Question meaning = resolution conditions*

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Abstract

Traditional approaches to the semantics of questions analyze questions indirectly, via the notion of an answer. In recent work on inquisitive semantics, a different perspective is taken: the meaning of a question is equated with its resolution conditions, just like the meaning of a statement is traditionally equated with its truth-conditions. In this paper I argue that this proposal improves on previous approaches, combining the formal elegance and explanatory power of Groenendijk and Stokhof's partition theory with the greater generality afforded by answer-set theories.

1 Introduction

Classically, the meaning of a statement is equated with its truth conditions: one knows what a statement means if one knows what a state of affairs has to be like for the statement to be true. This simple but powerful notion of meaning plays a fundamental role in disciplines connected to language and meaning, including logic, linguistics, philosophy of language, computer science, and cognitive science. From a linguistic point of view, truth-conditions allow us to give a perspicuous characterization of the information that a speaker conveys in uttering a sentence, namely, the information that the actual state of affairs is one in which the sentence is true. From a logical point of view, truth-conditions allow us to characterize fundamental logical notions like entailment and consistency.

In the standard intensional semantics framework, complete states of affairs are modeled as entities called *possible worlds*, or simply *worlds*. Truth can then be modeled formally as a relation holding between worlds and statements. This allows us to package the meaning of a statement into a single semantic object, namely, the set consisting of all those worlds where the statement is true. This set of worlds is referred to as the *proposition* expressed by the statement.[1]

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[1]For the sake of simplicity, I am abstracting away here from an important feature of the semantics of statements in natural languages, namely, *context-sensitivity*. In general, it is only

This classical view on meaning, however, is not applicable when it comes to analyzing sentences which are questions, rather than statements.[2] Like statements, questions play a fundamental role in a number of fields: linguistically, they make information exchange possible, allowing speakers to raise issues and to steer the conversation towards certain goals. Cognitively, questions drive the process of inquiry (Friedman, 2013), allowing us to pursue and achieve knowledge; additionally, they have been argued to play a key role in human reasoning (Koralus and Mascarenhas, 2014). The role of questions in logic is perhaps less evident, but not less crucial (see Wiśniewski, 2013; Ciardelli, 2016a,b, for discussion). It thus seems of great importance to have a general, simple, and clear notion of the meaning of a question—one that can play the same fundamental role as the notion of truth-conditional content plays for statements. However, no consensus on such a notion has thus far emerged: a number of influential theories have been proposed, but none has acquired a status which is comparable to that of the truth-conditional approach to statements.

In different ways, traditional theories of questions have approached the problem of giving a semantics to questions by reducing a question to its possible answers: answers are statements, so they can be associated with propositions, and this gives us an indirect handle on the semantics of the question. In this paper, we will focus in particular on two families of traditional theories of the semantics of questions.[3]

1. *Answer-set theories* (Hamblin, 1973; Karttunen, 1977; Bennett, 1979; Belnap, 1982) are based on the following tenets:
   - the meaning of a question μ is a set $\mathsf{BSA}(\mu)$ of propositions;
   - $p \in \mathsf{BSA}(\mu)$ holds iff p counts as a *basic semantic answer* to μ.[4]
2. *Partition theories* (Higginbotham and May, 1981; Groenendijk and Stokhof, 1984) are based on the following tenets:[5]

relative to a specific context that a statement, for instance "You were in London yesterday", can be assigned truth-conditions (Stalnaker, 1978). Thus, when considering statements in natural language, we should really talk about the proposition expressed *in a given context*. Since the points I will make here are not specific to the analysis of natural language (but also concern questions in formal languages), and since they are unaffected by context-sensitivity, in this paper I will omit reference to the context.

[2]For detailed arguments against the view that the semantics of questions can be analyzed in terms of truth-conditions, see, e.g., Belnap (1990) Groenendijk and Stokhof (1997).

[3]A third important family consists of the so-called *categorial theories* (also known as *functional theories*) (Tichy, 1978; Hausser and Zaefferer, 1978; Scha, 1983). These theories differ radically from the ones that we will discuss, in that they do not assume that all questions express the same type of semantic object. We will come back to these theories briefly in Section 7.4.

[4]This is a simplification: more precisely, in these theories it is the extension of a question at a possible world which is a set of proposition. The meaning of a question can be identified with its intension, which is a function mapping each world to the corresponding extension. In addition, in the theories of Bennett (1979) and Belnap (1982), the extension of a question is a set of so-called *open* propositions, i.e., functions from sequences of individuals to propositions. These complications, while important to the concrete workings of these theories, are immaterial to the features that we shall be concerned with in this paper.

[5]A similar treatment was proposed by Lewis (1988) for *subject matters*, which can be seen as questions under a particular role.

- the meaning of a question μ is an equivalence relation $\equiv_\mu$ on the space of possible worlds;
- $w \equiv_\mu w'$ holds iff the true complete answer to μ is the same in w and w'.

Recently, a different approach has been taken in the framework of *inquisitive semantics* (Ciardelli, Groenendijk, and Roelofsen, 2013a). This approach does not pursue a reduction of questions to answers; rather, it is closer to the standard semantics for statements in terms of truth-conditions. The meaning of a question is taken to lie in its *resolution conditions*: one knows what a sentence means if one knows what information needs to be available for the question to be resolved. This notion of question meaning is very similar to the standard notion of meaning for statements: in both cases, the semantics takes the form of a relation that holds when a certain semantic object "satisfies" a sentence. Only, in the case of a question, the relevant object is not a state of affairs, but rather a *state of information*, and the notion of satisfaction is not cashed out in terms of truth, but in terms of resolution.[6,7]

In the standard intensional semantic framework, information states can be modeled as sets of worlds, following a tradition that goes back at least to Hintikka (1962), and which is commonly used in the analysis of language since Stalnaker (1978): more specifically, an information state can be identified with the set of worlds which are compatible with the given information. This allows us to package up the resolution conditions of a question into a single semantic object, namely, the set consisting of those information states where the question is resolved. Thus, the inquisitive semantics approach to questions can be described as based on the following tenets:

- the meaning of a question μ is a set $\mathsf{Res}(\mu)$ of information states;
- $s \in \mathsf{Res}(\mu)$ holds iff μ is resolved in the information state s.[8]

[6] This perspective is characteristic of "modern" systems of inquisitive semantics, starting with Ciardelli (2009). Previous systems of inquisitive semantics (Groenendijk, 2009; Mascarenhas, 2009) were closer to the partition theory in this respect: they took questions to express binary relations on the logical space, as in the partition theory, but without the requirement that the relevant relations be equivalence relations. This approach will be discussed in Section 7.2.

[7] In fact, inquisitive semantics brings statements and questions even closer together by letting both kinds of sentences be interpreted in terms of satisfaction at an information state—referred to as *support*. A question is supported if the information available in the given state resolves the question, while a statement is supported if the available information establishes that the statement is true. The possibility of such a uniform interpretation is a key asset of the inquisitive view on question meaning. Nevertheless, we will set aside this important aspect in this paper, and focus exclusively on the semantic analysis of questions.

[8] Notice that, formally, information states are the same thing as propositions, namely, they are sets of possible worlds. However, when we look upon a set of worlds as an information state, we think of it as encoding an arbitrary body of information, rather than a single content capable of being expressed by a sentence or grasped as a unit. Thus, our perspective is somewhat different in the two cases. Nevertheless, in order to facilitate the comparison between inquisitive semantics and previous approaches based on propositions, below we will usually blur the distinction, and we will often refer to the elements of $\mathsf{Res}(\mu)$ as propositions.

The goal of this paper is to make a case for the notion of question meaning adopted in inquisitive semantics, illustrating how it improves both on the answer-set tradition and on the partition tradition. In doing so, I bring together a number of arguments from the traditional literature on questions (notably from Groenendijk and Stokhof, 1984; Belnap, 1982) with arguments given in recent work on inquisitive semantics (especially from Ciardelli, 2009; Groenendijk, 2011; Roelofsen, 2013; Ciardelli *et al.*, 2013a, 2016). The case relies on some theoretical desiderata for a theory of questions that were first identified by Groenendijk and Stokhof (1984). As Groenendijk and Stokhof already observed, answer-set theories fail to meet these desiderata. Groenendijk and Stokhof's partition theory does meet the desiderata but, as we will see, it does so at the cost of a reduced generality. We will see that, by contrast, the approach taken in inquisitive semantics meets Groenendijk and Stokhof's desiderata without being restricted in a similar way. Thus, inquisitive semantics combines the conceptual and formal advantages of the partition theory with the broader empirical scope afforded by answer-set theories.

The paper is structured as follows: in Section 2 we introduce two desiderata for a theory of questions, drawn from Groenendijk and Stokhof (1984). In Section 3 we discuss answer-set theories, and we show that these desiderata are not met on these approaches. In Section 4 we discuss the partition theory and show that, while it meets the desiderata, it also makes the strong assumption that questions have a unique true complete answer at each world. In Section 5 we discuss three important classes of questions which do not satisfy this assumption. In Section 6 we show that inquisitive semantics meets Groenendijk and Stokhof's desiderata without being restricted to unique-answer questions. In Section 7 we consider how answer-set theories and partition theories might try to overcome their respective problems, we clarify a potential misconception about the inquisitive approach, and we point out some empirical limitations that all these theories share. Finally, Section 8 sums up and concludes.

2 Two theoretical desiderata

At the outset of their celebrated PhD thesis, Groenendijk and Stokhof (1984) (henceforth, G&S) identified a number of desiderata that a theory of questions should satisfy. Two of these desiderata are especially interesting in that, while arising from general conceptual considerations, they provide strong, concrete guidelines for building a theory of questions.

The desiderata stem from the idea that a theory should not just have descriptive value, but also *explanatory* value. What this means is that the theory should not just account for the phenomena which occur in the relevant domain, but should do so on the basis of assumptions which are as minimal, general, and independently motivated as possible. In particular, general phenomena should receive a uniform account across the various domains in which they occur.

> It seems natural to require of a semantic theory that deals with a certain domain of phenomena, that it account for such

> phenomena as they occur elsewhere too, by using general principles, notions and operations which can be applied outside the particular domain of the theory as well. (G&S 1984, p. 11)

Concretely, G&S take this desideratum to apply to two specific notions. The first is the fundamental semantic relation of *entailment*.

> An example of a relation which can be found in every descriptive domain is the relation of entailment. Whatever concrete phenomena some particular analysis deals with, the relation of entailment will be one of the most fundamental relations that the analysis will have to account for. Descriptive adequacy requires only that the analysis give a correct account of whatever entailments hold in its descriptive domain. But explanatory adequacy is achieved if this account is based on a general notion of entailment, one that applies in other domains equally well. In fact, the semantic framework one uses brings along a general definition of entailment. For example, if the framework is based on set-theory, entailment will basically be inclusion. Hence, whenever some analysis in this framework is to account for the fact that one expression entails another, it should do so by assigning them meanings in such a way that the meaning of the one is included in the meaning of the other. (ibid., p. 11)

Given that their proposal, like most model-theoretic semantics, is indeed formulated within the set-theoretic framework of intensional type-theory, G&S aim at a theory that assigns to each question μ a meaning $[\![\mu]\!]$ in accordance with the following desideratum: a question μ entails a question ν, denoted $\mu \models \nu$, if and only if $[\![\mu]\!] \subseteq [\![\nu]\!]$.

Desideratum 1. For any questions μ and ν: $\mu \models \nu \iff [\![\mu]\!] \subseteq [\![\nu]\!]$

Now, how exactly should we think of entailment among questions? G&S characterize this relation as follows: a question μ entails a question ν if every proposition giving an answer to μ also gives an answer to ν. In this paper, we will talk of *resolving* a question rather than *giving an answer*, since we will want to avoid relying on an underlying notion of an answer; however, we will construe this relation in the same way as G&S did: a proposition p resolves μ just in case μ is resolved whenever the information provided by p is available. Letting $\mathsf{Res}(\mu)$ denote the set of propositions/information states that resolve a question μ, the notion of question entailment can thus be characterized as follows.

(1) $$\begin{aligned} \mu \models \nu &\iff \forall p : p \in \mathsf{Res}(\mu) \text{ implies } p \in \mathsf{Res}(\nu) \\ &\iff \mathsf{Res}(\mu) \subseteq \mathsf{Res}(\nu) \end{aligned}$$

For an illustration of how Desideratum 1 constrains a semantics of questions, consider the sentences below: clearly, (2-a) entails (2-b): whenever we establish what Alice's phone number is, we also automatically establish whether or not her number ends with a 6. Thus, meeting Desideratum 1 requires assigning meanings to these sentences in such a way that $[\![(2\text{-a})]\!] \subseteq [\![(2\text{-b})]\!]$.

(2) a. What is Alice's phone number?
b. Does Alice's phone number end with a 6?

Besides entailment, the other general phenomenon that G&S consider is coordination by means of conjunction and disjunction. G&S write:

> Coordination, too, is to be found in all kinds of categories. Hence, the explanatory power of an analysis that deals with coordinations of expressions of some particular category is greatly enhanced if the account it gives is based on general semantic operations associated with the coordination processes. Again, the semantic framework defines these operations. If the framework is based on set theory, conjunction and disjunction of expressions in whatever category will have to be interpreted as intersection and union, respectively. (ibid., pp. 11-12)

Thus, G&S aim at a theory that interprets coordinated questions in accordance with the following desideratum, where conjunction and disjunction are denoted respectively by $\wedge$ and $\vee$.

Desideratum 2. For any questions μ and ν:

- $[\![\mu \wedge \nu]\!] = [\![\mu]\!] \cap [\![\nu]\!]$
- $[\![\mu \vee \nu]\!] = [\![\mu]\!] \cup [\![\nu]\!]$

In order to meet this desideratum, we need a notion of question meaning according to which we have, e.g., $[\![$(3-a)$]\!] = [\![$(3-c)$]\!] \cap [\![$(3-d)$]\!]$ and $[\![$(3-b)$]\!] = [\![$(3-c)$]\!] \cup [\![$(3-d)$]\!]$.[9]

(3) a. What is Alice's phone number, and what is her email address?
b. What is Alice's phone number, or what is her email address?
c. What is Alice's phone number?
d. What is Alice's email address?

Let me conclude this section by addressing one reasonable concern about G&S's desiderata: one might object to G&S's argument by rejecting the idea that using a semantic framework based on set-theory requires that entailment, conjunction, and disjunction be analyzed in terms of inclusion, intersection, and union. While this is a fair objection, the fact remains that an explanatory theory should be based on a general analysis of these notions. Thus, if one wishes to defend a theory of questions which requires us to depart from the standard notions provided by the type theoretic framework, the burden is on them to show that their non-standard

[9] Some authors (notably Szabolcsi, 1997, 2015; Krifka, 2001) have claimed that questions cannot be truly disjoined, and that the only reading available for a question like (3-b) is one where *or* is interpreted as a correction, so that a speaker uttering (3-b) is simply asking what Alice's email address is. Here I assume, with Groenendijk and Stokhof (1984, 1989), that (3-b) admits a non-corrective reading, where the question asks the addressee to specify either Alice's phone number, or her email address. For a more natural example, consider:

(i) Where can we rent a car, or who has one that we could borrow?

For a detailed discussion of this point, see Ciardelli *et al.* (2015a).

analysis can be derived from a general analysis of entailment and coordination which applies cross-categorically. As long as no such alternative is proposed and shown to be viable, G&S's desiderata retain their appeal.

3 Answer-set theories

Desiderata 1 and 2 are central to the argument that G&S make against the answer-set approach to questions. As discussed above, in answer-set theories, the meaning of a question μ is taken to be a set $\mathsf{BSA}(\mu)$ of propositions, and the propositions in this set are construed as *basic semantic answers* to the question, where the notion of a basic semantic answer is not further characterized in terms of more primitive notions.

Answer-set theories do not satisfy G&S's desiderata. To see this, consider again the questions (2-a) and (2-b), repeated below as (4-a) and (4-b), which exemplify the relation of entailment.

(4) a. What is Alice's phone number?
b. Does Alice's phone number end with a 6?

For x a sequence of digits, let p_x be the proposition that Alice's phone number is x: $p_x = \{w \mid \text{Alice's phone number in } w \text{ is } x\}$. Also, let q_6 be the proposition that Alice's phone number ends with a 6, and let $\overline{q_6}$ be the proposition that her phone number does not end with a 6. Setting aside details which are immaterial for our purposes, the interpretation of these questions in answer-set theories is as follows:

(5) a. $\mathsf{BSA}(\text{4-a}) = \{p_x \mid x \text{ a sequence of digits}\}$
b. $\mathsf{BSA}(\text{4-b}) = \{q_6, \overline{q_6}\}$

Clearly, $\mathsf{BSA}(\text{4-a}) \nsubseteq \mathsf{BSA}(\text{4-b})$. This shows that Desideratum 1 is not satisfied: on proposition-set theories, question entailment is not accounted for by the general type-theoretic notion of entailment as meaning inclusion.

Desideratum 2 is not satisfied either. To see this, consider again (3-a), repeated below as (6-a):

(6) a. What is Alice's phone number, and what is her email address?
b. What is Alice's phone number?
c. What is Alice's email address?

Proposition-set theories assign the following sets of basic semantic answers to (6-a) and (6-b), where r_x denotes the proposition that Alice's email address is a certain sequence of characters x.

(7) a. $\mathsf{BSA}(\text{6-b}) = \{p_x \mid x \text{ a sequence of digits}\}$
b. $\mathsf{BSA}(\text{6-c}) = \{r_x \mid x \text{ a sequence of characters}\}$

Under unproblematic assumptions on the space of possible worlds, no single proposition can be both of the form p_x and of the form r_y. Thus, the sets $\mathsf{BSA}(\text{6-b})$ and $\mathsf{BSA}(\text{6-c})$ are disjoint. If we were to interpret the conjunctive question (6-a) in accordance with Desideratum 2, we would get $\mathsf{BSA}(6\text{-a}) = \mathsf{BSA}(6\text{-b}) \cap \mathsf{BSA}(6\text{-c}) = \emptyset$. Clearly, this is not the result that we expect for a perfectly consistent question like (6-a). This shows that Desideratum 2 fails as well: on the basis of answer-set theories, the general type-theoretic treatment of conjunction in terms of intersection cannot be used to analyze conjunctive questions.

Thus, we conclude that answer-set theories fail to provide an account of question entailment and coordination based on the general type-theoretic notions of entailment and coordination. Absent an alternative general account of these phenomena, answer-set theories are thus unsatisfactory in terms of explanatory adequacy. In Section 7.1, we will set aside G&S's requirements and ask whether a satisfactory characterization of question entailment and coordination based on answer-set theories—even an *ad-hoc* one—is at all possible. We will see that such a characterization, while possible under certain assumptions, brings out some problems with the notion of meaning adopted in these theories (for discussion of these problems, see also Roelofsen, 2013; Ciardelli *et al.*, 2016). Since entailment and coordination are such fundamental notions—relevant not only to linguistics, but also to logic and cognition—I regard the difficulty in analyzing these notions as a serious shortcoming of the answer-set approach as a general foundation for the analysis of questions.

4 Partition theory

G&S take the observations made in the previous section to "clearly indicate that the [answer-set] framework simply assigns the wrong type of semantic object to interrogatives". They then go on to develop their own, rather different theory of questions. In this theory, the meaning of a question μ is not a set of propositions, but an equivalence relation $\equiv_\mu$ on the space of possible worlds. Given two worlds w and w', the relation $w \equiv_\mu w'$ holds if and only if the true complete answer to the question is the same in w and w'. The relation $\equiv_\mu$ induces a corresponding partition Π_μ of the logical space, with the elements of the partition being the equivalence classes of worlds modulo $\equiv_\mu$: these equivalence classes are then viewed as the possible complete answers to the question μ. A proposition p resolves the question μ if it entails one of these complete answers. So, given a question μ we have:

(8)
$$\begin{aligned} p \in \mathsf{Res}(\mu) &\iff p \subseteq a \text{ for some } a \in \Pi_\mu \\ &\iff \forall w, w' \in p:\ w \equiv_\mu w' \end{aligned}$$

Using this connection between the G&S meaning of a question and its resolution conditions, one can easily verify that in G&S's theory, question entailment is indeed captured as meaning inclusion, i.e., Desideratum 1 is met.[10]

[10]Recall that a binary relation is identical with the set of all pairs which are related by it. Thus, to say that the inclusion $\equiv_\mu \subseteq \equiv_\nu$ holds is just to say for any two worlds w and w', if $w \equiv_\mu w'$ then $w \equiv_\nu w'$. In terms of the associated partitions, $\equiv_\mu \subseteq \equiv_\nu$ means that the partition Π_μ is a refinement of the partition Π_ν, i.e., every block of Π_ν is a union of blocks from Π_μ.

(9) $\mu \models \nu \iff \equiv_\mu \subseteq \equiv_\nu$

For instance, consider again the pair consisting of the questions $\mu =$ (2-a) and $\nu =$ (2-b). If $w \equiv_\mu w'$, then the answer to μ must be the same in w as in w', i.e., Alice must have the same phone number in the two worlds. But then, w and w' must also agree on whether the last digit of Alice's number is 6. So, the answer to ν must be the same in the two worlds as well, which means that $w \equiv_\nu w'$. This shows that the inclusion $\equiv_\mu \subseteq \equiv_\nu$ holds, as it should according to Desideratum 1.

Now consider the questions $\mu =$ (3-c) and $\nu =$ (3-d), and the corresponding conjunctive question $\mu \wedge \nu =$ (3-a). For the complete answer to $\mu \wedge \nu$ to be the same in w and w', it is necessary and sufficient that both the answer to μ and the answer to ν be the same. Thus, we have:

(10) $w \equiv_{\mu\wedge\nu} w' \iff w \equiv_\mu w'$ and $w \equiv_\nu w'$

This shows that the relation $\equiv_{\mu\wedge\nu}$ associated with the conjunction coincides with the intersection $\equiv_\mu \cap \equiv_\nu$ of the relations associated with the conjuncts. Thus, Desideratum 2 is satisfied. It is easy to see that this holds not just for (3-a), but for conjunctive questions in general.[11]

A problem arises when we consider disjunctive questions such as (3-b). Desideratum 2 implies that the meaning of a disjunctive question should be obtained by taking the union of the meanings of the disjuncts. However, the union $\equiv_\mu \cup \equiv_\nu$ of two equivalence relations, unlike their intersection, is not in general an equivalence relation, and therefore it is not the kind of object that can serve as the meaning of a question in G&S's theory. Thus, Desideratum 2 is bound to fail for disjunction. In fact, as we will discuss in a moment, a disjunction like (3-b) simply cannot be assigned a suitable meaning in G&S's theory.

Setting aside disjunctions of questions for the moment, G&S's approach provides us with a theory of questions which is well-behaved and explanatory. In particular, question entailment and conjunction can be analyzed simply by applying to questions the general notions of entailment and conjunction made available by the framework of type theory. Furthermore, this result is obtained by working with objects that are formally simpler than the ones used in answer-set theories.[12]

However, the simplicity of G&S's semantic objects comes at a price: namely, G&S's theory is built on the assumption that the question μ under consideration has a unique true complete answer at each world. This assumption is presupposed when defining $\equiv_\mu$ as the relation that holds between two worlds when *the* true complete answer to μ in these worlds is the same, and it is reflected formally by the fact that the set of complete answers forms a partition of the logical space; this means that at each world, exactly one complete answer to the question is true. However, in the next section we will see that for several important classes

[11] A general argument can be given starting from the assumption that to resolve a conjunctive question is to resolve both conjuncts, using the fact that $w \equiv_\mu w' \iff \{w, w'\} \in \mathsf{Res}(\mu)$, which is a special case of the relation in (8).

[12] For G&S, the extension of a question at a world is a single proposition—the true complete answer to the question—rather than a set of propositions, as in answer-set theories.

of questions, this assumption fails. This point was forcefully made by Belnap (1982), who referred to the assumption underlying the partition theory as the *unique-answer fallacy.*

5 Non-partition questions

Let us say that a question μ is analyzable in the partition theory if there exists some equivalence relation $\equiv_\mu$ such that the resolution conditions for μ are given by $\equiv_\mu$ according to relation (8). In order to understand exactly which questions can be analyzed in partition semantics, let us look more closely at the notion of a complete answer. In terms of resolution conditions, we can characterize the complete answer to a question μ at a world w as a proposition a_w such that establishing a_w is necessary and sufficient in order to truthfully resolve μ at w.

(11) **Complete answer to a question at a world:** a proposition a_w is the complete answer to μ at w if (i) a_w is true at w and (ii) for all propositions p true at w:

$$p \in \mathsf{Res}(\mu) \iff p \subseteq a_w$$

It is easy to see that if the complete answer to μ at w exists, then it is uniquely determined. We will say that a question μ is a *partition question* if at every world w there exists a proposition a_w which is the complete answer to μ at w. We can show that the questions which are analyzable in the partition theory are exactly the partition questions.

Theorem 1. A question is analyzable in the partition theory if and only if it is a partition question.

A proof of this fact is given in the appendix. We will now discuss some important classes of questions which are not partition questions, and which, by what we have just seen, cannot be analyzed in the partition theory.

First, it may not be possible to truthfully resolve a question at a world. For instance, consider again our question (2-a), repeated below as (12). As soon as our logical space includes worlds where Alice does not have a phone number (say, because she has no phone) the question cannot have a complete answer at these worlds.

(12) What is Alice's phone number?

In other words, the partition theory in its simplest form cannot deal with questions whose presuppositions are not satisfied at some possible worlds in the logical space. However, this shortcoming can be fixed quite straightforwardly: it suffices to restrict the relation $\equiv_\mu$ to those worlds where the question can be truthfully resolved—i.e., to those worlds where the question's presuppositions are satisfied. The relation $\equiv_\mu$ will then be an equivalence relation defined over a subset of the logical space.

However, the partition theory cannot be patched up in a similar way to deal with questions that allow for various minimal resolving propositions that are all true at some world. The most important class of questions with this feature consists of so-called *mention-some* questions, such as the following ones.

(13) a. What is a common Russian name?
b. Where can I buy an Italian newspaper?
c. How can I get to the station from here?
d. What is an example of a continuous function?

In order to resolve (13-a) it is necessary and sufficient to establish of some x that x is a common Russian name. Clearly, at a world—say the actual world—there is no unique true proposition that resolves (13-a) in a minimal way. For instance, the propositions expressed by the following sentences are both true at the actual world, and both resolve (13-a) in a minimal way.

(14) a. Sergey is a common Russian name.
b. Anastasia is a common Russian name.

This means that at the actual world, there is no single proposition that counts as the complete answer to (13-a). This means that (13-a) is not a partition question, and therefore cannot be analyzed in the partition theory. Since mention-some questions are a broad and practically important class of questions, this is a heavy restriction that the partition approach faces.

Another class of non unique-answer questions consists of what we might call *approximate value questions*, which play a key role in empirical sciences. Consider the following toy example from Yablo (2014).

(15) How many stars are there in the Milky Way, give or take ten?

In order to resolve (15), it is necessary and sufficient to establish of some number n that the number of stars lies within the range $[n-10, n+10]$. Now let n_0 be the actual number of stars in the Milky Way: then the propositions expressed by the following sentences are both true at the actual world, and both resolve (15) in a minimal way, showing that (15) cannot be captured in the partition theory.

(16) a. There are n_0 stars in the Milky way, give or take 10.
b. There are n_0+1 stars in the Milky way, give or take 10.

Finally, a third class of non-unique answer questions consists of *choice questions.* An example of choice questions is given by the disjunctive question (3-b), repeated below as (17-a).

(17) a. What is Alice's phone number, or what is her email address?
b. What is Alice's phone number?
c. What is Alice's email address?

In order to resolve (17-a), it is necessary and sufficient to resolve either of the disjuncts, that is, to provide either Alice's phone number, or her email address. This means that in a world where the following sentences are both true, the corresponding propositions each resolve (17-a) in a minimal way, showing that (17-a) is not a partition question.

(18) a. Alice's phone number is 067854890.
b. Alice's email address is `alice@email.com`.

In general, disjoining two questions yields a question that can be resolved by choosing one disjunct and resolving that disjunct—whence the term *choice questions*. Similarly, choice questions can also be formed by means of indefinites. Belnap (1982) discusses examples such as the following.

(19) What are two of your friends called?

To resolve this question under the reading that Belnap is interested in, it is necessary and sufficient to provide the names of two friends. Again, it is easy to see that this is not a unique-answer question, since different choices of friends lead to different ways to truthfully and minimally resolve (19).[13]

Summing up, then, while the partition theory achieves an attractive and explanatory analysis of the workings of questions, it does so at the cost of significant restrictions to its empirical scope: important classes of questions, including mention-some questions, approximate value questions, and choice questions, cannot be analyzed in this approach.

6 Inquisitive semantics

As discussed briefly in the introduction, inquisitive semantics departs from the traditional accounts of questions that are centered around the notion of an answer. Instead, the meaning of a question is identified with its resolution conditions: one knows what a question means if one knows what information needs to be available for the question to be resolved. As we discussed, in the standard framework for intensional semantics, this means that we can identify the meaning $[\![\mu]\!]$ of a question with the set $\mathsf{Res}(\mu)$ of information states in which the question is resolved. Let us now see how this approach fares with respect to the two criteria we have discussed so far, namely, explanatory adequacy and generality.

Let us start with the former. Desideratum 1 requires that entailment among questions be accounted for as meaning inclusion. Now, question entailment was characterized as the relation $\mu \models \nu$ that holds when resolving μ implies resolving ν; as spelled out in (1) above, this amounts precisely to $\mathsf{Res}(\mu) \subseteq \mathsf{Res}(\nu)$. This means that Desideratum 1 is satisfied tautologically in inquisitive semantics: our understanding of entailment in

[13]Choice readings associated to indefinites are often hard to get, but they seem to be available, as illustrated by the following question-answer pair taken from Yahoo Answers (URL: https://answers.yahoo.com/question/index?qid=20090218164107AAhYDxt).

(i) a. Q: What is a person from London called?
b. A: I have a neighbor from London, he is called Rob.

The answer is a joke, but it only works as such because (i-a) is ambiguous between the intended generic reading and a less salient choice reading, which is addressed by (i-b).

terms of "inquisitive strength" transparently amounts to a characterization in terms of inclusion of inquisitive meanings. It is important to notice that, to obtain this result, we have not defined our own, *ad-hoc* notion of question entailment, which contrasts with alternative notions considered in the literature. Rather, we have worked with the same notion of entailment that has been assumed at least since G&S's work, and which stems from what seems to be the natural way to compare questions in terms of strength.

Now let us turn to Desideratum 2. Consider again our examples of coordinated questions, repeated below as (20-a) and (20-b).

(20) a. What is Alice's phone number, and what is her email address?
b. What is Alice's phone number, or what is her email address?
c. What is Alice's phone number?
d. What is Alice's email address?

Clearly, to resolve the conjunctive question (20-a) is to resolve both (20-c) and (20-d); similarly, to resolve the disjunctive question (20-b) is to resolve either (20-c) or (20-d). In fact, the resolution conditions of arbitrary conjunctive and disjunctive questions follows the same pattern, that is, we have:

(21) a. s resolves $\mu \wedge \nu \iff s$ resolves both μ and ν
b. s resolves $\mu \vee \nu \iff s$ resolves either μ or ν

But this simply means that for any two questions μ and ν we have:

(22) a. $\mathsf{Res}(\mu \wedge \nu) = \mathsf{Res}(\mu) \cap \mathsf{Res}(\nu)$
b. $\mathsf{Res}(\mu \vee \nu) = \mathsf{Res}(\mu) \cup \mathsf{Res}(\nu)$

This means that, if we equate the meaning of a sentence with its resolution conditions, Desideratum 2 is satisfied as well.

Summing up, then, the inquisitive approach fully meets G&S's theoretical desiderata: on the basis of this approach, the notions of question entailment, conjunction and disjunction can be analyzed in terms of the general notions of entailment, conjunction and disjunction provided by type theory. Thus, equating question meaning with resolution conditions yields a theory which provides a perspicuous and explanatory account of these fundamental notions.

As we have discussed in the previous section, the partition approach allows for a similar result, but only under the crucial assumption that questions have a unique complete answer at each world—an assumption which, we saw, limits the scope of the theory. By contrast, the inquisitive approach requires no such assumption: both partition questions and non-partition questions can be interpreted straightforwardly in terms of resolution conditions. For partition questions, the inquisitive treatment is essentially isomorphic to the one given by the partition theory. More explicitly, given any partition question μ, the equivalence relation $\equiv_\mu$ and the set $\mathsf{Res}(\mu)$ of resolving states are inter-derivable, by means of the following connections:

(23) a. $s \in \mathsf{Res}(\mu) \iff \forall w, w' \in s : w \equiv_\mu w'$
b. $w \equiv_\mu w' \iff \{w, w'\} \in \mathsf{Res}(\mu)$

For example, in inquisitive semantics, our questions (2-a) and (2-b) are analyzed as follows.

(24) a. What is Alice's phone number?
b. $\mathsf{Res}((24\text{-a})) = \{s \mid s \subseteq p_x \text{ for some } x\}$
where $p_x = \{w \mid \text{Alice's phone number in } w \text{ is } x\}$

(25) a. Does Alice's phone number end with a 6?
b. $\mathsf{Res}((2\text{-b})) = \{s \mid s \subseteq p_6 \text{ or } s \subseteq \overline{p_6}\}$
where $p_6 = \{w \mid \text{Alice's phone number in } w \text{ ends with a } 6\}$
and $\overline{p_6} = \{w \mid \text{Alice's phone number in } w \text{ does not end with a } 6\}$

At the same time, all the non-partition questions considered in the previous section, which were out of the scope of the partition theory, can be analyzed quite straightforwardly in inquisitive semantics.

(26) a. What is a common Russian name?
b. $\mathsf{Res}((26\text{-a})) = \{s \mid s \subseteq p_x \text{ for some } x\}$
where $p_x = \{w \mid x \text{ is a common Russian name in } w\}$

(27) a. How many stars are there in the Milky Way, give or take 10?
b. $\mathsf{Res}((27\text{-a})) = \{s \mid s \subseteq p_n \text{ for some natural number } n\}$
where, letting s_w denote the number of stars in the Milky Way in world w, $p_n = \{w \mid s_w \in [n - 10, n + 10]\}$

(28) a. What is Alice's phone number, or what is her email address?
b. $\mathsf{Res}((28\text{-a})) = \{s \mid s \subseteq p_x \text{ or } s \subseteq q_x \text{ for some } x\}$
where $p_x = \{w \mid \text{Alice's phone number in } w \text{ is } x\}$
and $q_x = \{w \mid \text{Alice's email address in } w \text{ is } x\}$

The only assumption needed for the inquisitive approach to work is that a question determines some well-defined resolution conditions.[14,15]

Thus, the inquisitive approach combines the merits of the partition theory of questions with those of answer-set theories: like the partition theory, but unlike answer-set theories, it provides an elegant and explana-

[14]As we mentioned in Footnote 1, this needs to be refined somewhat by taking into account the role of the context. The crucial assumption of the inquisitive approach will then be that, *relative to a given context*, a question determines some well-defined resolution conditions.

[15]In addition to this core assumption, here we are also working under the assumption that information states—the objects at which the resolution conditions of a question are assessed—are modeled as sets of possible worlds. This does limit the scope of the theory somewhat, making it impossible, e.g., to distinguish between different questions that are resolved by tautological information. However, I do not view this assumption as a part of the view I am advocating, but rather as pertaining to the intensional semantics framework within which all of the theories that we are discussing are formulated. The view that the meaning of a question is to be identified with its resolution conditions is compatible with other, more fine-grained representations of information states. Substituting the underlying notion of information state would not affect the features we discussed in this section: in particular, regardless of the way in which information states are modeled, the resulting theory of questions will still satisfy G&S desiderata, while not being restricted to unique-answer questions.

tory account of question entailment and coordination; at the same time, like answer-set theories, but unlike the partition theory, it is not restricted by the assumption that questions always have a unique complete answer at a given world.

7 Discussion

In this section, I consider how traditional theories of questions may address the problems identified above, and I discuss some possible concerns with the inquisitive approach. I consider first how question entailment and conjunction may be analyzed in answer-set theories, and show that this brings out some issues with the notion of basic semantic answers. Second, I look at how one may try to relax the partition theory to analyze non-partition questions, and show that this still falls short of a general theory of questions. Third, I discuss what I view as a misconception on inquisitive semantics, namely, the idea that inquisitive semantics is an answer-set theory which allows for over-informative answers. Finally, I point out some limitations of the inquisitive approach, which are parallel to corresponding limitations of the truth-conditional view on statements.

7.1 Trying to repair answer-set theories

In Section 3, we have identified a problem for answer-set theories: these theories cannot be combined with the general type-theoretic treatment of entailment and conjunction to yield an analysis of question entailment and question conjunction. It seems natural to ask, then, whether a different account of question entailment and coordination can be given based on answer-set theories, and if so, how natural and general this account is.

Let us first consider entailment. It is natural to think of question entailment in terms of answerhood as follows: μ entails ν in case any basic semantic answer to μ yields some corresponding basic semantic answer to ν. We can thus consider the following relation $\sqsubseteq$ between question meanings:

(29) $\mathsf{BSA}(\mu) \sqsubseteq \mathsf{BSA}(\nu) \iff \forall a \in \mathsf{BSA}(\mu)\, \exists b \in \mathsf{BSA}(\nu)$ such that $a \subseteq b$

Does this indeed characterize the same relation of question entailment that we have been concerned with in this paper? To answer the question, one should specify how the resolution conditions of a question are connected to its basic semantic answers. A natural assumption is the following: a question is resolved in an information state s if and only if at least one basic semantic answer to μ is established in s. In other words, establishing a basic semantic answer is both necessary and sufficient to resolve the question.[16] Formally, this amounts to the following:

[16]While this connection is very natural, it does not reflect the way that BSAs are construed in all answer-set theories. While Bennett (1979) and Belnap (1982) seem to take this view, Karttunen (1977) explicitly views BSAs as *not* sufficient, in general, to resolve the question. This discrepancy makes it even clearer that some kind of characterization of what is supposed to count as a BSA is needed in order to assess the predictions of these theories.

(30) $p \in \mathsf{Res}(\mu) \iff p \subseteq a$ for some $a \in \mathsf{BSA}(\mu)$

In the terminology of Ciardelli (2016a), this amounts to the assumption that the set $\mathsf{BSA}(\mu)$ be a *generator* for the set $\mathsf{Res}(\mu)$. On the basis of this assumption, one can indeed show that the relation $\sqsubseteq$ characterizes question entailment:

(31) $\mu \models \nu \iff \mathsf{BSA}(\mu) \sqsubseteq \mathsf{BSA}(\nu)$

Thus, the answer-set approach, in combination with some natural assumptions, does allow us to characterize the relation of entailment among questions, even though unlike in the partition approach and in the inquisitive approach, an *ad-hoc* treatment of entailment is needed.

However, this characterization brings out a puzzling feature of the answer-set approach, first discussed by Roelofsen (2013). Let us say that two questions μ and ν are *logically equivalent*, notation $\mu \equiv \nu$, if they entail each other. If two questions are logically equivalent, we would want them to be assigned the same meaning: after all, if μ asks for at least as much information as ν, and ν asks for at least as much information as ν, then μ and ν ask for exactly the same information. This is indeed so in the partition theory and in inquisitive semantics, but not on the answer-set approach. Suppose, e.g., that μ and ν are interpreted as follows by our theory: $\mathsf{BSA}(\mu) = \{a, b, c\}$ and $\mathsf{BSA}(\nu) = \{a, b\}$, where $c \subset b$. Then each BSA for μ is included in a BSA for ν and vice versa, so μ and ν are logically equivalent. Yet, μ and ν are assigned different meanings.

Is there a genuine difference between the meaning of μ and ν that the answer-set approach allows us to track? If so, one should be able to clearly characterize what this difference amounts to, in pre-theoretic terms. Presumably, then, the logic should also be made sensitive to whatever extra content is captured besides resolution conditions. However, a different diagnosis seems more plausible to me: that the answer-set approach draws spurious semantic distinctions; in the previous example, for instance, the sets $\{a, b, c\}$ and $\{a, b\}$ should not be regarded as two distinct meanings, but as two *representations* of one and the same meaning. Inquisitive semantics provides a way to make this idea fully precise: $\{a, b, c\}$ and $\{a, b\}$ generate exactly the same set of resolving information states, and it is this set that can be taken to be the common meaning expressed by our two equivalent questions μ and ν.

The mismatch we just pointed out is primarily a conceptual problem, involving our understanding of the relations between logic and semantics, and of the semantic representations delivered by the theory. However, this problem also has empirical repercussions, as discussed in detail in Ciardelli and Roelofsen (2017). Consider the following two questions:

(32) a. Does Alice live in Canada, in the US, or in California?
b. Does Alice live in Canada or in the US?

In a normal context, where it is presupposed that California is part of the US, (32-a) is an odd question. In the inquisitive approach, this has a simple explanation: (32-a) has the same meaning as (32-b), since the two questions are resolved in exactly the same information states. Thus, a speaker uttering (32-a) would be using a form that contains a redundant constituent, one which does not make any contribution to the meaning expressed. This sort of structural redundancy can be held responsible for the infelicity of our sentence (Katzir and Singh, 2013; Meyer, 2014). In standard answer-set approaches, however, (32-a) and (32-b) would be associated with different sets of basic semantic answers. Thus, the third disjunct in (32-a) would make a non-trivial contribution to the meaning of (32-a), and the explanation for the oddness of the question would be lost.[17]

Let us now consider conjunction. We saw in Section 3 that, in answer-set theories, conjunction cannot be analyzed in terms of intersection. Rather, in such a theory it is natural to analyze a conjunctive question $\mu \wedge \nu$ as having as basic semantic answers propositions that are themselves intersections of a BSA to μ with a BSA to ν:

(33) $\mathsf{BSA}(\mu \wedge \nu) = \{p \cap q \mid p \in \mathsf{BSA}(\nu) \text{ and } q \in \mathsf{BSA}(\mu)\}$

This operation has indeed been considered in some logics based on the answer-set approach (e.g., in Belnap and Steel, 1976). From the point of view of entailment, this clause defines a natural operation. Indeed, one can see that, under the assumption that establishing a BSA is a necessary and sufficient condition to resolve the question (i.e., under the assumption that (30) holds), for any two questions μ and ν we have:

- $\mu \wedge \nu \models \mu$
- $\mu \wedge \nu \models \nu$
- if $\lambda \models \mu$ and $\lambda \models \nu$, then $\lambda \models \mu \wedge \nu$

Thus, from the point of view of entailment, the operator $\wedge$ behaves as a greatest lower bound operator (*meet*), just as in classical logic.

However, as discussed in Ciardelli *et al.* (2016), the disconnect between logical equivalence and semantic equivalence has repercussions for conjunction as well.[18] For instance, we would expect that conjoining a question with itself is just a redundant operation, but this is not the case: if $\mathsf{BSA}(\mu) = \{a, b\}$, where a and b are not included in each other, then $\mathsf{BSA}(\mu \wedge \mu) = \{a, b, a \cap b\} \neq \mathsf{BSA}(\mu)$. Thus, with respect to the semantics, not only conjunction cannot be characterized as a meet operator, but it is not even idempotent.

Conceptually, this issue is connected with the fact that logical equivalence does not guarantee sameness of meaning. Indeed, the prediction is that μ and $\mu \wedge \mu$ are logically equivalent, yet they have different meanings, with the latter having an extra basic semantic answer. However, it is far

[17]In some cases, questions where one disjunct entails another are in fact felicitous (e.g., *Did Alice drink coffee, tea, or both?*). This is completely analogous to what happens in the realm of disjunctive statements (compare the felicity of *Alice drank either coffee, or tea, or both.*) An elegant explanation of the difference between the felicitous disjunctions and the infelicitous ones has been given by Chierchia *et al.* (2009). Inquisitive semantics allows us to extend this explanation to questions (see Ciardelli and Roelofsen, 2017).

[18]The crucial observation goes back to Ciardelli (2010), where it was mentioned as a problem for an answer-set style implementation of inquisitive semantics. A problem analogous to the one discussed here arises for recent versions of truth-maker semantics where truth-makers are taken to be *exact*, such as the system of Fine (2015).

from clear how we should understand this semantic distinction, and how we should convince ourselves that a real difference exists.

As for the problem with entailment, this issue with conjunction also has empirical repercussions: standardly, conjoining a sentence with itself is a redundant operation, and this can be taken to explain why sentences of the form $\varphi \wedge \varphi$ are generally perceived as odd, no matter whether they are statements or questions. However, the moment we accept that conjunction is not idempotent, this explanation is lost.

My conclusion is that the problems with answer-set theories go beyond those pointed out by G&S. Not only do these theories not enable us to analyze entailment and coordination by means of general notions which are applicable outside the domain of questions. Even an *ad-hoc* analysis of these notions, while possible, faces serious conceptual and empirical issues. These issues call for an elucidation of the fundamental notion on which these theories are built, the notion of *basic semantic answer*, and for an explanation of how differences in basic semantic answers are to be assessed.

7.2 Trying to repair the partition theory

Let us now consider how the partition theory may be amended to remove the restriction to partition questions. Suppose we want to preserve the essence of the partition approach, namely, the idea that a question expresses a binary relation on the logical space, but without relying on the restrictive assumption that questions always have a unique complete answer at each world. The natural way to go seems to be to characterize the relation $\sim_\mu$ expressed by a question μ as follows:

(34) $w \sim_\mu w' \iff w$ and w' share some complete answer to μ

Given this characterization, $\sim_\mu$ is still symmetric, but not reflexive (since the presupposition of μ may fail at w, in which case no complete answer to μ is true at w) nor transitive (since some answer w and w' may share a complete answer, and w' and w'' may share some different complete answer, while w and w'' do not share any complete answer). This is an approach to the semantics of questions that has been pursued in early versions of inquisitive semantics (Groenendijk, 2009; Mascarenhas, 2009).

By taking this approach, some generality is indeed gained. For instance, conditional questions like (35), which are out of the scope of the partition theory (unless extended with a dynamic component, as in Isaacs and Rawlins, 2008), can now be analyzed, as shown by Velissaratou (2000).

(35) If Alice comes to the party, will Bob come as well?

However, this approach turns out to have problems that the partition theory does not have: in particular, it does not allow us to properly characterize the resolution conditions of questions. The only reasonable candidate for a characterization of $\mathsf{Res}(\mu)$ in terms of $\sim_\mu$ seems to be the following:

(36) $s \in \mathsf{Res}(\mu) \iff \forall w, w' \in s : w \sim_\mu w'$

But this simply does not deliver the correct predictions. To see why, consider a mention-some question like (37).

(37) What is a color that Alice likes?

Suppose that w_1, w_2, w_3 are possible worlds where the situation is as follows:

- in w_1 Alice likes only green and red;
- in w_2 Alice likes only red and yellow;
- in w_2 Alice likes only green and yellow.

Clearly, any pair of worlds from $\{w_1, w_2, w_3\}$ shares some answer to the question (37). So, if $s = \{w_1, w_2, w_3\}$, the condition $\forall w, w' \in s : w \sim_\mu w'$ is satisfied. On the basis of (36) we would thus predict that our question (37) is resolved in s. But this is not the case: given the information that the actual world is one among w_1, w_2 and w_3, it does not follow of any specific color that Alice likes it, and so, (37) is unresolved in the state s.

In fact, the example can also be used to show that, regardless of the recipe we use to derive resolution conditions from $\sim_\mu$, the approach simply cannot deal in a satisfactory way with a mention-some question like (37). For suppose that our whole space of possible worlds is $W = \{w_1, w_2, w_3\}$. Then, the meaning of the question (37) is the total relation—the relation that holds between any two worlds in the set. This is the same as the meaning of a tautological question, such as (38):

(38) Does 2 equal 2?

Thus, in this model, the approach would assign exactly the same meaning to the tautological question (38) and to the non-tautological question (37), which requires non-trivial information to be resolved. This shows that this relation-based approach is too restricted to deal with mention-some questions like (37). And, in fact, the problem that we have just pointed out can be reproduced with other kinds of non-partition questions, including approximate value questions and choice questions.[19]

In conclusion, while some extra generality is gained by moving from partition relations to arbitrary symmetric relations, the resulting framework is still quite restricted in scope. In particular, the three important classes of questions that we have considered in Section 5 still remain out of reach. Thus, this attempt to extend the partition theory to a general theory of questions, while taking a step in the right direction, is essentially unsuccessful.[20]

[19]The problem we just illustrated was first pointed out in Ciardelli (2008), where it was also shown that the same problem arises if we replace binary relations with relations of any fixed arity (for dicussion of the argument, see also Ciardelli and Roelofsen, 2011; Groenendijk, 2011; Ciardelli *et al.*, 2015b; Ciardelli, 2016b). Interestingly, exactly the same formal problem was encountered in a very different area, related to Carnap's (1961) project to view properties as constructed out of a more primitive similarity relation; see Leitgeb (2007) for discussion.

[20]Groenendijk and Stokhof (1989) propose a different way to generalize their theory so as to deal with non-partition questions. They treat these questions as expressing objects of a more complex type than those expressed by partition questions. To retain a general account of question entailment and coordination, they provide a recipe for lifting a basic question

7.3 Resolution conditions and felicitous responses

Inquisitive semantics is sometimes erroneously characterized as a theory which belongs to the answer-set class, but assumes that anything that implies a basic semantic answer is itself a basic semantic answer. Coupled with the further assumption that statements expressing basic semantic answers should be felicitous in response to a question, this misunderstanding gives rise to claims that the inquisitive approach predicts the following to be a felicitous exchange.

(39) a. What is Alice's phone number?
     b. Alice loves risotto, and her phone number is 06389203.

This paper provides an opportunity to set this misunderstanding straight. Inquisitive semantics does not make any assumption about basic semantic answers; rather, it departs from the answer-set paradigm altogether, taking a different perspective, more similar to the standard truth-conditional approach to statements. As we saw, in inquisitive semantics a question is not interpreted indirectly, via its answers, but directly, by laying out what information needs to be available in order for the question to be resolved.

It is clear that, if the information described by the statement (39-b) is available in an information state, then the question in (39-a) is resolved in that information state, as well as in any information state that contains even more information. By itself, this does not yield any predictions about what counts as a felicitous response once (39-a) is asked in a conversation; for a statement to constitute a felicitous response to a question, being issue-resolving is neither a sufficient condition, nor a necessary one.

One might be tempted to think that, by laying out a set of semantic answers, the answer-set approach does provide a characterization of the felicitous responses to a given question. If so, this may be viewed as an advantage of this approach. But this is not the case: the felicity of a response depends on whether it is *relevant* to the question in the discourse, and this is simply not something that we can tell on the basis of semantics alone. For instance, in an ordinary context, (41-a,b) are felicitous replies to (40), while (41-c,d) are not; yet no account of questions dreams of pre-encoding this difference into the semantics of the question in (40).

(40) Is Alice home?

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meaning (an equivalence relation) to a question meaning in the higher type (a function from worlds to sets of sets of propositions). They then go on to stipulate that this lifting is to be used to repair type mismatches which occur when questions are compared or coordinated. Unfortunately, this proposal does not lead to a proper treatment of entailment, since one can show that the resulting notion of entailment is not even transitive. For instance, this approach correctly predicts that (i-a) entails (i-b) and that (i-b) entails (i-c), but it fails to predict that (i-a) entails (i-c).

(i) a. What is Alice's phone number and what is her email address?
    b. What is Alice's phone number?
    c. Does Alice's phone number end with a 6?

Thus, this proposal forfeits one of the most attractive features of partition semantics, namely, the elegant and uniform analysis of question entailment and coordination.

(41) a. Yes, she's preparing her class.
b. Yes, I just talked to her on the phone.
c. ??Yes, her brother is a chemist.
d. ??Yes, I've known her for years.

The upshot of this discussion is that on either the answer-set approach or the inquisitive approach, we cannot expect the contrast between felicitous and infelicitous responses to be directly captured by the semantics. And, in my view, we shouldn't, just like we do not expect to read off the truth-conditions of the statement (42) that (43-a), but not (43-b), is a felicitous response to (42) in a standard scenario.

(42) The bus was late again.

(43) a. You should get yourself a bike.
b. ??You should get yourself a dog.

7.4 Anaphora and discourse referents

For statements, the view of meaning as truth-conditions has proven extremely useful in many domains. Yet, there are also phenomena that call for a richer level of semantic representation. The most important case, in my view, is provided by anaphora. For instance, the following two sentences have the same truth-conditions.

(44) a. Some students are not here.
b. Not all students are here.

However, the two differ in their potential to license certain anaphoric expressions. The discourse in (45-a) is perfectly coherent, unlike the one in (45-b).

(45) a. Some students are not here. They are sick.
b. Not all students are here. ??They are sick.

Even though this is not a fatal argument against a purely truth-conditional view on meaning (see Stalnaker, 1998), the most perspicuous explanation of these data assumes a semantic difference between (44-a) and (44-b): the former sentence, unlike the latter, creates a *discourse referent*, which can later be referred to by means of the pronoun *they*. This is formalized in various versions of dynamic semantics, where the meaning of a sentence is identified not with its truth-conditions, but with its potential to bring about a change in a certain information structure (Kamp, 1981; Heim, 1982; Groenendijk and Stokhof, 1991)

With questions, we find a similar situation. Consider the following sentences, modeled after examples in Roelofsen and Farkas (2015).

(46) a. Are you married?
b. Are you unmarried?

Under any of the theories that we discussed so far, these questions are regarded as semantically equivalent. In particular, they are equivalent in inquisitive semantics, since both are resolved if and only if it is established that the addressee is married, or it is established that the addressee is not married. However, notice that an answer *yes* (or *no*) means something different in response to (46-a) than in response to (46-b).

(47)
a. Is Alice married? Yes. $\rightsquigarrow$ Alice is married.
b. Is Alice unmarried? Yes. $\rightsquigarrow$ Alice is unmarried.

While a pragmatic explanation of this fact is in principle possible, a semantic account of the contrast requires a more fine-grained representation of the semantics of the given questions than provided by resolution conditions (or by any of the theories that we discussed above). If we see resolution conditions as analogous to truth-conditions, this should not strike us as surprising: after all, what the particle *yes* is doing is to refer anaphorically to a certain proposition. Just like truth-conditions, then, resolution-conditions do not capture what discourse referents a sentence makes available for anaphoric reference.

A class of theories of questions that we have not discussed so far, the so-called *categorial theories* (Tichy, 1978; Hausser and Zaefferer, 1978; Scha, 1983), put the interpretation of answers in the context of questions at the center of attention, and provide an analysis of questions that immediately account for the contrast between (47-a) and (47-b). However, these theories have troubles in other respects. In particular, the analysis of question entailment and coordination is problematic on this view, since there is no uniform semantic type for questions. Moreover, these theories make it difficult to account for the contribution of questions embedded under verbs such as *know*, unless they are supplemented with some type-shifting device that retrieves, e.g., a partition-theory meaning for the question. This situation was already clear to Groenendijk and Stokhof (1984), who combined their partition theory with a categorial-style treatment of term answers.[21] Aloni and van Rooij (2002) made the idea more systematic, implementing it in the framework of dynamic semantics. It seems reasonable to expect that a similar approach can be developed replacing partition semantics with inquisitive semantics.

This does not mean that we should not, after all, analyze the meaning of a question in terms of resolution conditions. Just like truth-conditions, I believe that resolution conditions provide a level of semantic representation which is as fine-grained as needed to discern certain important notions, such as entailment, and to analyze many linguistic and cognitive phenomena. At the same time, the observations above indicate that to analyze other phenomena, in particular involving anaphora, a more fine-grained approach is needed.[22]

[21] A term answer is an answer consisting of a constituent rather than a full statement, like the answer *thirty-two* to the question *how old are you?*.

[22] For instance, see Roelofsen and Farkas (2015) for an account of the contrast shown in (47) formulated within a refinement of inquisitive semantics.

8 Conclusion

Inquisitive semantics provides an approach to questions that closely resembles the truth-conditional approach to statements. Questions are not analyzed indirectly, by reducing them to answers, but directly, in terms of a relation of satisfaction relative to certain states. The only difference with statements is that the relevant states are not states of affairs, but states of information, and that satisfaction does not amount to rendering the sentence true, but rather to rendering it resolved.[23]

The fundamental notions of question entailment and coordination are accounted for straightforwardly by applying the general type-theoretic treatment of entailment and coordination to questions. Thus, the approach has the explanatory value that Groenendijk and Stokhof (1984) demanded of a theory of questions—something which answer-set theories lack. Remarkably, this result is not achieved through some clever artifice; rather, given the inquisitive perspective, the technical characterization of the relevant notions directly corresponds to our pre-theoretical understanding of these notions. For instance, the technical fact that question conjunction is captured by intersection amounts to the intuitive fact that to resolve a conjunctive question is to resolve both conjuncts. Similarly, the technical fact that question entailment is captured by inclusion amounts to the intuitive fact that for a question to be stronger than another is to be more inquisitive, i.e., to ask for more information.

The fact that this approach allows us to get a firm grip on question entailment and coordination is clearly of great importance from the perspective of logic. And indeed, the development of inquisitive semantics has lead to the construction and investigation of a range of logics in which statements and questions interact (see Ciardelli, 2016b, for an overview).

In addition, unlike the partition theory, the approach is not restricted by any specific assumptions about questions, except for the assumption that a question (possibly in combination with a context) should determine certain well-defined resolution conditions. In particular, unlike partition semantics, the approach is applicable to questions which cannot be resolved in some worlds—because of a presupposition failure—as well as questions which can be resolved in multiple consistent ways—including important classes like mention-some questions, approximate value questions, and choice questions. This makes inquisitive semantics suitable as a foundation for a fully general theory of questions.

Overall, I hope to have convinced the reader that resolution conditions can and should play for questions the same fundamental role that truth-conditions have traditionally played in the analysis of statements.

[23]In fact, as mentioned in Footnote 7, in inquisitive semantics statements are interpreted relative to information states as well, and truth-conditions are obtained as a derived notion. This makes the analysis of statements and questions even more uniform than I am suggesting here.

Appendix

Proof of Theorem 1. Suppose μ is analyzable in the partition theory. This means that there is an equivalence relation $\equiv_\mu$ such that $p \in \mathsf{Res}(\mu) \iff \forall w, w' : w \equiv_\mu w'$. Let $[w]$ denote the equivalence class of world w, that is, $[w] = \{w' \in W \mid w \equiv_\mu w'\}$. It is easy to verify that for each $w \in W$, its equivalence class $[w]$ is the complete answer to μ at w.

Conversely, suppose μ is a partition question, i.e., suppose that for every w there is a proposition a_w which is the complete answer to w. Let $\equiv_\mu$ be the relation defined by setting $w \equiv_\mu w' \iff w' \in a_w$. We need to show two things: (i) $\equiv_\mu$ is an equivalence relation and (ii) the resolution conditions of μ are induced by $\equiv_\mu$ in accordance with relation (8).

- $\equiv_\mu$ is reflexive. By definition of complete answer, a_w is true at w, i.e., $w \in a_w$. Thus, $w \equiv_\mu w$.
- $\equiv_\mu$ is symmetric. Suppose $w \equiv_\mu w'$. This means that $w' \in a_w$. Since also $w \in a_w$, we have $\{w, w'\} \subseteq a_w$, which by definition of complete answer implies $\{w, w'\} \in \mathsf{Res}(\mu)$. Since $\{w, w'\}$ is true at w', again by definition of complete answer we have $\{w, w'\} \subseteq a_{w'}$, which implies $w \in a_{w'}$. By definition, this means that $w' \equiv_\mu w$.
- $\equiv_\mu$ is transitive. Suppose $w \equiv_\mu w'$ and $w' \equiv_\mu w''$. By definition, $w' \equiv_\mu w''$ means that $w'' \in a_{w'}$. By symmetry, from $w \equiv_\mu w'$ we obtain $w' \equiv_\mu w$, which means that $w \in a_{w'}$. Since we also know that $w' \in a_{w'}$, we have $\{w, w', w''\} \subseteq a_{w'}$. By definition of complete answer this implies $\{w, w', w''\} \in \mathsf{Res}(\mu)$. Since $\{w, w', w''\}$ is true at w, again by definition of complete answer we have $\{w, w', w''\} \subseteq a_w$. In particular, $w'' \in a_w$, which by definition means $w \equiv_\mu w''$.
- Suppose $p \in \mathsf{Res}(\mu)$ and take two elements $w, w' \in p$. By definition of complete answer, since p is true at w we must have $p \subseteq a_w$. So, we have $w' \in a_w$, which means $w \equiv_\mu w'$. So, $\forall w, w' \in p : w \equiv_\mu w'$.

  Conversely, suppose $\forall w, w' \in p : w \equiv_\mu w'$. If $p = \emptyset$, i.e., if p is the inconsistent proposition, then μ is trivially resolved in p. Otherwise, fix $w \in p$: for any $w' \in p$ we have $w \equiv_\mu w'$, which means $w' \in a_w$. Thus, $p \subseteq a_w$. Since p is true at w, by definition of complete answer it follows that $p \in \mathsf{Res}(\mu)$, as we wanted.

□

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