the context must supply it (just as it does when we quantify over individuals). It comes as no surprise, then, that questions without a semantic restriction range only over natural functions, i.e., functions that we can readily access or define. In spite of the fact that list readings are a special case of functional readings, I will keep using the terms 'functional readings' and 'list readings' to refer to readings involving natural functions and lists, respectively. There is no quantifying into question in the sense of an iterable operation based on something like $\mathbf{Q}_n$ in (55). This does not necessarily mean that adjunction to CP is impossible (as on May's analysis). It merely means that if such an adjunction is admitted, it cannot be interpreted via $\mathbf{Q}_n$. For the cases involving just one NP, the semantics for list readings is a (Skolemized) variant of the semantics proposed in G&S (1984, ch. 6). For cases involving sequences of NPs, my proposal covers facts that G&S's proposal does not. And, as we shall see in the next section, it makes a host of predictions that no approach based on quantifying in, by itself, makes.

5. CONSEQUENCES

The consequences of the approach we have developed are far reaching. Some are more speculative than others.

5.1. *Absence of Quantification into Yes/No Questions*

This point is noted by Lahiri (1991). I assume that the type of questions is set up in such a way as to disallow quantifying in.[29] We have an independent device that yields list readings, namely Absorption as construed in the previous section. But such a device does not apply to yes/no questions for principled reasons. On our proposal, list readings require a functional *wh*-complex. But it is only *which, who,* and *what* that can be interpreted as quantifying over functions, whereas *whether* cannot. As Lahiri puts it:

> If *whether*-questions had a functional reading, the function would be a function from propositions into truth-values, with no variable to be bound by a quantifier. This predicts that given that quantification in natural language is non-vacuous the functional reading [and hence the list reading — GC] should be unavailable in yes/no questions.
> (Lahiri 1991, p. 114)

As we saw, there is no obvious way to derive this result on an approach that allows for quantification into questions. That was the main empirical difficulty which that kind of approach runs into.

5.2 *Wh-Quantifier Asymmetries*

The main empirical issue in the semantics of questions that we raised at the outset concerns the asymmetry in (1), repeated here:

(1) a. Who_i does everyone like t_i?
b. Who_i t_i likes everyone?

In this section, we simply note that the crossover account of this asymmetry outlined in section 1.3 goes through in a straightforward manner in the theory we are adopting.

List readings are a case of functional readings, so in order to get the list reading of (1b), the *wh*-trace would have to be a functional one. Accord-

[29] If we take the type of questions to be $\langle p, t\rangle$, then that is a conjoinable type and, hence, Q_n is defined for it. This is an accident, however, stemming from the use of IL as the semantic meta-language in dealing with questions. A simple way out is to regard questions as individuals, using, e.g., the type theory of Chierchia (1984).

ingly, the S-structure of (1b) would have to be as shown in (69a), and its LF as in (69b):

(69) a. who$_i$ [e^j_i] likes everyone$_j$

b. [who$_i$ everyone$_j$] [[e^j_i] likes t_j]

But in (69), the object NP cannot be a proper antecedent for the a-index, as it does not c-command it. In order for the object NP to bind *j*, it would have to cross over it. Notice that it does not matter where *everyone*$_j$ lands. In particular, it does not matter whether it crosses over the preposed *wh*-phrase or not. The relevant action takes place within IP. In order to bind the a-index, the quantifier has to cross over it. There is just no other way. The parallel with standard crossover configurations, such as (70), is there for everybody to see.

(70) a. his$_j$ mother loves everyone$_j$

b. who$_j$ does his$_j$ mother loves t_j

Whatever accounts for the ungrammaticality of (70) cannot fail to extend to (69). Our understanding of weak crossover may still be largely incomplete.[30] But under the present view it is clear that *wh*-quantifier interactions fall squarely in the same natural class as weak crossover phenomena.

Consider, in contrast, the LF associated with (1a) that admits a pair-list reading. Such a LF is given in (71).

(71) [who$_j$ everyone$_j$] [[t_j] loves [t^j_i]]

Here *everyone* binds the trace in subject position, which in turn binds the a-index of the *wh*-phrase in object position. No violation of weak crossover ensues. The quantifier *everyone*$_j$ is first adjoined to IP, then undergoes Absorption, forming a binary operator with the *wh*-word.

The present approach makes a very strong prediction concerning the distribution of functional readings: whenever a list reading yields a weak crossover violation, so should a functional reading. Hence, in those very contexts, functional readings should be unavailable. It is easy to see why. In order to get a functional reading in the relevant context, we must get a quantifier to bind the a-index of the functional trace. If the quantifier is

[30] Some influential approaches to weak crossover are Jacobson (1977), Higginbotham (1980), Reinhart (1983), Koopman and Sportiche (1982), and Safir (1984), to mention but a few.

c-commanded by the trace at S-structure, this will inexorably trigger a crossover violation. The relevant structures are like (69) and (71) (except that Absorption doesn't take place).

The prediction is indeed borne out. A functional answer like *his mother* is acceptable as an answer to (1a) but not as an answer to (1b). Here is a further example, involving a quantifier that does not license list readings:

(72) a. Which paper did no speaker criticize?
b. The one by his or her spouse

(73) a. What speaker criticized no paper?
b.* Its author (meaning: no paper was criticized by its author)

As far as I can tell, this parallelism between list readings and functional readings is left unaccounted for by all the theories I am familiar with. May (1988, fn. 2) claims that his theory does account for it on the grounds that the Path Containment Condition would force the quantifier in (1b) to adjoin to VP. But at the same time he argues that the scope of VP-adjoined quantifiers extends to IP (May 1985, pp. 58ff) and makes crucial use of this fact. It is, therefore, unclear to me what would prevent a VP-adjoined quantifier from binding the a-index of the NP trace in subject position, thereby making the functional reading of (1b) grammatical.

5.4. *Asymmetries with VP*

A contrast parallel to the one in (1) has been observed in structures like the following:

(74) a. Who did you give everything to?
I gave the book to John, the paper to Mary, . . .
b. What did you give to everybody?
* I gave the book to John, the paper to Mary, . . .

These examples (and judgments) are taken from Williams (1988). Similar examples are discussed in May (1985). Again, approaching these sentences in terms of functional *wh*-complexes makes the parallelism with crossover configurations impossible to miss. In (75a) I give the S-structures of the sentences in (74a). In (75b) I provide, for comparison, standard examples of crossover configurations.

(75) a. i. Who_i did you give everything_j to $[e_i^j]$
ii. What_i did you give $[e_i^j]$ to everybody_j
b. i. John gave every paper_j to its_j author
ii. ?? John gave his_j paper to every student_j

There is nothing special to say about this contrast, except that it is well known that in VP's with an indirect object, weak crossover violations appear to be less sharp. Many speakers find the following acceptable, for example:

(76) John returned his paper to every student.

In fact, in precisely these environments, functional and list answers do not seem so bad either:

(77) Which paper did John return to every student?
   a. His phonology paper
   b. John returned to Bill his paper on clitic doubling, to Mary her paper on psych verbs, . . .

This further supports the idea that we are dealing with a crossover phenomenon here.

5.5 *Long Wh-movement*

May (1985) observed that functional and list readings are also available in case of long *wh*-movement:

(78) Who do you think that everyone invited?
   a. His best friend
   b. I think that John invited Sue, Paul invited Mary, . . .

This is to be expected on our theory. The relevant structures are given in (79)

(79) a. Functional Reading:
   who_i do you think that [$everyone_j$ [e_j invited [e_i^j]]]?
   b. List Reading:
   [who_i $everyone_j$] do you think that [e_j invited [e_i^j]]

Of particular interest is (79b). *Who*$_i$ is fronted at S-structure. At LF, *everyone*$_j$ is adjoined to the lower IP on the first cycle. At this point it undergoes Absorption, which turns the *wh*-quantifier sequence into a complex *wh*-operator.[31] On the second cycle, this operator undergoes further LF-movement and is moved to the higher Spec of CP.

[31] In the case at hand, Absorption applies to *everyone* and the intermediate *wh*-trace, in the manner indicated here:

(i) $[_{wh}\ e_i]$ [$everyone_j$ ⇒ $[[_{wh} e_i]$ $everyone_j$]

This operator is then moved to the matrix Comp.

A theory that relies on quantifying in is forced to assume that *everyone* in (78) can be assigned scope at the highest IP node in order to derive the list reading. This is problematic in view of the well-known fact that quantifier scope is generally clause bound. For example, the quantifier in the embedded sentence in (80) cannot be assigned scope over the quantifier in the matrix clause:

(80) A student thinks that every professor hates him.

Kratzer (1991) argues that even de dicto/de re ambiguities are best accounted for within an approach that maintains the clause-bounded nature of scoping.

As is to be expected, the availability of list and functional readings in long-movement structures disappears where the conditions in the embedded clause result in a crossover violation. The question in (81) only admits an individual reading:

(81) who$_i$ do you think [t$_i$ invited everyone]?

5.6. *Inverse Linking*

Inverse linking structures are another interesting set of cases where my theory makes predictions that differ from those of other available approaches:

(82) a. Tell me where the advisor of every student is
    i. In his office
    ii. John's advisor is here, Bill's is there, . . .
  b. Tell me who saw the advisor of every student
    i. *His chair
    ii. *John saw Bill's advisor, Mary saw Paul's advisor

Following May, I assume that at LF, inversely linked NPs have the structure in (83a) which, following Rooth (1985), I assume is interpreted as in (83b):

(83) a. [NP$_k$ every student$_j$ [the advisor$_k$ of t$_j$]]
  b. λP[every student (λx_k (the advisor of x_k (P))] =
    $\lambda P \forall x$ [student(x) $\rightarrow$ $\exists! y$ [advisor of $x(y)$ $\wedge$ $P(y)$]]

Given these assumptions, let us illustrate what the predictions are, using functional readings. The situation is wholly parallel for list readings. The LFs of (82a, b) would be as shown in (84a, b), respectively:

(84) a. where$_i$ [NP$_k$ every student$_j$ [the advisor$_k$ of t$_j$]] [t$_k$ is [e_i^k]]?

b. who$_i$ [NP$_k$ every student$_j$ [the mailbox$_k$ of t$_j$]] [[e_k^k] saw t$_k$]?

It is clear that (84b), but not (84a), induces a crossover violation. Rooth's semantics for inverse linking automatically yields the right meaning for these LFs. It is interesting to note that May makes different predictions in this connection. The NP *every student* is prevented by the intervening NP$_k$ node from forming a Σ-sequence with the *wh*-phrase. Hence, as he explicitly notes, a pair-list reading should never be possible with inversely linked structures. But I find the list reading of (82a), as well as the functional one, impeccable.

5.7 *Quantificational Variability*

The present approach makes two predictions vis-à-vis quantificational variability with list readings. The first prediction is simply that list readings involving universal NPs should display quantificational variability. To see why, consider a simple question like (85a) and a question like (85b) on its list reading:

(85) a. Who does John likes?

b. Who does everyone like?

Their respective interpretations are given in (86):

(86) a. $\lambda PP(\lambda p[\exists x\, p = {}^\wedge\text{like}(j, x)])$

b. $\lambda P \exists A[W(\text{everyone}, A) \wedge P(\lambda p[\exists f \in [A \rightarrow \text{people}]\ \exists x \in A[p = {}^\wedge\text{like}(x, f(x))]])]$

The lifted question in (86a) clearly corresponds to a unique simple question. And the same is true of (86b), since a universally quantified NP has a unique witness set. So in both cases we can assume that the unique simple questions to which (86a, b) correspond provide the domain from which the restriction of a quantificational adverb is drawn. In section 2.2, we saw how such a restriction is constructed out of the maximal (relevant) answer to the question.

Indeed, sentences like (85b) do display quantificational variability:

(87) Mary knows, for the most part, who everyone loves.

In a situation with three people *a*, *b*, and *c*, where *a* loves *b*, *b* loves *c*, and *c* loves *a*, if Mary knows that *a* loves *b* and *b* loves *c*, sentence (87) would be true. This is all rather straightforward at this point. What is perhaps more interesting is the second prediction that our theory makes. Consider a list reading involving an indefinite, as for example:

(88) Who do three students like?

This question will denote a lifted question that *does not* correspond to a unique simple question. It will correspond to as many simple questions as there are groups of three people. In fact, such questions do not typically have one unique complete answer, but several. Hence, there is no unique domain out of which the restriction for a quantificational adverb can be constructed. Remember that we use the locution "*the* maximal answer" to construct the restriction for quantificational adverbs. In cases where a question admits more than one maximal answer, this locution will be undefined. Hence, sentences like (88) should *not* display quantificational variability. In fact, this seems to be so. Consider:

(89) John knows in part what three students like.

The only reading that this sentence has is the following: take all the things that some group or other of three students like; for some of those things, John knows that a group of three students likes them. This reading is obtained out of the individual one. However, sentence (89) lacks the following reading: take a particular group $\{a, b, c\}$, where a likes a', b likes b', and c likes c'; John knows that a likes a' (i.e., he knows part of one of the possible answers to (89)).

So the present theory predicts that quantificational variability should affect lists involving universal NPs but not lists involving existential ones, which seems to be true.

5.8. *Psych Verbs*

The following considerations are more tentative than those put forth so far, but still, perhaps, worth making. Kim and Larson (1989) claim that judgments concerning the availability of functional and list readings appear to be reversed with psych verbs:

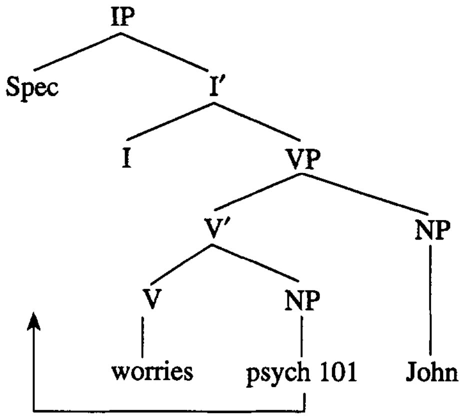
(90) What worries everyone?
  a. His B-exam
  b. The B-exam worries Bill, the language requirement worries Mary, . . .

(91) Who does every conference worry the most?
John

Kim and Larson adopt Belletti and Rizzi's (1988) approach, according to which a sentence like (92a) underlyingly has the flipped structure in (92b):

(92) a. Psych 101 worries John.

b.



The underlying object moves at S-structure to Spec of IP for case-theoretic reasons. Kim and Larson argue that upon adopting this analysis and a version of May's approach based on Path Containment, one should expect the flipping of grammaticality judgments for psych verbs.

I agree with Kim and Larson on the general availability of list and functional readings for (90), but disagree with them on their unavailability for sentences like (91). Kim and Larson (1989, fn. 2) admit, in fact, that judgments concerning the unavailability of list and functional readings for (91) do not hold for many speakers. I believe that if the examples are pragmatically plausible, functional and list readings will systematically go through with structures like (91). In (93)—(94), I give some further examples.

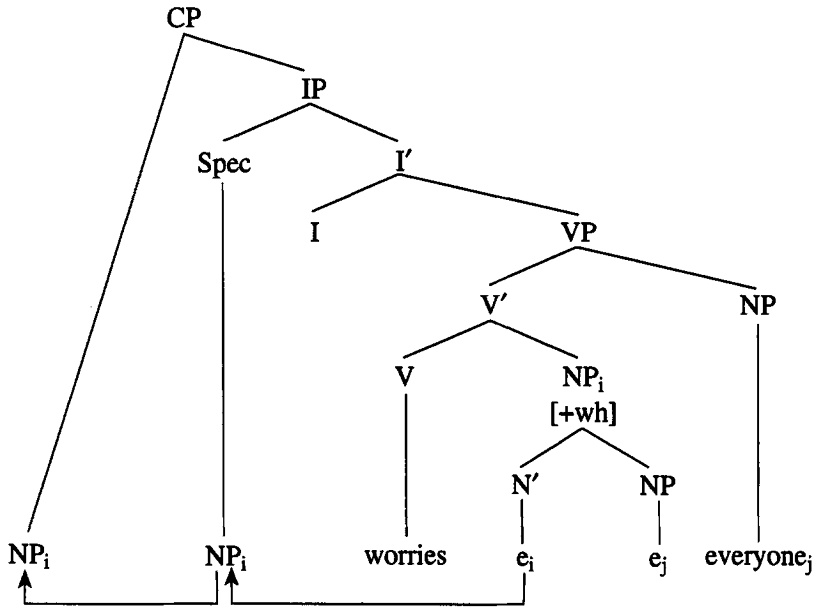
(93) a. Who does every conference worry the most?
b. Its organizers
c. NELS worries Bill, WCCFL worries Mary, ...

(94) Recently there were three mishaps in the department: a budget cut, a conflict with the graduate students, and a nasty letter from the dean, which caused a lot of distress among the faculty.
a. I would like to know which faculty member every mishap affected most directly.
b. Whoever was responsible for it.
c. The budget cut affected Sue most directly, as she is the chair. The conflict with the graduate students bothered John the most, as he is the Graduate Field Rep. ...

Notice that example (94a) contains a singular *which*-phrase and that the subject of the embedded clause is inanimate, both factors that are supposed to disfavor list readings. Yet a list reading of (94a) is fairly natural. So I disagree with Kim and Larson's characterization of the facts and maintain that list and functional readings with psych verbs are generally grammatical, wherever we extract from.

I think that my theory predicts that both (90) and (91) should have list readings. Perhaps the easiest way to see this is by taking a closer look at the relevant structures. Consideration of the relevant S-structures will suffice. Let us begin by looking at the S-structure of (90):

(95) What worries everyone?



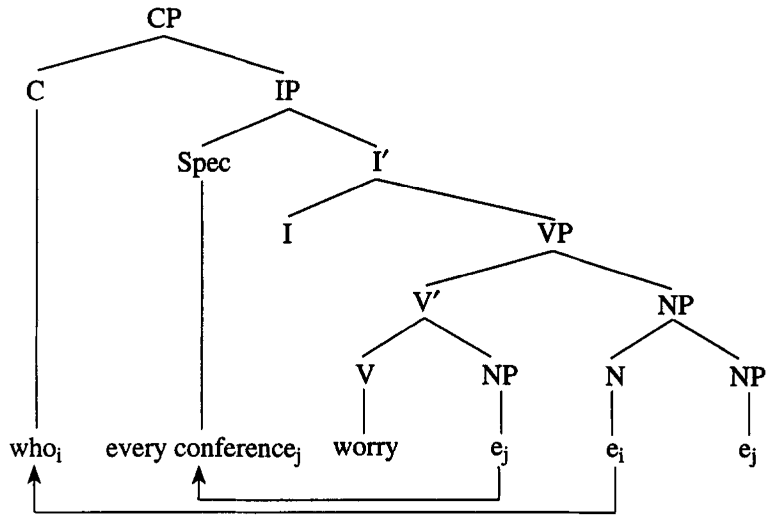
The key observation here is that when a functional *wh*-phrase moves, it only carries along the index associated with the head (cf. sec. 2). As a result, the a-index of the *wh*-functional complex has a c-commanding antecedent at S-structure. Hence no crossover violation arises in scoping *everyone* out, and list and functional readings are expected to be available. Notice that this contrasts with what happens with ordinary NP-movement. Sentences like (96) constitute canonical crossover violations:

(96) * [his_j defense]$_i$ worries e_i $everyone_j$

The sentence in (96) is ungrammatical because there is no way for a non-*wh*-phrase to leave behind an a-index.

Consider next the S-structure of (91):

(97) Who does every conference worry?



Again, the a-index of the *wh*-phrase has a c-commanding antecedent at S-structure, which suffices for well-formedness and, hence, for the availability of functional and list readings. Thus our theory, coupled with Belletti and Rizzi's approach, explains why *wh*-quantifier contrasts are neutralized with psych verbs.

I would like to make one final observation, before leaving this topic. Intuitions with respect to passive vary somewhat. Some speakers (including myself) generally get a fairly robust asymmetry, as far as list and functional readings are concerned. For example, I collected the following judgments:

(98) a. By whom was every speaker introduced?
b. John by Bill, Mary by Sue
c. By his host

(99) a. Who was introduced by every faculty member?
b.* John was introduced by Bill, Mary by Sue, . . .
c.* The person that he invited (meaning: every faculty member introduced the person who he invited)

The grammatically of (98) on the relevant readings is to be expected, as it has virtually the same structure as (97). What is prima facie more surprising is the ungrammaticality of the list reading of (99), which is parallel to

(95). I think that this difference is due to the presence of the by-phrase that, for some speakers at least, must block c-command between the a-index and its intended antecedent, rendering the structure ungrammatical. There are, of course, many open questions in this intricate area. Yet, it seems that the basic generalizations can be derived in a plausible manner from our assumptions.

5.9. *Crosslinguistic Variations in Questions*

It may be worth considering, if only speculatively, what one would expect to find crosslinguistically on the basis of the present theory. The main claim of the theory is that the distribution of functional and list readings should correlate with weak crossover: functional and list readings should be banned whenever weak crossover manifests itself (factoring out plurality and special cases such as those considered in the previous section). If it turned out that this correlation fails to hold up on a large scale, my theory would be seriously undermined.[32] A second claim that the theory makes is that the distribution of list readings should never be broader than the distribution of functional readings, as the former are a special case of the latter (at least if we disregard multiple *wh*-questions). There should be no structure in any language allowing for a list reading but not for a functional reading. I know of no counterexample to this.

A third consideration concerns the availability of list readings in a language. Functional readings are expected to be licenced universally by *wh*-words[33] and to be compatible with any quantifier under a *wh*-word, as the semantic operation involved is not sensitive to the nature of any quan-

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[32] One of the reviewers points out that German might be a problem in this connection; in particular, if an object is scrambled weak crossover doesn't hold. So for example, the following is acceptable, at least in some dialects of German:

(i) Jeden Mann_1 mag seine_1 Mutter
Every man-acc_i likes his_i mother-nom
'his_1 mother likes everyone_1'

And yet the same *wh*-quantifier asymmetries as in English are said to hold. This is precisely the kind of state of affairs that would be problematic for my approach. However, the reviewer also points out that the facts are not undisputed.

[33] This does not mean that functional readings are licensed *only* by *wh*-phrases. G&S discuss cases of the following kind, which might be analyzed as instances of functional readings. This would suggest that functional readings also come about independently of questions:

(i) Everyone loves someone, namely his mother.

Thanks to one of the reviewers for bringing these examples (back) to my attention.

tifier in particular. In contrast, list readings are suggested to be related not only to licensing by a *wh*-word but also to the capacity of an NP to act as domain regulator. Here we might expect some crosslinguistic variation. Some languages may lack absorption of the relevant type. Other languages might use it more selectively, i.e., they might restrict absorption to a somewhat different class of NPs.

In this connection, it is interesting to remark that such a variation in the distribution of list readings across languages seems to occur indeed. For example, Yoshida (1990) claims that in Japanese, list readings with *every*-like quantifiers are generally disallowed in questions, while being possible with definite NPs with a plural interpretation. Similar facts have been reported for Hungarian (A. Szabolcsi, pers. comm.). While there is some room for crosslinguistic variation in the theory I have articulated, not enough is known at this point on the relevant phenomena to venture any further speculation on the precise dimensions along which languages may vary.

6. Concluding Remarks

The heart of my proposal on list readings is that they come about by means of an operation that uses a *wh*-phrase and an NP jointly as a kind of binary operator. The NP in this operation plays two roles. On the one hand, it determines the domain of a Skolem function. On the other, it also determines the internal structure of families of questions (i.e., how many simple questions they contain). The proposed approach (for the simple binary case) is a variant of a proposal due to G&S (1984).

On the syntactic side, my proposal boils down to the claim that functional *wh*-complexes are actually projected in the syntax as two distinct indices, possibly associated with distinct empty categories.

In section 5, I have discussed seven independent empirical consequences that derive from the proposed approach. To my knowledge, these consequences do not fall out in any direct way from any of the theories I am familiar with.

One of the central claims that I have made is that *wh*-quantifier interactions are an instance of weak crossover. Notice that I have not adopted a semantic approach to weak crossover, or, for that matter, any approach at all. The point is simply that if I am wrong, if *wh*-quantifier interactions are not an instance of weak crossover, then some other constraint or principle must be invoked. But the independent evidence in favor of those previously proposed appears to be weak, at best.

To reiterate this same point in different terms, it is certainly possible to deal with the semantics of list readings without using Skolem functions, as is well attested in the literature we have discussed. Probably the problems for such theories (if problems they are) can be solved in some way. But then we are stuck without a story on *wh*-quantifier interactions (at least none that has a comparably robust independent motivation). On the other hand, the present proposal is certainly no more complicated than any available alternative: it uses the same pieces and simply puts them together in a slightly different way.

What of quantifying into questions? The situation seems to be fairly clear. If we let loose the standard quantifying-in operation on questions, we get very little at best, and only problems at worst, depending on the details of the specific theory. We can make up a new operation that combines questions with quantified NPs. Higginbotham's and G&S's proposals, as well as the one developed here, are operations of such a kind. But they all strike me as being rather distant cousins of quantifying in. At any rate, beyond a certain point, this issue becomes purely terminological and ceases to be interesting. What counts, as always, is the internal elegance of each proposal and what it buys us. I have tried to be as candid as I could on what I see as the merits and demerits of the present account.

APPENDIX

I. *Set-Theoretic Notation in IL*

In this section I introduce the set-theoretic notation that I have employed explicitly in IL on various occasions. For any expression β, let $\tau(\beta)$ denote its type:

(1) a. $\{a:\phi\} = \lambda a\phi$

b. $b \in B = B(b)$, where $\tau(B) = \langle a, t\rangle$, $a \neq s$

(2) *Subsets*

a. $R \subseteq R' = \forall x_1, \ldots, \forall x_n\, [R(x_1, \ldots, x_n) \rightarrow R'(x_1, \ldots, x_n)]]$ where $\tau(R) = \tau(R') = \langle a_1, \ldots, \langle a_n, t\rangle, \ldots\rangle$, and each of the $a_i \neq s$

b. $p \subseteq q = \Box[{}^{\vee}p \rightarrow {}^{\vee}q]$, where $\tau(p) = \tau(q) = \langle s, t\rangle$

(3) *Intersections*

$$\cap\, S = \begin{cases} \lambda u\, \forall r[S(r) \rightarrow r(u)], \text{ where } \tau(r) = \langle a, t\rangle, \tau(S) = \langle\langle a, t\rangle, t\rangle, a \neq s \\ \iota p \forall q[S(q) \rightarrow p \subseteq q \wedge \forall r[\forall q[S(q) \rightarrow r \subseteq q] \rightarrow r \subseteq p]], \text{ where } \tau(S) = \langle\langle s, t\rangle, t\rangle \end{cases}$$

(4) *Unions*

$$\cup S = \begin{cases} \lambda u \exists r[S(r) \wedge r(u)], \text{ where } \tau(S) = \langle\langle a, t\rangle, t\rangle, a \neq s \\ \iota p \exists q[S(q) \wedge q \subseteq p \wedge \forall r[\exists q[S(q) \wedge q \subseteq r] \rightarrow \\ \quad q \subseteq r]], \text{ where } \tau(S) = \langle\langle s, t\rangle, t\rangle \end{cases}$$

II. *Polyadic Absorption*

Here I extend Absorption to the general case of n NPs. I will call the case where one NP is absorbed "diadic" (since a diadic operator is formed), the case where two NPs are absorbed "triadic," and so on. I employ a technique developed in G&S (1984, ch. 5), but used by them for different purposes. First, out of n monadic quantifiers, we can form a single n-adic quantifier as follows:

(5) a. $\langle \text{NP}_1, \ldots, \text{NP}_n \rangle = \lambda R'[\text{NP}_1(\lambda x_1 \ldots \text{NP}_n(\lambda x_n[R'(x_1, \ldots, x_n)]) \ldots)]$

b. Example:
$\langle$every man, a woman$\rangle = \lambda R$[every man (λx [a woman (λy [$R(x, y)$])])]

(5b) collects any relation that holds between every man and a woman. Second, from each n-adic quantifier, we can extract the minimal witness relations it contains:

(6) $W(\mathbf{R}, R) = \mathbf{R}(R) \wedge \neg \exists R' [R' \neq R \wedge \mathbf{R}(R') \wedge R' \subseteq R]]$
where $\mathbf{R}$ is a set of n-place relations and R is an n-place relation

For example, a minimal witness relation for the diadic quantifier in (5b) must be a relation that holds of every man in its first argument and of some woman in its second argument (and nothing else).

At this point, it is straightforward to generalize the operation that interprets Absorption to the n-adic case.

(7) $[wh\ \text{N}_j\ \text{NP}_{i_1}, \ldots \text{NP}_{i_n}]\ S \Rightarrow$
$\lambda P \exists R[W(\langle \text{NP}_{i_1}, \ldots, \text{NP}_{i_n}\rangle, R) \wedge P(\lambda p[\exists f_j \exists x_{i_1}, \ldots, \exists x_{i_n} [f_j \in [R \rightarrow N] \wedge R(x_{i_1}, \ldots, x_{i_n}) \wedge p = {}^\wedge S]])]$

As an example, I will consider two readings of the sentence given in (8a). The first one is given in (8b), the second in (12):

(8) a. To whom did every boy give two books?

b. [to whom$_i$ every boy$_j$ two books$_k$] [t_j give t_k $t_i^{j,k}$] $\Rightarrow$
$\lambda P \exists R[W(\langle$every boy$_j$, two books$_k\rangle, R) \wedge P(\lambda p[\exists f_i \exists x_j \exists x_k [f_j \in [R \rightarrow$ people$] \wedge R(x_j, x_k) \wedge p = {}^\wedge$give$(x_j, x_k, f_i(x_j, x_k))]])]$

Let us unpack (8b) further:

(9) a. $\langle$every boy$_j$, two books$_k\rangle = \lambda R$[every boy (λx[two books (λy $[R(x, y)]$)])]

b. $W(\langle$every boy$_j$, two books$_k\rangle, R) =$
$W(\lambda R$[every boy (λx[two books ($\lambda y[R(x, y)]$)])]$, R) =$
[every boy (λx[two books ($\lambda y[R(x, y)]$)])] $\neg\ \exists R'[R' \neq R \wedge$ [every boy (λx[two books ($\lambda y[R'(x, y)]$)])] $\wedge R' \subseteq R]]$

Suppose for example, that the boys $= \{a, b, c\}$ and the books $= \{l, m, n\}$. In this situation, a minimal witness relation would be:

(10) $R_1 = \{\langle a, l\rangle, \langle a, m\rangle, \langle b, l\rangle, \langle b, n\rangle, \langle c, n\rangle, \langle c, l\rangle\}$

Consequently, one of the simple questions contained in (8b) will be the following set:

(11) $\{u$ gives u' to $f(u, u')$: $\langle u, u'\rangle \in R_1$ and f is a way of mapping any member of R_1 into a person$\}$

Consider now the same sentence (8a) on the logical form in (12a). It will have the interpretation specified in (12b). With the same set of boys and the same set of books as in the previous example, a possible witness relation is given in (12c):

(12) a. [to whom$_i$ two books$_k$ every boy$_j$] [t$_j$ give t$_k$ t$_i$]

b. $\lambda P \exists R[W(\langle$two books$_k$, every boy$_j\rangle, R) \wedge$
$P(\lambda p[\exists f_i \exists x_j \exists x_k[f_j \in [R \rightarrow$ people$] \wedge R(x_j, x_k) \wedge p =$
$^\wedge$give $(x_j, x_k, f_i(x_j, x_k))]]])]$

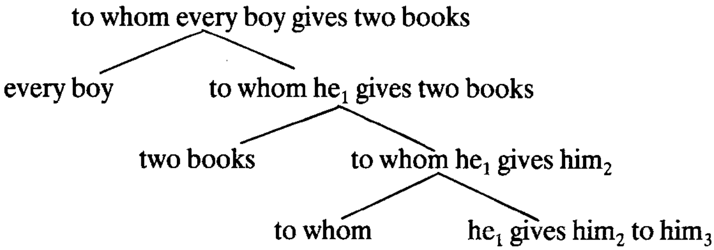
c. $R_2 = \{\langle l, a\rangle, \langle l, b\rangle, \langle l, c\rangle, \langle m, a\rangle, \langle m, b\rangle, \langle m, c\rangle\}$

The relation R_2 pairs two specific books with all of the boys. So an answer to (8a) on reading (12a) will list for two books the people that every boy gave those two books to. It is interesting to note that on the theory proposed in G&S (1984, ch. 6), we only get this second reading for (8a). Their key rule is reproduced below:

(13) $\lambda \mathbf{R}^{n+1}[\beta(^\wedge\lambda R^n \exists P[\text{choice}(\alpha)(P) \wedge \mathbf{R}^{n+1}(^\wedge\lambda x_k|P|\ ^\vee R^n)])]$
(G&S 1984, p. 513)

I have merely translated G&S's rule into IL. Rule (13) turns an n-place (lifted) abstract and NP into an n+1 abstract. Lifted abstracts are then mapped into questions in the manner discussed in sec. 3.2. A close examination of the abstract will suffice to make our point. β in (13) is the translation of the input abstract and α the translation of the NP. '$\lambda x_k|P|\ ^\vee R^n$' is a form of restricted λ-abstraction (the example below will make clear what is meant by that). First let us give, in schematic form, the analysis tree that we would interpret by means of reiterated applications of (13):

(14)



Notice that the NP *every boy* has wide scope in the analysis tree. Now we will give a step-by-step interpretation of this tree, using rule (13).

(15) a. to whom he_1 gives him_2 $\Rightarrow \lambda \mathrm{P}[{}^{\vee}P({}^{\wedge}\lambda x_3 \text{ give } (x_1, x_2, x_3))]$

b. to whom he_1 gives two books $\Rightarrow \lambda\, \mathbf{R}^2[\lambda P[{}^{\vee}P({}^{\wedge}\lambda x_3 \text{ give } (x_1, x_2, x_3))]$
$({}^{\wedge}\lambda R^1\, \exists P[\text{choice (two books)}(P) \wedge \mathbf{R}^2({}^{\wedge}\lambda x_k|P|\ {}^{\vee}R^1)])]$

Reductions of (b):

c. $\lambda \mathbf{R}^2[\lambda R^1\, \exists P[\text{choice (two books)}(P) \wedge \mathbf{R}^2({}^{\wedge}\lambda x_2\, |P|\ {}^{\vee}R^1)]\, ({}^{\wedge}\lambda x_3 \text{ give } (x_1, x_2, x_3))]]$

d. $\lambda \mathbf{R}^2[\exists P[\text{choice (two books)}(P) \wedge \mathbf{R}^2({}^{\wedge}\lambda x_2\, |P|\, \lambda x_3 \text{ give } (x_1, x_2, x_3))]]$

e. $\lambda \mathbf{R}^2[\exists P[\text{choice (two books)}(P) \wedge \mathbf{R}^2({}^{\wedge}\lambda x_2\, \lambda x_3[\text{give } (x_1, x_2, x_3) \wedge {}^{\vee}P(x_2)])]]$

f. to whom every boy gives two books $\Rightarrow \lambda \mathbf{R}^3[\exists P'[\text{choice (every boy) } (P') \wedge \exists P[\text{choice (two books) } (P) \wedge \mathbf{R}^3({}^{\wedge}\lambda x_1 \lambda x_2 \lambda x_3\, [\text{give } (x_1, x_2, x_3) \wedge {}^{\vee}P(x_2) \wedge {}^{\vee}P'(x_1)])]]$

There are two things that do not seem to work in this rule. The first is that, as stated, it involves an improper λ-conversion: x_2 is free in (15c) and winds up bound in (15d). The second is that it doesn't get the scope relations among NPs right. To see this, notice that in (15f), P' is a property that has to be true of every boy and P is a property that has to be true of two books. The choice of P and the choice of P' are independent of one another. Hence, we get the same two books for each of the boys. The same result would obtain if we were to plug in *every boy* and *two books* in the opposite order in (14). It follows that an answer of the form:

(16) John gave book *a* to Mary and book *b* to Bill, Frank gave book *c* to John and book *d* to Joan, . . .

is not predicted to be a possible answer for this question. The proposal in (7) solves both of these problems.

The semantics of questions we have proposed can be given the form of an operator Δ, defined as follows:

(17) *Question-forming Operator* Δ

Case a. $\Delta_n(S) = \lambda P P(\lambda p \exists \alpha_n [p = {}^\wedge S])$

Case b.
$$\Delta_n(N, S) \begin{cases} \lambda P P(\lambda p \exists \alpha_n [N(\alpha_n) \wedge p = {}^\wedge S]), \\ \quad \text{if } \alpha_n \text{ is of type } e \\ \lambda P P(\lambda p \exists \alpha_n [\forall x \, N(\alpha_n(x)) \wedge p = {}^\wedge S]), \\ \quad \text{if } \alpha_n \text{ is of type } \langle e, e \rangle \text{ etc.} \end{cases}$$

Case c. $\Delta_{j,i_1,\ldots,i_n}(N, NP_1, \ldots, NP_n, S) = \lambda P \exists R [W(\langle NP_{i_1}, \ldots, NP_{i_n} \rangle, R) \wedge P(\lambda p [\exists f_j \exists x_{i_1}, \ldots, \exists x_{i_n} [f_j \in [R \rightarrow N] \wedge R(x_{i_1}, \ldots, x_{i_n}) \wedge p = {}^\wedge S]])]$

Case (a) takes care of simple *wh*-questions (functional or not) if we are willing to ignore the sortal restrictions imposed by *who/what.* Case (b) handles functional and nonfunctional *which*+N questions. And case (c) is the Absorption case. This format makes more intuitive sense of the notion that Absorption creates a polyadic operator. Multiple *wh*-questions would amount to adding a few more cases to (16).

III. *De Dicto Readings*

Here I will indicate how de dicto readings can be derived. I will consider only the case of diadic absorption and leave it to the reader to work out the generalization to the *n*-adic case. First, let us assume that NPs have the type they have in PTQ, namely $\langle\langle s, \langle e, t\rangle\rangle, t\rangle$. Now intensionalize the definition of W as follows:

(18) $W(\mathscr{P}, P) = \mathscr{P}(P) \wedge \forall Q \Box [\mathscr{P}(Q) \rightarrow \forall x [{}^\vee P(x) \rightarrow {}^\vee Q(x)]]$
where P and Q are of type $\langle s, \langle e, t\rangle\rangle$

Finally, let us restate the rule that interprets Absorption as follows:

(19) $\lambda P \exists Q [W[NP_i, Q) \wedge P(\lambda p \exists f_j \exists x_i [p = {}^\wedge [S \wedge {}^\vee Q(x_i) \wedge N(f_j(x_i))]]])]$

Let us illustrate what this restatement of the semantics for Absorption gets us:

(20) a. Which professor does every student prefer?
b. LF: [which professor$_i$ every student$_j$] [t$_j$ prefer t$_i^j$]
c. $\lambda P \exists Q [W(\text{every student}, Q) \wedge P(\lambda p \exists f_j \exists x_i [p = {}^\wedge[\text{prefer}(x_i, f_j(x_i)) \wedge {}^\vee Q(x_i) \wedge \text{professor}(f_j(x_i))]]])]$

Since 'student' is the only witness property for *every student*, (20c) is equivalent to:

(20) d. $\lambda PP(\lambda p \exists f_j \exists x_i [p = {}^\wedge[\text{prefer}(x_i, f_j(x_i)) \wedge \text{student}(x_i) \wedge \text{professor}(f_j(x_i))]]])$

This in turn corresponds to:

(20) e. $\lambda p \exists f_j \exists x_i [p = {}^\wedge[\text{prefer}(x_i, f_j(x_i)) \wedge \text{student}(x_i) \wedge \text{professor}(f_j(x_i))]]$

It should be added that (20e) is only one of the conceivable ways in which de dicto readings can be presented. Another way to do so is by using partial propositions (i.e., by adopting a presuppositional approach — cf. Higginbotham 1991). De re readings can be obtained from de dicto readings by λ-ing in the common noun, as proposed by G&S. In the case of (20a), this would give us:

(21) $\lambda X_{\langle e, t\rangle} \lambda p \exists f_j \exists x_i [p = {}^\wedge[\text{prefer}(x_i, f_j(x_i)) \wedge {}^\vee\text{student}(x_i) \wedge X_{\langle e, t\rangle}(f_j(x_i))]]]$ (professor)

This amounts to analyzing which [+N] phrases act as hidden partitives, roughly equivalent to "Of the professors, who does every student like?"

Adopting this way of getting the de dicto/de re distinction is consistent with my general view that it is wise not to quantify into questions. The rule we need to obtain (20) is just λ-conversion, not the full-blown $\mathbf{Q}_n$ as defined in (55) in section 3.2. Moreover, there are reasons to believe that de dicto/de re ambiguities are in general not scopal, quite independent of this particular manifestation of the phenomenon (Kratzer 1991 has offered some arguments to this effect).

IV. *Disjunctive Questions*

In this section, I indicate how questions such as (21) can be treated, by adapting a proposal by G&S (1989) to my purposes yet again.

(22) Who do John or Mary like?

As argued by G&S among others, this question is ambiguous between the two readings indicated in (23):

(23) a. Which x's are such John likes x or Mary likes x?
b. Who does Mary like? or Who does John like?

The reading in (23a) is just the individual reading. (23b) represents the "conjunction reduction" reading of (22), whereby (22) is equivalent to a disjunction of questions. The issue here is how to obtain reading (23b). Partee and Rooth (1983) and several others have argued for the usefulness of type lifting in the treatment of phenomena of this kind. Let me indicate how to apply this technique to the case at hand. The target interpretation is:

(24) $\lambda P[P(\lambda p \exists x[p = {}^\wedge\text{like}(j, x)]) \vee P(\lambda p \exists x[p = {}^\wedge\text{like}(m, x)])]$

To obtain (24), we need the standard cross-categorial generalization of '$\vee$' and the following instances of type-lifting rules. We first lift the type of *John* and *Mary* as indicated:

(25) $j \rightarrow \lambda\pi\pi(j)$, where π is of type $\langle e, lq\rangle$, and lq is the type of lifted questions

By disjoining *John* and *Mary* at this lifted level, we obtain:

(26) John or Mary $\Rightarrow \lambda\pi[\pi(j) \vee \pi(m)]$

This NP must combine with the VP *love* t_n. In order for the combination to be possible, we have to lift the type of *love* t_n appropriately. This can be done as follows:

(27) $\lambda x \lambda\Pi\Pi(\text{love}\,(x, x_n))$, where Π is a variable of the same (polymorphic) type as Δ.

The expressions in (26) and (27) can now combine, the result being:

(28) $\lambda\pi[\pi(j) \vee \pi(m)]\,(\lambda x\lambda\Pi\Pi(\text{love}\,(x, x_n)))$
$= [\lambda x\lambda\Pi\Pi(\text{love}\,(x, x_n))\,(j) \vee \lambda x\lambda\Pi\Pi(\text{love}\,(x, x_n))(m)]$
$= [\lambda\Pi\Pi(\text{love}\,(j, x_n)) \vee \lambda\Pi\Pi(\text{love}\,(m, x_n))]$
$= \lambda\Pi[\Pi(\text{love}\,(j, x_n)) \vee \Pi(\text{love}\,(m, x_n))]$

This then combines further with the question-forming operator Δ_n, and the result is shown in (29):

(29) $\lambda\Pi[\Pi(\text{love}\,(j, x_n)) \vee \Pi(\text{love}\,(m, x_n))]\,(\Delta_n)$
$= \Delta_n\,(\text{love}\,(j, x_n)) \vee \Delta_n(\text{love}\,(j, x_n))$
$= [\lambda P[P(\lambda p \exists x_n[p = {}^\wedge\text{like}(j, x_n)]) \vee \lambda P[P(\lambda p \exists x_n[p = {}^\wedge\text{like}(m, x_n)])]]$
$= \lambda P[P(\lambda p \exists x_n[p = {}^\wedge\text{like}(j, x_n)]) \vee P(\lambda p \exists x_n[p = {}^\wedge\text{like}(m, x_n)])]$

This is the intended reading. The derivation is complex. However, it only uses type-lifting techniques that have been independently proposed, merely adapting them to the case of questions. Type lifting has its problems, of course (it needs to be constrained to prevent overgeneration), but I know of no approach that does significantly better.

It is worth noticing that a reading equivalent to the desired one can be obtained from the following LF:

(30) $[\text{who}_i\ [_{NP_j}\ \text{John or Mary}]]\ [t_j\ \text{like}\ t_i^j]$

Here the NP *John or Mary* is QR-ed and then undergoes Absorption. If one computes the semantic interpretation of (29), one finds out that it is equivalent to (28) indeed. However, if we could get disjunctive readings via Absorption only, we would expect that questions such as (31a), where the disjunct is in object position, should *not* have such readings:

(31) a. Who likes John or Mary?
a′. $[\text{who}_i\ [_{NP_j}\ \text{John or Mary}]]\ [t_i^j\ \text{like}\ t_j]$
b. Who likes John? or Who likes Mary?

For in order to get the intended reading (namely (31b)) we would need a LF such as (31a′), which constitutes a crossover violation. But questions like (31a) do have a conjunction reduction reading just as questions like (22). Conjunction reduction readings do not display asymmetries of any kind. This entails that they must have a source different from Absorption. But this should come at no cost, since it is fairly clear that conjunction reduction phenomena, however poorly understood, take place with all sorts of constructions, not just questions. Presumably there is a uniform process that is responsible for them. Type shifting, for now, is our safest bet.

Notice that this point goes through on *any* approach to questions. In order to account for *wh*-quantifier interactions, one needs a constraint that blocks, in certain configurations, whatever mechanism delivers choice readings. If conjunction reduction readings of questions arose through such a mechanism alone, the relevant constraint would apply to them as well, predicting the absence of such readings in certain configurations, contrary to fact.

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