Questions Under Cover

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I present a refinement of the logic of questions presented in Groenendijk & Stokhof (1984, 1997), which involves relativizing queries to specific conceptualizations of the universe of discourse. I show that in this way a number of difficulties arising for the interpretation of who-questions and their answers are avoided.

1 Introduction

The present paper discusses the interpretation of who-interrogatives and their answers. To fix ideas I adopt as formal framework the logic of questions of Groenendijk and Stokhof (G&S). The choice is motivated by the technical sophistication of the G&S system which enables the perspicuous formulation of the problems I intend to discuss. Most of these problems though are not peculiar to the G&S analysis and arise (although sometimes in different forms) for other approaches as well.[1]

The structure of the paper is the following: In section 2, I briefly introduce the G&S logic of questions. In section 3, I discuss a number of difficulties that arise for the interpretation of who-interrogatives. I

[*]Most of the ideas I defend in the paper are to be found in the literature, in particular in the work of Jaakko Hintikka and more recently Jelle Gerbrandy. I am grateful to these two authors and to Jeroen Groenendijk for their inspiring work. I am also indebted to Paul Dekker for many discussions, Gennaro Chierchia for essential corrections and Martin Stokhof for having read and commented a previous version of the paper. David Beaver, Shai Berger, Orin Perkus, Robert van Rooy and two anonymous reviewers also provided insightful comments. I further benefited from the feedbacks of audiences in Leipzig (Sinn und Bedeutung 1998) and Stanford (LLC 1999). Part of this research has been financially supported by the Netherlands Organization for Scientific Research (NWO).

[1]This holds in particular for other partition theories of questions (e.g. Higginbotham and May (1981)); but also for proposition set theories (Hamblin (1973), Karttunen (1977)) and structured meaning approaches (e.g. von Stechow (1990), Krifka (1999)). See Aloni (in preparation) for an extension of the present analysis to these frameworks.

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argue that these difficulties are due to the standard method of individuating objects implicit in the G&S analysis. In section 4, I propose a modified analysis in which different identification methods are available. Identification methods are formalized by what I call 'conceptual covers'. Conceptual covers represent different ways of conceiving the elements of the domain. Questions are relativized to contextually given conceptual covers. What counts as an answer to a who-question depends on which conceptualizations of the universe of discourse are used in the specific circumstances of the utterance. In the last section, I discuss Ginzburg's pragmatic theory of questions and compare my account of the context dependency of questions with his explanation of the fact that different contexts require different answers.

2 Formal Framework

The formal framework I adopt is based on G&S (1984, 1997). The language under consideration is a language of first order predicate logic with the addition of a question operator ?

Definition 1 [Language] Let PL be a language of predicate logic. The Query Language is defined as the smallest set QL such that:

1. If $\phi \in PL$, then $\phi \in QL$
2. If $\phi \in PL$, $\vec{x}$ is a sequence of n variables $(0 \leq n)$, then $?\vec{x}\phi \in QL$

Interrogative sentences are obtained by prefixing a question mark and a sequence of n variables to the sentences of PL. We can express polar questions $(n = 0)$, single-constituent questions $(n = 1)$, multi-constituent questions $(n > 1)$.

Interrogatives receive an intensional interpretation, so a model for a query language will contain a set of possible worlds.

Definition 2 [Models] A model M for QL is a pair $M = \langle D, W \rangle$ where

(i) D is a non-empty set;

(ii) W is a non-empty set of mappings w that assign to each constant symbol a in PL an item $w(a) \in D$ and to each n-ary relation symbol R of PL a relation $w(R) \subseteq D^n$.

A model is a pair consisting of a set of individuals (the universe of discourse) and a set of worlds. A world in such a set is identified with an interpretation function for the non-logical constants in PL. It is normal practice in formal semantics to assume models which are large enough to represent the whole space of logical possibilities. I will call such models standard models. A *standard model* for a language QL is a model $M = \langle D, W \rangle$ such that W (the logical space) contains all possible interpretations w for the non-logical constants in PL on D under which singular terms are possibly interpreted as rigid designators. A *rigid designator* is a term which denotes one and the same individual in all possible worlds.

A classical interpretation is assumed for the indicative part of the language. The denotation of an indicative sentence relative to a world is a truth value. $[\![\phi]\!]_{M,w,g} \in \{1, 0\}$ where w is a world and g is a value-assignment to the individual variables in PL.

Interrogatives are analyzed in terms of their possible answers. The denotation of an interrogative in a given world is the proposition expressing the complete true answer to the question in that world. (I use $\vec{\alpha}$ to denote sequences $\alpha_1, \ldots, \alpha_n$, where the α_i can be variables or individuals.)

Definition 3 [Interrogatives]

$$[\![?\vec{x}\phi]\!]_{M,w,g} = \{v \in W \mid \forall \vec{d} \in D^n : [\![\phi]\!]_{M,v,g[\vec{x}/\vec{d}]} = [\![\phi]\!]_{M,w,g[\vec{x}/\vec{d}]}\}$$

An interrogative $?\vec{x}\phi$ collects the worlds v in which the set of sequences of individuals satisfying ϕ is the same as in the evaluation world w. If $\vec{x}$ is empty, $?\vec{x}\phi$ denotes in w the set of the worlds v in which ϕ has the same truth value as in w. For example, a polar question $?p$ denotes in w the proposition *that* p, if p is true in w, and the proposition *that not* p otherwise. As for who-questions, suppose a and b are the only two individuals in the extension of P in w, then the proposition *that a and b are the only P* is the denotation of $?xPx$ in w, that is the set of v such that $v(P) = \{a, b\}$.

While indicatives express propositions, interrogatives determine *partitions* of the logical space. I will write $[\![\phi]\!]_M$ to denote the meaning of a closed sentence ϕ with respect to M. If ϕ is an indicative, $[\![\phi]\!]_M$ is the set of worlds in which ϕ is true. If ϕ is an interrogative, $[\![\phi]\!]_M$ is the set of all possible denotations of ϕ in M. While the meaning of an indicative corresponds to its truth conditions, the meaning of an interrogative is identified with the set of all its possible complete answers. Since the latter is a set of mutually exclusive propositions whose union exhausts the set of worlds, we say that questions partition the logical space. For example, $?p$ determines a partition of the set of worlds in two alternatives, the alternative in which p is true, and the alternative in which p is false; $?xPx$ partitions the set of worlds in as many alternatives as there are possible denotations of P within M. Intuitively, two worlds belong to the same block in the partition determined by a question if their differences are irrelevant to the issue raised by the question.

Answers A question determines a partition of the set of worlds into a number of alternatives. Each of these alternatives is a complete answer to the question. A (partial) answer is a disjunction of at least one but not all complete answers.[2]

Definition 4 [answer]

1. ψ is a (partial) *answer* to $?\vec{x}\phi$ in M, $\psi \rhd_M ?\vec{x}\phi$ iff

$$\exists X \subset [\![?\vec{x}\phi]\!]_M : [\![\psi]\!]_M = \cup\{\alpha \mid \alpha \in X\} \neq \emptyset$$

2. ψ is a *complete* answer to $?\vec{x}\phi$ in M, $\psi\ {}_c\!\rhd_M ?\vec{x}\phi$ iff

$$[\![\psi]\!]_M \in [\![?\vec{x}\phi]\!]_M$$

While for (non-vacuous) polar questions the notions of a complete and a partial answer collapse, the distinction is non-trivial in the case of constituent questions, for which we can have partial answers which are not complete. Both (a) and (b) partially answer (1), but only (b) answers (1) completely.

(1) Who called?
 a. Bill did not call.
 b. Only Eduard called.

The notion of a partial answer defines the response space generated by a particular query and can be used to characterize the notion of relevance in discourse.[3] Partial answers are replies which exclusively address the issue raised by a question. Complete answers resolve an issue exhaustively. The notion of a complete answer is usually employed for the analysis of a certain class of question embedding verbs like *know* or *tell*.[4] These verbs can be analysed as relations between agents and

[2]These definitions are proposed in G&S (1984) where a more liberal notion of an answer is also defined which covers propositions which *imply* rather than *are* complete or partial answers. Here over-informative replies do not count as answers.

[3]Cf. Roberts (1996) and Groenendijk (1999) for examples of such an enterprise. They assume notions of a partial answer though, which are slightly different from the one presented here.

[4]These verbs sometimes are called extensional, in contrast to intensional question-embedding verbs (like for instance *wonder*). The former take extensions of interrogatives (that is propositions) the latter take intensions of interrogatives (that is propositional concepts).

true complete answers to questions. Roughly, a sentence like "a knows wh-ϕ" is true iff a stands in the *know*-relation to the denotation of the embedded question, i.e. iff a believes the true complete answer to the question.[5] Clearly the notion of a partial answer is not useful for the analysis of embedded interrogatives as is shown by the contrast between (2) and (3). We expect only the latter to be valid in our logic.

(2) If Al knows that Bill did not call, then Al knows who called.

(3) If Al knows that only Eduard called, then Al knows who called.

3 Methods of Identification

Dilemma

In most analyses of interrogatives a strong link exists between constituent questions and the notion of a rigid designator. A constituent question like "Who P?" asks for a specification of a set of individuals. This specification requires that these individuals are semantically identified; this means that the terms from which an answer is built up must be rigid designators. On the other hand, an identity question like "Who is t?" asks for the identification of the denotation of t; this means that if t is rigid, asking "Who is t?" is a vacuous move. In G&S's logic of questions, we can prove two facts that state this connection in a perspicuous way.

The first fact says that in a standard model M, the sentence 't is (the only) P' (completely) answers the question 'Who is P?' iff t is a rigid designator in M. (I write $!Pt$ for the sentence expressing the proposition that t is the only P, i.e. $!Pt = \forall y(Py \leftrightarrow y = t)$.)

Fact 1 [rigidity and answerhood] Let M be a standard model.[6]

$$Pt \rhd_M ?xPx \quad \Leftrightarrow \quad t \text{ is rigid in } M$$

[5] One of the advantages of the G&S analysis is that we can define the notion of a complete answer directly in terms of the denotation of the question and therefore we have a ready account of embedded uses of questions. Proponents of other approaches have to do some extra work here. See Lahiri (1991) p.16-22 for an attempt of a definition of the notion of a complete answer assuming a Hamblin-Karttunen denotation for questions. Her definitions are rather complicated though and not completely general, as she admits. See Heim (1994) and Krifka (1999) for analysis of knowing-wh constructions in the Hamblin-Karttunen tradition and in the Structured Meaning framework respectively. Their strategy consists in attempting to match the partition theory predictions by complicating the lexical semantics of the relevant embedding verbs.

[6] Recall that a standard model is a model containing all possible interpretations under which singular terms are possibly interpreted as rigid designators.

$$!Pt \;{}_c\!\rhd_M\; ?xPx \quad \Leftrightarrow \quad t \text{ is rigid in } M$$

The second fact says that if t is a rigid term, then the question 'Who is t?' is trivial. An interrogative $?\vec{x}\phi$ is *trivial* in M iff the tautology is a complete answer to $?\vec{x}\phi$ in M, i.e., if the partition determined by the question consists of a single block comprising the whole of logical space.

Fact 2 [rigidity and triviality]

$$t \text{ is rigid in } M \quad \Leftrightarrow \quad ?x\; t = x \text{ is trivial in } M$$

These two facts have consequences that clash with our intuitions in a dramatic way. Consider again the intuitively valid principle (3) and the standard question-answer pair A:

(3) If Al knows that only Eduard called, then Al knows who called.

A Who called? ($?xPx$)
Eduard called. (Pe)

Pe is predicted to partially answer $?xPx$ and (3) is predicted to be valid, only if e is a rigid designator. So we would like 'Eduard' to be rigid. However, if we analyse proper names as rigid designators, then intuitively correct identity questions like (4) are rendered vacuous:

(4) Who is Eduard? ($?x\; x = e$)

We are faced with a dilemma: either we give up accounting for the 'non-triviality' of (4) or for the correctness of A and the validity of (3).

Semantic theories of questions[7] choose the first option. Kripke's analysis of proper names, according to which they are rigid designators, is normally adopted. Questions are interpreted with respect to standard models in which names are formalized as constant functions and as a consequence of this, questions like (4) are not accounted for.

A more information-oriented theory of questions[8] might choose for the second option. Such a theory takes seriously the strong epistemic connotation of notions like (vacuous) questions and proper answers. Correct (non-vacuous) questions signal gaps in the information of the

[7] Cf. Hamblin (1973), Karttunen (1977), Groenendijk and Stokhof (1984), etc.

[8] G&S (1984) already recognized the connection between questions and information (cf. their notion of a pragmatic answer). Jäger (1995), Hulstijn (1997), Groenendijk (1999) are more recent examples of information-oriented theories of questions. As far as I know though, nobody has explicitly proposed the strategy I describe in this paragraph.

questioner and whether a proposition provides an adequate answer depends not only on the content of the proposition, but also on the information state of the questioner. More in particular, questions like (4) are correct because subjects can lack information about the actual denotations of proper names even though the latter are semantically rigid designators.[9] In order to formalize these intuitions, questions and answers can be interpreted with respect to information states S which are characterized as subsets of the logical space W in some standard model in which proper names can denote different individuals in different worlds. The non-triviality of (4) can then be captured. In some states, (4) is vacuous, in others, it partitions the relevant set of worlds in a non-trivial way. On the other hand, it then depends on the relevant information state whether (3) is true or whether A counts as a question-answer pair. This is the case only with respect to states in which e is identified. It should be clear that pursuing this line really means choosing for the second branch of the dilemma and so giving up the standard account of the correctness of A and the validity of (3). The described information-oriented theory fails indeed to define a natural notion capable to discern standard examples like A from strongly marked question-answer pairs like the following:

B Is it raining?
I am going to the cinema.

Note firstly that the described information-dependent notion of an answer is not suitable for characterizing standard answers at all. As it stands, it does not even allow you to distinguish the following exemplary pair from B above:

C Is it raining?
Yes it is raining.

By properly selecting a class of worlds S, anything can count as an answer to anything else with respect to S. For example, "I am going to the cinema" counts as an answer to "Is it raining?" in any S in which it is presupposed that I go to the cinema if and only if it rains. If we want to distinguish standard from marked (C from B), we have to abstract from the particular factual information that can be presupposed

[9] It is important to notice that the phenomena which are typically considered in discussions of rigid designators (alethic modalities and counterfactuals) are of a different nature than the epistemic phenomena considered by information-oriented theories. Many authors (e.g. Hintikka) have distinguished semantically rigid designators from epistemically rigid designators - the former refer to specific individuals in counterfactual situations, the latter identify objects across possibilities in information states - and concluded that proper names are rigid only in the first sense.

in a specific situation and look at the general case. A natural way of doing this involves universally quantifying over all possible states. A standard answer is a reply which is an answer with respect to all information states in which the sentence is informative. Note however that if proper names have a non-rigid interpretation, the result of this universal quantification is that no answer to a who-question involving proper names will count as standard, so no line is drawn between our intuitively correct pair A and the clearly marked pair B: while C counts as standard, for both A and B only an information-dependent notion of answerhood holds.

To summarize, a dilemma arises for the interpretation of constituent questions and their answers. Either we are unable to account for the correctness of questions asking for the denotation of t, or we do not manage to distinguish answers built up from t from highly marked situation-dependent answers. Standard semantic theories of questions fail to account for identity questions involving proper names. The described information-oriented theory fails to account for standard answers involving proper names. Although correct in taking the connection between questions and information seriously and in recognizing the context dependency of the notion of an answer, its treatment of who-question and their answers is inadequate. These constructions are certainly context sensitive, but as the examples in the following section will show, their sensitivity is of a different nature than is captured by an information-dependent notion of an answer.

Context Sensitivity

What counts as a good answer to a question in a given context depends on various pragmatic factors.[10] In this section, I discuss two examples illustrating one specific aspect of this context sensitivity.

Priscilla: Consider the following situation. Your daughter Priscilla is doing her homework. She asks you:

(5) Who is the president of Mali?

In order to give her an adequate answer you fly to Mali, kidnap Konare (the present president of Mali), bring him in your living room and finally utter:

[10] Many researchers have recognized the context-sensitivity of questions and answers: see Boër and Lycan (1985), Ginzburg (1995) and Gerbrandy (2000). In the latter an approach is presented close in spirit to mine.

a. He [pointing at him] is the president of Mali.

Unfortunately, by uttering a proposition with, to quote from Kaplan, Konare himself 'trapped in it', you have not answered Priscilla's intended question. You had better have said:[11]

b. Konare is the president of Mali.

If there is such a thing as a rigid designator in natural language, the demonstrative pronoun in (a) is. Still, in the described situation (a) is not an appropriate answer. Literally providing the actual denotation of the relevant predicate, displaying it concretely, does not always give the required result. The notion of a rigid designator as normally intended does not seem to cut any ice in relation to these phenomena. Compare the situation above (call it α) with the following scenario β. You are at a party with many African leaders. Priscilla wants to meet the president of Mali.

(5) Who is the president of Mali?

a. He [pointing at him] is the president of Mali.

b. Konare is the president of Mali.

Assume again that Priscilla does not know what Konare looks like. In context β, (a) is an adequate answer to Priscilla's intended question and (b) is not. What counts as an answer to a who-question depends on the circumstances of the utterance. In one situation, an appropriate answer consists in giving the name of the man; in another, it consists in pointing out the man himself. Both (a) and (b) can be thought of as providing a characterization of the actual denotation of the relevant predicate. The individual that satisfies the property 'being the president of Mali', namely Konare, is identified in both, only in two different ways: in (a) it is identified by ostension, in (b) by the use of a proper name. Which of (a) and (b) counts as an appropriate answer to (5) depends on which of the two methods of identification is salient in the specific circumstances of the utterance. Since Priscilla, given her purposes, is interested in locating Konare in her perceptual field, in context β an appropriate answer consists in pointing out the man himself. In contrast, given Priscilla's goals in α, identification by proper names is the unique intended method of identification there.

[11] The contrast between (a) and (b) corresponds to the distinction between *real* and *nominal* answer (cf. Belnap and Steel (1976)). The analysis I propose in this work will cover more than just this two-fold distinction.

What counts as an answer to who-questions seems to depend on the contextually assumed method of identification. The following example, which involves *knowing who* constructions, illustrates the same point.

Spiderman Someone killed Spiderman.

γ: You have just discovered that John Smith is the culprit. You utter:

c. (John Smith did it. So) I know who killed Spiderman.

δ: You now want to arrest John Smith. He is attending a ball. You go there, but you don't know what he looks like. You utter:

d. (This person might be the culprit. That person might be the culprit. So) I don't know who killed Spiderman.

In both contexts, your belief state supports the following information:

(6) John Smith killed Spiderman.

However only in context γ, (6) intuitively resolves the question:

(7) Who killed Spiderman?

and so only then you can truly utter (c). Again we find that the G&S logic has difficulties in accounting for these examples. If it is combined with the theory of rigid reference, according to which proper names and demonstratives are rigid designators, it trivially fails. If it is combined with an information-oriented notion of rigid reference, it is also inadequate. Intuitively in both examples, the shift from one context to the other does not involve any gain or loss of *information*. In both contexts α and β, Priscilla lacks information about the denotation of "Konare" and in both γ and δ you don't know what John Smith looks like. Again the difficulty described in this section is not peculiar to the G&S analysis, their system only enables us to give it a perspicuous formulation.

The Flexible Model Strategy

In order to get a handle on the issue, I call *identifiers* in a particular situation the terms that 'belong' to the specific method of identification assumed by the questioner in that situation. For example, in β and δ

above demonstratives are identifiers; in α and γ proper names are identifiers. As is evident from the examples in the previous section, natural language terms are identifiers only relative to a particular situation.

One conservative way of modeling this variability consists in formalizing identifiers in the same way as rigid designators, that is, as terms that denote one and the same individual in all elements of a certain model. Their context sensitivity is accounted for by selecting different models in different contexts. Paraphrasing the notion of a flexible universe strategy of Westerståhl (1984)[12] I call this strategy the flexible model (FM) strategy.

Consider how the Priscilla case could be accounted for by the FM strategy. In context β, we can interpret our sentences with respect to a (standard) model M_1 in which demonstratives denote one and the same individual everywhere. In context α, we can adopt a (standard) model M_2 in which proper names denote one and the same individual everywhere. We obtain that (a) counts as an answer to (5) with respect to M_1, and (b) with respect to M_2.

(5) Who is the president of Mali?

a. He [pointing at him] is the president of Mali.

b. Konare is the president of Mali.

Furthermore the identity questions "Who is Konare?" and "Who is he?" count as non-trivial in M_1 and M_2 respectively. The dilemma seems to disappear, it depends on the model whether the question $?x\ x = t$ is vacuous, or whether the sentence Pt answers the question $?xPx$.[13] By interpreting different terms as rigid in different situations, the FM strategy accounts for the variability shown by the examples above within the standard analysis. The right class of identifiers is clearly selected by mechanisms that belong to pragmatics rather than semantics. The FM strategy formally characterizes this selection as the

[12] Westerståhl (1984) discusses the context sensitivity of determiners in natural language. If talking about your party, I say "Everybody was crazy", I don't mean to attribute madness to everybody on earth, but I clearly refer only to the people at the party. Westerståhl calls these contextually selected domains of quantification 'context sets' and argues against the flexible universe strategy, which identifies them with (temporarily chosen) model universes. Following the line of Westerståhl's argumentation, I will argue against the flexible model strategy which formalizes identifiers as terms denoting constant functions in temporarily chosen (standard) models.

[13] Since we are dealing with temporarily selected *standard* models the difficulty arising for the information-oriented theory is avoided here. Question-answer pairs like A or (5) which depend on the assumed method of identification are clearly distinguished from information-dependent pairs like B above.

selection of a suitable model. Semantic theory, it is assumed, should simply abstract from these mechanisms. Semantics deals with interpretation conditions, rather than actual interpretations, it tells you, given a certain model, what is the interpretation of a sentence in that model. Pragmatics determines which model should be assumed in a particular situation in order to obtain the intended interpretation in that situation. I would like to show, nevertheless, that the FM strategy has serious methodological and empirical limitations. Different sets of identifiers should be distinguished also by semantics if we wish to properly account for the linguistic facts. Consider the following situation.

the workshop You are attending a workshop. In front of you lies the list of names of all participants, around you are sitting the participants in flesh and blood. Consider the following dialogue:

(8) A: Who is that man?

B: That man is Ken Parker.

A: Who is Nathan Never?

B: Nathan Never is the one over there.

In these dialogues we seem to find a shift of identification methods. In order to account for them an advocate of the FM strategy would have to adopt two different models depending on which question-answer pair she is willing to interpret. The first pair must be analyzed with respect to a structure in which proper names (and not demonstratives) are interpreted as constant functions. For the second we need a model in which demonstratives (and not names) are treated as identifiers. This seems to be methodologically suspect and leads to serious difficulties once we assume a perspective which takes discourses as objects of investigation rather than isolated sentences. Intuitively, (8) is a coherent piece of discourse because no move is a trivial move and each move is consistent with the rest.[14] However if we assume the FM strategy, the two questions in their non-trivial interpretation do not have any model in common, so we lack a semantic characterization of their compatibility.

The FM strategy does not only fail on the discourse level, though. The pluralism of identification methods that it allows is not enough to account for all cases even on the sentential level.

[14] Cf. Groenendijk (1999) for an elegant formalization of such a notion of discourse coherence.

the workshop 2 In the situation above you can ask (9) or assert (10):

(9) Who is who? ($?xy\ x = y$)

(10) I don't know who is who.

A typical answer to (9) is one which specifies a mapping from the set of names to the set of people in the room. In the G&S logic even if combined with the FM strategy, (9) is trivial and so (10) is contradictory. In order to account for these sentences, we have to improve upon the G&S analysis in which different identification methods can not play a role simultaneously.[15]

It is interesting to notice that examples involving indexical expressions show the same variability that we find in the workshop case (I am grateful to Martin Stokhof for this observation):

(11) You come with me; you stay here.

There are interpretations of (11) in which the speaker is not contradicting herself, because the pronoun "you" can clearly refer to two different people, even inside a single sentence. After the influential work of Kaplan, the standard way of accounting for indexical expressions involves the introduction of the context as an explicit parameter of the interpretation function. In order to account for cases like (11), we further have to assume that the contextual parameter, which represents circumstances in continuous change, can assign different values to different occurrences of indexical expressions. In the following section, I adopt the same strategy to account for the variability of the interpretation of who-questions. Different sets of identifiers will be allowed to be

[15] A number of researchers (notably Boër and Lycan) have assumed that identity questions involve predicative uses of the copula rather than equative ones. A question like (9) would then be represented as (a) $?x?P\ be(x)(P)$ rather than (b) $?xy\ x = y$ and would not be trivial under such a representation. Note however that such a move would not improve the situation for the simple partition theory. The interpretation of an interrogative like (a) would involve a universal quantification over a set of properties which obviously must be contextually restricted and our semantics would still need to be able to distinguish different sets of properties as possible domains for different occurrences of the wh-phrase in order to account, for instance, for dialogues like (8). Furthermore, it is not at all clear whether the examples I am discussing here really involve predicational uses of the copula. See for instance Higgins (1973), chapter 5, who argues that proper names, demonstratives and *who* are never used predicationally. The analysis I propose in the following section, maintains the simple representation of identity questions in terms of logical identity and account for their meanings by proposing a non-standard interpretation of identity statements in intensional contexts.

selected in different contexts as domain of quantification for different occurrences of wh-expressions. The role of pragmatics in these cases is that of choosing not suitable models, as assumed by the FM strategy, but proper domains of quantification.

4 Questions under Conceptual Cover

In this section, I present a refinement of the G&S semantics in which different ways of identifying objects are represented and made available within one single model. Identification methods are formalized by conceptual covers. Conceptual covers are sets of individual concepts which represent different ways of perceiving one and the same domain. Questions are relativized to conceptual covers. What counts as an answer to a who-question depends on which conceptualizations of the universe of discourse are assumed in the specific circumstances of the utterance.

Conceptual Covers

Conceptual covers are sets of individual concepts satisfying a number of natural constraints (see Aloni (1997, 2000)). An *individual concept* is a total function from possible worlds to individuals. Concepts represent ways of identifying objects. Examples of concepts are the following: (a) $\lambda w\ d$ (where $d \in D$); (b) λw $[\text{Bob}]_w$; (c) λw $[\text{the shortest spy}]_w$. (a) is a constant function that assigns to all worlds the same value d, (b) and (c) assign to each world the individual which is respectively Bob or the shortest spy in that world. I call $c(w) = d$, i.e., the value d that a concept c assigns to a world w, the *instantiation* of c in w.

A conceptual cover is a set of concepts which satisfies the following condition: in each world, each individual constitutes the instantiation of one and only one concept.

Definition 5 Let $M = \langle D, W \rangle$. A *Conceptual Cover CC* over M is a set of individual concepts such that:

$$\forall w \in W : \ \forall d \in D : \ \exists! c \in CC : c(w) = d$$

The existential condition says that in a cover, each individual is identified by means of at least one concept in each world. The uniqueness condition says that in no world is an individual counted twice. In a conceptual cover, each individual in the universe of discourse is identified in a determinate way, and different conceptual covers constitute different ways of conceiving of one and the same domain.

Illustration Consider the following situation. In front of you lie two cards. One is the ace of spades, the other is the ace of hearts. Their faces are turned over. You don't know which is which. In order to formalize this situation, we just need to distinguish two possibilities. The simple model $\langle D, W \rangle$ visualized by the following diagram will suffice:

$$\begin{array}{lllll} w_1 & \mapsto & \heartsuit & \spadesuit \\ w_2 & \mapsto & \spadesuit & \heartsuit \end{array}$$

D consists of two individuals $\heartsuit$ and $\spadesuit$. W consists of two worlds w_1 and w_2. As illustrated in the diagram, either $\heartsuit$ is the card on the left (w_1); or $\heartsuit$ is the card on the right (in w_2).

There are only two possible conceptual covers definable on such a model, namely the set A which identifies the cards by their position on the table and the set B which identifies the cards by their suit:

$$\text{A} = \{\lambda w[\mathit{left}]_w, \lambda w[\mathit{right}]_w\}$$

$$\text{B} = \{\lambda w[\mathit{spades}]_w, \lambda w[\mathit{hearts}]_w\}$$

C below is an example of a set of concepts which is not a cover:

$$\text{C} = \{\lambda w[\mathit{left}]_w, \lambda w[\mathit{hearts}]_w\}$$

Formally, C is not a cover because it violates both the existential condition (no concept identifies $\spadesuit$ in w_1) and the uniqueness condition ($\heartsuit$ is counted twice in w_1). Intuitively, C is ruled out because it does not provide a proper perspective over the universe of individuals. Its inadequacy does not depend on its two elements taken individually, but on their combination. Although the two concepts *the card on the left* and *the ace of hearts* can both be salient, they cannot be regarded as standing for the two cards in D. If taken together, the two concepts do not constitute an adequate way of looking at the domain.

Interrogatives Under Cover

I propose to relativize questions to conceptual covers. Contextually supplied conceptualizations determine what counts as possible answers to constituent questions.

I add a special index $m \in N$ to the variables in PL. These indices range over conceptual covers. Conceptual perspectives determine their values.

Definition 6 Let M be a model for QL. A *conceptual perspective* $\wp$ in M is a function from N to the set of conceptual covers over M.

Conceptual perspectives represent one aspect of the pragmatic contexts, in that they determine the identification methods which are assumed.[16] In order to simplify the notation, I will ignore indices and write $\wp(x)$ for the conceptual cover assigned by $\wp$ to the index of x. Questions are interpreted with respect to perspectives $\wp$. In case of multi-constituent questions, different variables can be assigned different conceptualizations. (Recall that by $\vec{\alpha}$ I mean sequences $\alpha_1, \ldots, \alpha_n$. By $\vec{c}(w)$ I mean the sequence $c_1(w), \ldots, c_n(w)$.)

Definition 7 [Interrogatives under cover]

$$[?\vec{x}\phi]^{\wp}_{w,g} = \{v \mid \forall \vec{c} \in \prod_{i \in n}(\wp(x_i)) : [\phi]_{w,g[\vec{x}/\vec{c}(w)]} = [\phi]_{v,g[\vec{x}/\vec{c}(v)]}\}$$

The essential idea of this definition is that by interpreting an interrogative one quantifies over tuples of elements of possibly distinct conceptual covers rather than directly over (tuples of) individuals in D. If analyzed in this way, a question like $?xPx$ groups together the worlds in which the denotation of P is identified by means of the same set of elements of the selected conceptual cover.

Illustration Consider a slightly modified version of the card situation described above. In front of you lie two turned over cards. One is the ace of hearts, the other is the ace of spades. You don't know which is which. Furthermore one of the cards is marked, but you don't know which. We can model this situation as follows:

$$\begin{array}{lcll} w_1 & \mapsto & \heartsuit & \spadesuit^{\bullet} \\ w_2 & \mapsto & \spadesuit & \heartsuit^{\bullet} \\ w_3 & \mapsto & \heartsuit^{\bullet} & \spadesuit \\ w_4 & \mapsto & \spadesuit^{\bullet} & \heartsuit \end{array}$$

Our model now contains four worlds representing the possibilities which are compatible with the described situation. Consider now two possible conceptual perspectives: $\wp$ and $\wp'$. $\wp$ assigns to the index of the variable x the cover that identifies the cards by means of their position on the table, $\wp'(x)$ identifies the cards by their suits.

$$\wp(x) = \{\lambda w[left]_w, \lambda w[right]_w\}$$

$$\wp'(x) = \{\lambda w[spades]_w, \lambda w[hearts]_w\}$$

[16] The present formalization in terms of conceptual perspectives avoids the issue of how covers are contextually determined. See Aloni (in preparation) for an analysis of the pragmatic selection procedure of conceptual covers.

Consider the following interrogative:

(12) Which card is marked? ($?x\ x^{\bullet}$)

It is easy to see that (12) structures the set of worlds in two different ways depending on which perspective is assumed:

$$\text{under } \wp : \quad \begin{array}{|c|} \hline w_1 \\ w_2 \\ \hline w_3 \\ w_4 \\ \hline \end{array} \qquad\qquad \text{under } \wp' : \quad \begin{array}{|c|} \hline w_1 \\ w_4 \\ \hline w_2 \\ w_3 \\ \hline \end{array}$$

Under $\wp$, (12) disconnects those worlds in which the dotted card occupies a different position; under $\wp'$, (12) groups together those possibilities in which the marked card is of the same suit. In the first case, the relevant distinction is whether the left card or the right card is marked; in the second case the question expressed is whether spades is marked, or hearts. Since different partitions are determined under different perspectives, we can account for the fact that different answers are required in different contexts. For instance, (13) counts as an answer to (12) only under $\wp'$:

(13) The ace of spades is marked.

That the difference really matters, is easy to see. Imagine you are playing the following game: you can take a card from the table, if it is the marked card you win one million dollars. In this scenario, given your goals (formalized by perspective $\wp$), (13) does not answer (12).

Furthermore, since different variables can range over different covers, we can easily account for examples like the following:

(14) Which card is which card? ($?xy\ x = y$)

Assume $\wp$ assigns different covers to (the indices of) x and y.

$$\wp(x) = \{\lambda w[\mathit{left}]_w, \lambda w[\mathit{right}]_w\}$$

$$\wp(y) = \{\lambda w[\mathit{spades}]_w, \lambda w[\mathit{hearts}]_w\}$$

If interpreted under such perspective, (14) groups together those worlds that supply the same mapping from one cover to the other, and is not vacuous in our model.

$$\text{under } \wp : \quad \begin{array}{|c|} \hline w_1 \\ w_3 \\ \hline w_2 \\ w_4 \\ \hline \end{array}$$

Cardinality

In this section, I show that a natural property of the G&S semantics holds here as well. The proof of this fact relies essentially on the uniqueness and existential conditions that define conceptual covers. This is a welcome fact which therefore constitutes the main justification for the two conditions.

First note that intuitively how many-questions and numeral answers seem to be unsensitive to methods of identification. Consider again the workshop situation above, in which two identification methods were equally salient, identification by name and identification by ostension.

(15) How many persons were late today?

This question should determine one and the same partition whatever perspective is assumed. (15) should be analyzed as grouping together those worlds in which the same number of people were late today irrespective of how these are identified.

Secondly, we have strong intuitions that knowing who is P implies knowing how many are P. The following is inconsistent:[17]

(17) I don't know how many were late today, but I know who was late today.

In our logic these intuitions are satisfied as can be seen from the following fact:

Fact 3 [cardinality] $\forall M : \forall \wp : \forall \alpha \in [\![?\vec{x}\phi]\!]^{\wp}_{M} : \forall w, w' \in \alpha : \forall g :$

$$|\lambda \vec{d}\,[[\![\phi]\!]^{\wp}_{M,w,g[\vec{x}/\vec{d}]} = 1]| = |\lambda \vec{d}\,[[\![\phi]\!]^{\wp}_{M,w',g[\vec{x}/\vec{d}]} = 1]|$$

Who-questions cannot group worlds together in which the set of sequences of individuals who satisfy the relevant property has different

[17]There are interpretations under which this sentence might be consistent, namely if we interpret the second conjunct as saying that you know which *kind* of person was late today. For instance you could say:

(16) I don't know how many were late today, but I know who was late today, namely some linguists and some logicians.

The distinction individual-kind is of a different nature than the one formalized by different covers. The former involves looking at one domain assuming different levels of granularity, the latter involves different (though equivalently fine-grained) ways of identifying the entities in the domain. Ginzburg (1995) accounts for examples like (16) by adopting a relative notion of answerhood. See Gerbrandy (2000) for an indication of how to deal with these cases by assuming that different contexts select different quantificational domains for the wh-phrase.

cardinality. If you know the true complete answer to the question "Who P?", then, fact 3 says that all worlds in your belief state are worlds in which the predicate P is assigned denotations of equal cardinality. If we assume that how many-questions collect those worlds in which the same number of sequences of individuals satisfy the relevant property, this means that you believe the true complete answer to the question "How many P?". In the present logic, you know how many P, if you know who P. The proof of fact 3 follows directly from the existential and uniqueness conditions on conceptual covers. Irrespective of which perspective you assume, the number of the individuals satisfying a certain property doesn't change.

Fact 4 Let $M = \langle D, W \rangle$ be a model. $\forall CC$ over M: $|CC| = |D|$

If we had allowed questions to quantify over randomly collected concepts, rather than conceptual covers, fact 3 would have been falsified. Consider another version of the card situation above:

$$\begin{array}{lll} w_1 & \mapsto & \heartsuit^{\bullet} \quad \spadesuit \\ w_2 & \mapsto & \spadesuit^{\bullet} \quad \heartsuit^{\bullet} \end{array}$$

Consider now the set of concepts $C = \{\lambda w[\mathit{left}]_w, \lambda w[\mathit{hearts}]_w\}$, which as we saw, is not a conceptual cover. Suppose we interpret the question

(12) Which card is marked?

as grouping together those worlds in which the marked card is the instantiation of the same elements of C. Example (12) would place the two worlds in the same block, thus supplying a counterexample to our cardinality fact. Assume the two worlds constitute your information state. In such a situation, it would be predicted that you know which card is marked without knowing how many cards are marked, which is highly counter-intuitive.

Answers under cover

We can relativize the notions of a partial and a complete answer to conceptual perspectives in an obvious way.

Definition 8 [answer under cover]

1. ψ is a (partial) answer to $?\vec{x}\phi$ in M *under* $\wp$, $\psi \rhd_{M,\wp} ?\vec{x}\phi$ iff

$$\exists X \subset [\![?\vec{x}\phi]\!]^{\wp}_{M} : [\![\psi]\!]^{\wp}_{M} = \cup\{\alpha \mid \alpha \in X\} \neq \emptyset$$

2. ψ is a complete answer to $?\vec{x}\phi$ in M *under* $\wp$, $\psi\ {}_{c}\rhd_{M,\wp}\ ?\vec{x}\phi$ iff

$$[\![\psi]\!]^{\wp}_{M} \in [\![?\vec{x}\phi]\!]^{\wp}_{M}$$

The dilemma above is solved. Problems of identification can be represented as problems of mapping elements from different covers onto each other. It depends on the perspective assumed whether an identity question is a vacuous move.

Fact 5 [perspectives and triviality]

$$?x\ t = x \text{ is trivial in } M \text{ under } \wp \ \Leftrightarrow\ \lambda w\ [t]_{M,w} \in \wp(x)$$

We assume that choices of $\wp$ which render questions vacuous are ruled out by general conversational principles.[18] We can thus account for the fact that "Eduard is Eduard" hardly counts as an adequate answer to "Who is Eduard?" The latter, if genuine, asks to map the concept *Eduard* to an element of a conceptualization which crucially does not include it.

On the other hand, terms from which answers are built up need not be rigid designators, it suffices that their interpretations are elements of the assumed methods of identification. We can then account for the difference between the A, B, C question-answer pairs of section 3:

Fact 6 [perspective and answerhood] Let M be a standard model and $p \neq q$.

A $\forall\wp:\ \lambda w\ [t]_{M,w} \in \wp(x)\ \Leftrightarrow\ (!)Pt\ {}_{(c)}\rhd_{M,\wp}\ ?xPx$;

B $\forall\wp: q\ {}_{(c)}\not\rhd_{M,\wp}\ ?p$;

C $\forall\wp: p\ {}_{(c)}\rhd_{M,\wp}\ ?p$.

"Eduard called" counts as an appropriate answer to "Who called?" if and only if the interpretation of "Eduard" is part of the assumed conceptual cover (A). Although context dependent who-questions and their answers are clearly distinguished from highly marked pairs such as "Is it raining? - I am going to the cinema" (B). The adequacy of the former depends on the perspective assumed, the correctness of the latter relies on the factual information presupposed. Standard pairs such as "Is it raining? - It is raining" are always correct irrespective of the circumstances of the utterance (C).

[18]The selection procedure of conceptual covers can be formulated as a decision problem. Choices which lead to the violation of general rationality principles (in this case Grice's Quantity Maxim) are never optimal. See Aloni (in preparation).

Finally notice that our analysis allows the characterization of a perspective relative notion of knowing who: a sentence like "a knows $?\vec{x}\phi$" is true in w under $\wp$ iff a stands in the *know*-relation to $[\![?\vec{x}\phi]\!]^{\wp}_{w}$ in w, i.e. iff a believes the true complete answer to the question under $\wp$.

5 Alternative Analysis

Recently the issue of the context sensitivity of questions has received new attention in the linguistic literature in the work of Jonathan Ginzburg. In order to account for the influence of pragmatic factors on the interpretation of questions and answers, Ginzburg (1995) proposes what he calls a *relative* notion of an answer resolving a question. Questions are analyzed as in the structured meaning approach (though in the framework of situation semantics, rather than possible world semantics); extensional question-embedding verbs are analyzed as imposing a resolvedness condition on their interrogative complement and what counts as resolving crucially depends on contextual parameters such as the goals and inferential capabilities of the questioner. The Spiderman case above could then be analyzed roughly as follows. Recall the relevant situation. Someone killed Spiderman. In context γ, you are at the police department investigating the murder. In context δ, you are at a ball with the intention to arrest the culprit. In the two contexts, you are after two different goals. Goals can be described by propositions, intuitively the proposition that is true once the goal desired by the relevant agent is fulfilled.

goal in γ = You know the name of the culprit.

goal in δ = You know what the culprit looks like.

In the situation described, (18) below is true in both contexts. From (18), the proposition expressing the goal in γ can be 'inferred', but not the one expressing the goal in δ. So (19) is true in one context and false in the other.

(18) You know that John Smith killed Spiderman.

(19) You know who killed Spiderman.

However, once we try to formalize this analysis we get into problems. According to the theory of rigid reference, which Ginzburg seems to adopt, the following two propositions are still equivalent:

(20) John Smith killed Spiderman.

(21) He [pointing at John Smith] killed Spiderman.

Thus it is not clear how (18) and (22) can have different implications:

(22) You know that he (pointing at John Smith) killed Spiderman.

The simple introduction of goals and perspectives as explicit parameters of the answerhood relation is not sufficient to explain the phenomenon I discussed in this paper and needs to be combined with a more sophisticated theory of how objects are identified in cognitive states. Identification under conceptual covers is such a theory. In this paper however, I also showed a different way of formalizing the same idea that goals and perspectives are relevant for an analysis of questions. In Ginzburg's approach, different answers resolve, in different contexts, an interrogative whose meaning stays constant. In the present analysis, an interrogative expresses different partitions in different contexts, because in different contexts different domains of quantification are selected for the wh-expression. Goals and perspectives are not parameters of the answerhood relation, but play a role in selecting a domain of quantification.

6 Conclusion

A domain of individuals can be observed from different angles. Our interpretation of who-questions and their answers may vary relative to which ways of identifying objects we assume. By letting wh-expressions range over elements of conceptual covers, we can account for this variability while maintaining the intuitive characterization of constituent questions as asking for the specification of a set of determinate individuals. The elements of a cover do not stand for representations of individuals but rather for the individuals themselves but identified in a particular way.

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