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A Modal Approach to Open Questions

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0. Introduction

Received wisdom holds that questions, themselves lacking truth conditions, should be analyzed in terms of the propositions that count as answering the question. The literature on interrogatives often focuses on *informative* and *polar* questions which ask for a specific piece of information or a *yes-no* answer respectively (see for example Hamblin 1958, 1973; Karttunen 1977; Groenendijk and Stokhof 1982, 1984). These accounts more or less agree that a question denotes its true and complete answer, either as a partition of logical space (Groenendijk and Stokhof 1984), or as a set of propositions (Karttunen 1977).

In this paper I am concerned with a different kind of question, the class of *open questions*, like the ones in (1a) – (d).

(1) a. How do you feel?
b. What is Chicago like?
c. What do you make of Paris Hilton?
d. What is the effect of the stimulus plan on the economy?

Open questions display a number of properties that are different from other question types that make a formal analysis along the lines of the traditional accounts difficult. As Groenendijk and Stokhof (1997) have also noted, open questions do not seem to fit the picture drawn by various accounts of interrogatives, as answering an open question appears to be a creative process, where the answers are not pre-set, or exhaustive. They further note that it often does not make sense to qualify them as 'true' or 'false' but rather 'good,' 'helpful,' and so on (p. 55-56). To illustrate the difference between open and informative questions consider the two questions in (2). While (1a) is an informative question seeking a particular piece of information, (2b) very intuitively asks for an opinion, or a comment of some sort. Crucially, the answer is relative to the speaker, and there is no obvious sense in which an answer to such a question can be exhaustive.

(2) a. Who lives in Chicago?
b. What is living in Chicago like?

My goals in this paper are three-fold. First, I will show that the semantic analyses of interrogatives available do not account for data from open questions. In particular, I will be concerned with the observation that unlike informative questions, answers to open questions are agent-relative and non-exhaustive, and that the propositions in the answer space are non-mutually exclusive. Second, I propose an account of open questions using insights from modal semantics (Kratzer 1977, 1981), which builds directly on Karttunen's (1977) analysis and maintains the intuition that questions denote their true and complete answer. Finally, I show that this account is easily extendable to other problematic and unproblematic question types, moving toward a unified theory of questions. The proposed analysis has at its core the intuition that open questions merit a semantic analysis in their own right, one that incorporates concepts from pragmatics and discourse, rather than marginalizing the semantics for problematic cases by appealing to various extra-semantic components.

I will proceed as follows: Section 1 presents some background on the semantics of interrogatives. In section 2 I review the crucial data from open questions that seem to defy the conclusions of previous analyses. A formal framework and its extensions are laid out in section 3. Section 4 concludes.

1. Background on the Semantics of Interrogatives

Semantic accounts of interrogatives fall into two main camps: those that view questions as denoting sets of propositions and those that hold that questions denote a singe proposition corresponding to a partition of logical space.

1.1. Questions as Sets of Propositions

The foundational work for the semantics of questions was laid by Hamblin (1958, 1973), who was the first to postulate that a question denotes its answer. Hamblin viewed a question as denoting the set of alternatives that could count as answering the question. Karttunen (1977) builds on Hamblin's proposal by considering embedded questions. Based on the properties of some embedding verbs, such as *know*, *tell*, *find out*, he concludes that the meaning of an interrogative expression is not those propositions that count as possible answers, but only those which count as true answers. Thus the question *Who likes Bill?* denotes all the propositions containing individuals such that the property LIKES*(x, b)* is true of those individuals.

It is notable that the answer set consists of only those propositions, which include individuals of whom it is true in a world that they like Bill. The intuition is that when someone asks *Who likes Bill?* one is asking for only those answers, which include the individuals of whom the property of liking Bill is actually true in order to resolve the question. This contrasts with Hamblin's view in that there it does not matter whether individuals actually liked Bill.

One crucial feature of Karttunen's proposal is that a question denotes a set of propositions and is of type <s, <<s,t>, t >> as its sense is a function from worlds to sets of propositions. Thus the exhaustive answer to a question like *Who likes Bill?* is the conjunction of all the true instantiations of LIKES*(x, b)*. What is crucial here with regard to mutually exclusive alternatives is that the propositions in the answer space are not mutually exclusive with respect to other propositions that are true in that world of evaluation, but only with respect to other worlds of evaluation.

1.2. Questions as Partitions of Logical Space

Groenendijk and Stokhof (1982) appeal to the intuition that questions split up the logical space into different ways the world could be. In this respect, their analysis is more closely related to that of Hamblin (1958) who shared this intuition. More specifically Groenendijk and Stokhof explore in more detail Karttunen's notion of the exhaustive answer. They notice for example that knowing the answer to the question *Who likes Bill?* is not only knowing which individuals like Bill, but also which individuals do not. Thus they term Karttunen's view of answerhood as *weakly exhaustive*, and their own as *strongly exhaustive*.

Since strong exhaustivity does not follow from Karttunen's proposal, their analysis makes use of the intuition already familiar from Hamblin, that questions divide the logical space into partitions of possible worlds. For example, the question *Who likes Bill?* might partition the possible worlds into five compartments, in each of which one of these possible answers is true: 'Only Annie likes Bill,' 'Annie and Susan like Bill,' 'nobody likes Bill,' 'everybody likes Bill,' and 'Bill is the only one who likes Bill.' Knowing that one of these propositions is the true one thus entails knowing that the other four are false. In this view, a question is thus a function from worlds to propositions, of type <s, <s,t>> and a question denotes a single proposition that counts as its true and complete answer. Since a question denotes only one single proposition, this proposition is mutually exclusive with any other proposition since it is the only one that answers the question in a given world of evaluation.

Though both types of theories agree that a question denotes its true and complete answer, they do make different predictions concerning what precisely makes an answer complete. These differing predictions hinge on the two conceptions of the answer space with a set of non-mutually exclusive propositions on the one hand, and a single proposition which is mutually exclusive with respect to all other alternatives on the other hand. As we shall see in the next section, open questions present a challenge to both of these views.

2. Properties of Open Questions

Open questions appear at first glance to pose a problem to the semantic theories outlined above, as answers to these questions are agent-relative (to borrow a term from Ginzburg 1997), not exhaustive, and the propositions in the answer space are not mutually exclusive with respect to other propositions.

2.1. Agent-Relativity

One important property of open questions is that their answers are relative to the beliefs, or epistemic state of the speaker. Consider the following exchange taking place on a news show between the anchor Tom, and his guests Dick and Harry.

(3) Tom: What effects will the stimulus have on the economy?
Dick: It'll avert disaster, putting people to work doing jobs that needed to be done anyway.
Harry: Oh forget it. All it will do is drive the economy into the ground for good.

In this exchange Dick and Harry express opposite points of view on an issue, but neither one of them could be said to be right or wrong, at least not at speech time. It may turn out at some later point that Dick or Harry will be proven wrong, but at the time of speech the speakers do not have access to this knowledge and answer based on what they know about the issue and their beliefs. In short, the answer to this question, and other open questions like it, is relative to each individual's epistemic state, and not objective knowledge about the world.

This kind of relativity is reminiscent of what Lasersohn (2005, 2007) calls *faultless disagreement*, since despite the fact that the two propositions openly contradict each other, neither one can be said to be true or false. Though the kind of relativism found here is not exactly like faultless disagreement since disagreements about mistaken beliefs give rise to *at fault disagreement* according to this account, it is clear that speakers answering open questions are relativizing responses to their beliefs or knowledge state, rather than speaking objectively about the world.

2.2. The Answer Space

The two views on the semantics of questions paint different pictures concerning the organization of the answer space. On Karttunen's view, the answer space is made up of a set of propositions that jointly provide the exhaustive answer to a question. Thus, propositions within the answer space are mutually compatible. On the Groenendijk and Stokhof view, a singe proposition makes up one partition of the logical space, and that proposition is mutually exclusive with respect to all other possibilities.

Answers to open questions support the Karttunen view of the answer space, since answers are mutually compatible with a host of other propositions. Consider (4):

(4) Sally: What is Chicago like?
Mary: It's great. There's so much to do here, and the people are really nice.

If Mary's response were a partition of logical space corresponding to the true and complete answer to Sally's question, we would expect it to rule out all other possibilities. This prediction, however, does not appear to be borne out as her response is compatible with many other propositions, such as 'it's really cold in

the winter,' or 'Chicago is the third largest city in the world,' assuming these are both true statements about what Chicago is like.

The question of how the answer space is organized ties in directly with the question of what "exhaustive" means for the two theories of interrogatives in question.

2.3. Exhaustivity

Both the partitions of logical space view (Groenendijk and Stokhof 1982, 1984) and the sets of propositions view (Karttunen 1977) face a challenge with open questions since answers to these kinds of questions do not appear to be exhaustive in any relevant sense. Consider for example an answer to (1a) repeated here in (5) in a context where Ralph just got dumped and Susie is his best friend.

(5) Susie: How do you feel?
Ralph: # I feel rejected and lonely because my girlfriend left me, I have an ingrown toe-nail which is hurting my big toe, I feel a migraine coming on because I ate too much chocolate, I am nervous about my presentation, I have an itch on my arm...
Ralph′: I feel rejected and alone.

It is clear that Ralph's second answer is the more felicitous one, even if all the statements he makes about how he feels in the first scenario are true. Indeed one may argue that an embedded question like (6) should always be false under traditional analyses of questions.

(6) I know how you feel.

Very intuitively, this sentence means, "I know how you feel regarding such and such." What it does not mean is "I know the exhaustive set of propositions that correspond to how you feel." Answers to open questions are thus not exhaustive in the traditional sense of listing all the propositions that truthfully answer the question, but rather they are exhaustive only with respect to some relevant context or scenario.

2.4. To-do List

To sum up this section, we have seen that open questions present a challenge to existing theories of interrogatives, as answers to this type of question are agent relative rather than objectively true or false, as well as not exhaustive in the traditional sense, but rather exhaustive with respect to the relevant issue. Further we have seen that data from open questions support Karttunen's view of the answer space, i.e. that it is a set of propositions as opposed to a single proposition.

An analysis of open questions should capture their particular properties, and in addition maintain the basic intuition behind the semantics of questions, which is that questions denote their true and complete answer.

3. Towards a Meaning for Open Questions

In this section I present such an analysis that draws on insights from modal semantics (Kratzer 1977, 1981), making it possible to account for the facts with only a slight modification of Karttunen's original proposal. The proposed analysis also extends to other question types, yielding a unified account of interrogatives. I lay out the formal framework in section 3.1. and illustrate how the proposal works concretely on an example in section 3.2. Section 3.3. extends the analysis to other question types.

3.1. Formalizing Open Questions

This section lays out the formal framework that accounts for the various properties of open questions discussed above. The main departure from previous treatments of interrogatives (Hamblin 1958, Karttunen 1977, Groenendijk and Stokhof 1982) is that the propositions in the answer-space will be determined by a certain world of evaluation, rather than representing mutually exclusive alternatives. In order to get an ordering on the propositions that are possible answers, we can follow the semantics for modals presented by Kratzer (1977, 1981) for epistemic modals, and the semantics for imperatives and root modals presented by Portner (2007). The propositions that are true in the worlds that are BEST-ranked with respect to an epistemic modal base, and contextually determined ordering source are propositions that are resolving for a given question.

3.1.1. The Modal Base

I take an open question to denote a set of propositions and follow Karttunen (1977) in postulating that the answer space is defined by all the true propositions that can count as answering the question, rather than all the possible ones (Hamblin 1958). Karttunen's denotation for what he called a proto-question is given below - it is our point of departure:

(7) $[[?\varphi]]^{w1} = \lambda p(p = \lambda w[\varphi(w)]) \wedge p(w_1)$

That is, at a world, a question asks for a set of propositions that answers φ and is true in that world. In this section I show that by fixing the worlds of evaluation, we can leave Karttunen's analysis of interrogatives intact, while accounting for the full range of open questions data. Thus, in modal terms, the answer space is comprised of the set of propositions compatible with an epistemic modal base that contains all the propositions compatible with what the speaker knows. This is intuitively clear since it is reasonable to assume that a speaker asks an interlocutor a question because he thinks the interlocutor knows the answer. Thus, in a context *c*, an epistemic conversational background *cb* limits the worlds of evaluation to the ones accessible from what a speaker knows in *w*, such that *f(w)* represents a set of facts known by the speaker in *w*, and the set of worlds accessible from *w* is $\cap f(w)$.

(8) a. A conversational background *cb* is a function form worlds to sets of propositions (Kratzer 1977, 1981)

b. Epistemic *cb* function *f*: For any world w in the domain of *f*, *f(w)* = {*p*: the speaker of *c* knows *p* in *w*.}

As I pointed out in section 2.1., the answers to open questions are true only relative to an individual, so we can relativize the truth of these propositions to each individual using an individual anchor (Farkas 1992). Applying an individual anchor to an epistemic modal base thus relativizes the accessible worlds to an individual:

(9) $epistemic_x(w)$ = {*p*: *x* takes *p* to be true in *w*}

The intersection of all the propositions compatible with the speaker's knowledge $\cap f(w)$, is a set of worlds, the epistemic modal base. By anchoring an epistemic conversational background to any individual *x*, we can account for the truth-relativity of speakers (Farkas 1992). Truth is thus defined as follows:

(10) For any proposition *p*, context *c* and conversational background function *f* : *p* is true in *w* iff $w \in [[p]]^{c,f}$.

In other words, a proposition is true in any given world, if that world is a member of the modal base, the intersection of all the propositions compatible with an individual's epistemic state ($\cap f(w)$). Now we are in a position to consolidate the fact that to interlocutors may have conflicting opinions about any given question with Karttunen's intuition that a question denotes a set of true propositions. However, the modal base may still be compatible with some propositions that are not acceptable answers to a question. In order to narrow down the propositions that can count as "good" answers, we can further restrict which worlds are accessible for the evaluation of the question. This is done by applying a second *cb* function, an ordering source on the modal base.

3.1.2. Setting the Worlds of Evaluation

Ordering sources are also functions from worlds to sets of propositions, and can in principle be any of the following:

(11) a. $teleological_x(w)$ = {*p*: *p* expresses a belief of *x* in *w*}
b. $deontic_x(w)$ = {*p*: *p* expresses a an obligation of *x* in *w*}
c. $epistemic_x(w)$ = {*p*: *p* expresses knowledge of *x* in *w*}
d. $bouletic_x(w)$ = {*p*: *p* expresses a desire of *x* in *w*}
e. $circumstantial_x(w)$ = {*p*: *p* expresses a set of circumstances holding for *x* in *w*}
f. $stereotypical_x(w)$ = {*p*: *p* expresses an expectation on the part of *x* concerning what *w* is like}

g(w) is a set of propositions used an ordering source on the modal base. Thus the BEST-ranked worlds are those worlds from the modal base in which all of *g(w)* are true. $\leq_{g(w)}$ does the ordering:

(12) For any set of propositions *g(w)* and any worlds *w*, *v* in the modal base:
$w \leq_{g(w)} v$ iff for all $p \in g(w)$, if $v \in p$, then $w \in p$.

This definition says that ranking *w* higher or equal with respect to *v* means that any proposition in *g(w)* that is true in *v* is also true in *w*. The worlds that come out BEST according to this ranking are the accessible ones. Using a ranking of worlds in a modal base according to a contextually determined ordering source thus fixes the worlds of evaluation for open questions. Now we can express the meaning of an open question as in (14), where BEST is defined as in (13).

(13) $\text{BEST}^{w} = \{v \mid v \in \cap f(w)$ and there is no $v' \in \cap f(w)$ such that $v' \leq_{g(w)} v\}$.
(14) $[[?\varphi]]^{w,c,f,g} = \lambda p.p = \lambda w'.\ \varphi(w') \wedge \forall w'' \in \text{BEST}^{f(w)}.p(w'')$

This denotation says that an interrogative expression is evaluated with respect to a world, *w,* context *c* and two conversational background functions, *f*, and *g*. A question "*?φ*" thus asks for a set of propositions, such that the propositions are of the form *φ* and those propositions must true in all of the BEST-ranked worlds. As a result only those propositions that are true in all the BEST-ranked worlds are the actual answers, i.e. the propositions in the answer space. Another way of thinking about this is that all the BEST-ranked worlds have to be part of the denotation of any proposition that counts as the answer. This definition departs from that of Karttunen (1977) only in that the set of propositions that are true are restricted to the ones that are true in the BEST worlds according to the relevant conversational backgrounds.

3.2. How it Works

In this section I show how the proposed analysis achieves the desired result of relativizing truth to individual epistemic states, and exhaustivity to a specific context, while maintaining a standard denotation for questions. Consider once again our first question, given below, in two different contexts.

(15) $[[\text{How do you feel?}]]^{w,c,f,g} = \lambda p.p = \lambda w'[\exists f$ .you feel *f* in $w'] \wedge$
$\forall w'' \in \text{BEST}^{f(w)}.p(w'')$

3.2.1. Context 1

In this context Susie and Ralph are best friends, and Ralph's girlfriend just left him. The two relevant *cb* functions are the following:

(16) *f* = Epistemic
g = Circumstantial

Thus the modal base is a set of worlds comprised of the intersection of all the propositions compatible with Ralph's beliefs, and the ordering source is a set of propositions.

(17) Modal base:
$\cap f_{Ralph}(w)$ = Set of worlds compatible with Ralph's beliefs.
Ordering source:
$g(w)$ = {'My girlfriend just broke up with me,' 'She left me for another guy.'}

Recall the set of propositions that are true answers with respect to Ralph's beliefs from (5). We want to be able to get to the actual answer, which is *I feel rejected and alone* while at the same time eliminating such true but irrelevant statements as *My foot hurts because I have an in-grown toenail.*

To accomplish this end, the worlds in the modal base are ordered according to how may of the propositions in the ordering source are true in them and the (exhaustive) answer is made up all of propositions that answer the question and are true in the BEST-ranked worlds. Applying the ordering source to the epistemic modal base rules out statements about in-grown toenails and the like for the following reasons. The first concerns the ordering source; there are some worlds where Ralph has an in-grown toenail, and others where he does not, but the only thing all the BEST-ranked worlds have in common is that the set of circumstances in $g(w)$ hold. The second reason concerns universal quantification over BEST-ranked worlds; since the propositions that count as answers have to be true in all of the BEST-ranked worlds, propositions about toenails will be ruled out, as these are true in only some of the BEST-ranked worlds, but not all.

3.2.2. Context 2

In this context Ralph was still just broken up with but now Susie and Ralph are at the LSA where Ralph is about to give his first conference presentation. The *cb* functions are the same as before, with an epistemic modal base and circumstantial ordering source, but now Ralph considers different propositions to include in his ordering source.

(18) Modal base:
$\cap f_{Ralph}(w)$ = Set of worlds compatible with Ralph's beliefs.
Ordering source:
$g(w)$ = {'I am about to give my first conference presentation,' 'Famous people are here,' 'My advisor is watching to see how I'll do.'}

In this scenario, though he is still feeling lonely and rejected, answering so would not be felicitous given the circumstances. We might say that Susie is really asking *How do you feel in view of your impending presentation*? as opposed to *How do you feel in view of having been dumped?* as before. In this case the actual answer would be, *I feel a little nervous*. Furthermore, other true but irrelevant propositions would be ruled out as before since they may be true in all the worlds in the

epistemic modal base, but not all the BEST-ranked worlds according to this particular ordering source.

3.3. Extensions

The analysis presented above is straightforwardly extendable to other question types. In this section I show how the analysis can account for simple informative questions as well as mention-some questions, which have posed a problem to previous accounts of questions.

3.3.1. Informative Questions

Concerning informative like (19) are the basic case in the semantic literature on interrogatives.

(19) Who went to BLS this year?

There is a strong intuition here that the exhaustive answer to such a question would have to include all the individuals of whom it is true that they went to BLS last year. We can achieve just that using a modal approach by simply saying that the ordering source is simply empty in the case of informative questions, demanding the addressee to name all those individuals who came to BLS, as compatible with her epistemic state.

3.3.2. Mention-Some Questions

Mention-some questions, as the one below, have been problematic for theories subscribing to view that questions denote their true and exhaustive answer.

(20) Where can I buy a newspaper?

Questions such as this one are viewed as problematic, because they very intuitively do not ask for a complete list of places where you could buy a newspaper, but ones that are close by, or easily reachable. However, it is not necessary to resort to principles of pragmatic reasoning to capture this specific interpretation. A modal analysis allows a fully semantic explanation through the application of a circumstantial ordering source on the worlds compatible with the addressee's epistemic state to give us the correct outcome. The question will limit the accessible worlds to ones that are specified for a particular geographic location, requiring an exhaustive answer with respect to those worlds only.

In this respect open questions and mention-some questions are different from informative questions as these require a contextually determined ordering source to get the right denotation.

4. Conclusions and Direction for Future Research

In this paper I have argued that the semantic accounts of interrogatives account for only a small sample of the natural language data from interrogative expres-

sions. The main goal of the paper has been to present an analysis of questions that takes the seemingly most deviant data as basic and accounts for the standard interrogative types by extension. After reviewing the shortcomings of previous analyses in light of data from open questions, I presented an analysis in the framework of modal semantics that draws on insights from the literature on truth-relativity.

Specifically, I have shown that interrogatives, like modal expressions, rely on the context as part of their semantic meaning. Like a modal, a question is thus evaluated with respect to a context, a modal base, and an ordering source, which determine for each individual, and each context the denotation of the question.

In sum, I have argued for a meaning of interrogatives that is not very different from what Karttunen (1977) proposed. A question still denotes its true answer, only the truth of the answer hinges on the epistemic state of the individual questioned rather than the state of the world; and a question still denotes its exhaustive answer, only the answer is exhaustive with respect to the BEST-ranked worlds according to a contextually determined ordering source.

The analysis presented here raises a number of important questions for future research. The first concerns the structure of the discourse and the pragmatics involved in evaluating different question types. In the account I presented here, the pragmatics are directly 'built-in' to the semantics, as the pragmatics is responsible for selecting the relevant ordering source in a given context. In addition to integrating the pragmatics into the truth-conditional meaning of a question, the discourse plays an important role. It might be, for example, that the modal base is not an individual's belief worlds, but rather the intersection of all the propositions that make up the common ground (CG) (Stalnaker 1974, 1978). Outlining a model of questions that takes principles of pragmatics and the discourse into account in order to arrive at a meaning is thus one avenue for further inquiry.

Another question raised by the analysis concerns the difference between open questions and other kinds of questions with respect to truth-relativity. I have presented a view in which expressions are evaluated with respect to individual epistemic states rather than the tangible world. The obvious question is thus why the truth conditions of open questions should hinge on individual epistemic states while it appears that we use our knowledge about the world to evaluate expressions otherwise. This particular question is an extremely rich area of inquiry that I hope to be able to address in future work.

The study of open questions has thus led to a semantic account of interrogatives that is able to handle a range of data that was not possible under existing semantic proposals. In addition, this rich topic lies at the intersection of a number of other avenues of research well worth exploring.

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