Resolving Questions

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1 Introduction

1.1 Four theses on interrogative semantics

(1) Why am I writing this paper?

(1) is a question which for the casual reader is currently, to a large extent, unresolved. I can offer various answers: some readers, who, say, have more than a passing acquaintance with me, will find a subset of these satisfactory as a means of resolving that question, for instance:

(2) I need a journal publication; I'm trying to get my theory established.

Others, for instance those who know little of the academic process, will need quite different information for instance:

(3) I am a junior researcher. In order to get a permanent job, we need to publish at least three papers a year...

Others yet, say my closest colleagues, will be satisfied only if supplied with yet different answers. For instance:

(4) I'm hoping it will be possible to provide an account for the complementation facts which does not entirely ignore the illocutionary domain, is psychologically plausible and computationally tractable ...

For each audience there would appear to be a class of answers that, taken as a whole, would be considered by that audience to resolve the question: after receiving this information they would affirm that

(5) I had indeed told them why I'm writing this paper.

and, equally, would feel confident to assert that

(6) a. We know why he's writing this paper.

b. The issue of why he's writing this paper is resolved.

If our interaction were part of a dialogue, one might expect that at this juncture a different topic would be taken up. On the other hand, if a given audience were not satisfied with my answers, they could very well react by saying:

(7) Sure, sure, you've provided us with all this information about why you're writing this paper, it may well be true, but frankly we still understand only to a limited extent why you're writing this paper.

There might very well be additional information for me to provide. Equally, I might really have provided all the information there is to provide; their dissatisfaction stems from it not having been demonstrated to them that this is the case.

Let us finally note that if at a further point in one of these hypothetical dialogues someone were inadvertantly to raise again the issue which my excursus concerning (1) resolved, say: 'But you need a journal publication', I could respond by stating

(8) Well, but why am I writing this paper?!

to which she would hopefully respond: 'true enough'.

In the preceding paragraphs, I have tried to illustrate a number of theses about interrogative semantics, which, in somewhat refined form, will be argued to form a fundamental set of desiderata for a semantics for interrogatives.

1. **Resolvedness/Unresolvedness of questions:** Interrogatives can be used to raise unresolved questions (Example (1)), but also to describe a state of affairs as being one in which the issue is resolved (Example (6b)).

2. **Describing resolved questions:** Interrogatives can be used to *describe* information that resolves a question (Examples (5), (6a)) or *reevoke* such information (Example (8).

3. **Interrogative-aboutness**: But also to describe information *about* the question which is either at best partially resolving or even possibly false. (Example (7)).

4. **The contextual parameters of resolvedness:** What information constitutes the resolution of an issue described in that context by a given interrogative int_0, e.g. when an audience will assent to the speaker saying 'So, I told you int_0' or 'You now understand int_0', is determined in part by contextual parameters such as the audience's epistemic state and interests. (Examples (2), (3), (4)).

1.2 Some previous semantics for Interrogatives

How well do existing semantics for interrogatives jibe with these theses? Consider, for concreteness, two highly influential and insightful accounts to have emerged in Montague Grammar: Karttunen 1977 and Groenendijk and Stokhof 1984, 1989, 1993.[1]

Ignoring *unresolvedness*, which these accounts do not set out to capture,[2] we can observe, very roughly, the following: the properties of being resolving information, in their terms 'exhaustive', is not distinguished from information *about* the question.[3] "Weak", non-resolving information is assumed to be solely of pragmatic origin. Exhaustiveness is assumed to be denotationally specified by an interrogative.

I illustrate these points in more detail.[4]

Both Karttunen and Groenendijk and Stokhof assume the following:

(9) (ExtExh) Answers conveyed by felicitous responses to queries are specified to carry as part of their *semantic* import an "extension—exhaustive" force.

Thus, for a wh-interrogative i_0, (ExtExh) stipulates that on any use of i_0, *the* answer specified is the maximal, true instantiation of the open sentence underlying i_0:

(10) a. Who is going to buy this product

b. Karttunen: denotation at $< w >$: λp [TRUE(p) $\wedge \exists y$ (p = GOING-TO-BUY-THIS-PRODUCT$< w >$(y))]

c. Groenendijk and Stokhof: denotation at $< w >$: the partition class of w from among the set of possible worlds relative to the following equivalence relation: 'world w_0 is equivalent to world v_0 if and only for each x whether the property GOING-TO-BUY-THIS-PRODUCT(w_0) holds of x is equivalent to whether the property GOING-TO-BUY-THIS-PRODUCT(v_0) holds of x. The denotation at w is, thus, the set of worlds, a possible worlds proposition, that determine the extension of the property equivalently. The intension of the interrogative is the partition of the set of possible worlds induced by this equivalence relation.

[1] The concentration on these two works and work they have spawned is not intended to denigrate a variety of other types of analyses, most prominently the semantic accounts of interrogatives as n-ary relations (e.g. Keenan and Hull 1973, Hausser 1983) for an insightful discussion of which see Groenendijk and Stokhof 1984. Given the debts of my account to Groenendijk and Stokhof's work, their debt to the relational tradition extends to me.

[2] This is not to say that they could not accommodate such a notion in principle.

[3] In what follows I use 'exhaustive' in a technical sense akin to Karttunen and Groenendijk and Stokhof's, whereas the sense of 'resolvedness' will initially be pretheoretic, to be fixed according to data that will be subsequently presented.

[4] In this discussion, as elsewhere, I am ignoring issues pertaining to tense.

As an illustration of this criterion, consider the following mini-dialogue:

(11) a. Q: Who is going to buy this product?

b. A_1: Various noveau riche types, presumably.

c. A_2: Let me tell you one thing: Jenny and Jimmy will.

By the proposed criterion an utterance of (11b) does not convey an answer, at least not directly, since as a quantified proposition it cannot be the exhaustive answer. Does (11c) convey an answer? Sometimes: *only if* Jenny and Jimmy are being asserted to exhaust the set of future buyers of the product.

Both predictions seem at odds with intuition. (11b) would, in many contexts, be adjudged a perfectly natural, direct, non-evasive response. In fact, in some contexts, for instance one where marketing people are considering potential advertising strategies, it would probably be adjudged more natural than an exhaustively intended reading of (11c). Similarly, it seems that (11c) could be uttered by a responder who would not wish to commit herself to anything stronger than its literal content, in particular not to its exhaustiveness.

Both Karttunen and Groenendijk and Stokhof are explicitly aware of these problems. There is one, fairly natural line of defence, namely that non-exhaustiveness is a consequence of the use of questions as objects of querying: 'what we do need, of course, is an account of the *pragmatic* (emphasis added-J.G.) fact that direct wh-questions can be used to solicit more or less complete answers depending on the particular question and the circumstances of use.' (Karttunen 1977, p. 7.) 'For every question, there is at an index only one proposition that counts as the true answer to that question at that index. This may seem at odds with the obvious fact that in actual speech situations there may be many different ways of providing the information a questioner asks...[In] Groenendijk and Stokhof 1984a we have shown how pragmatic notions of answerhood can be defined that explain why in actual speech situations there are, in principle, far more possibilities of answering a question than semantics suggests, if one only takes into account that question-answering relates to the information of the questioner.' (Groenendijk and Stokhof 1984, p. 270.) Groenendijk and Stokhof's claim, nonetheless, is that interpreting utterances such as those in (11) involves construing them as exhaustive.[5] They offer a detailed account of how to do this.

This defence, however, is problematic in light of data such as we have already seen. First, if we expect the semantics to be one that, to some extent at least, captures intuitions about which responses cohere appropriately with a query, then in the light of data such as (11), one can question whether *pragmatics* can save accounts that predict that *semantically* responses conveying extension-exhaustive answers are differentially favoured. However, one need not resort simply to argumentation over the appropriate division of labour. Non-veridical/exhaustive answers *do* figure semantically, not solely as contents of responses, as we saw above in (7) and see here:

(12) a. Q: Can you guess who Jill bumped into?
Bill: Several of our old friends perhaps?

b. Bill made a guess about who Jill bumped into.

c. Bill managed to guess who Jill bumped into.

(12b) can be used to disquote Bill's response regardless of whether it is veridical or exhaustive and contrasts in this respect with (12c), for which an exhaustiveness/resolvedness condition

[5] In fact, in that paper p. 274 they claim of examples similar to (11) ('who walk in the garden' 'whom did John kiss', 'which boy kissed which girl') that 'if someone who has to answer the question expressed by ('who walk in the garden'-J.G.) wants to express that, as far as his information goes, there may be others that walk besides John and Mary, he cannot do so by using the indicative sentence ('John and Mary walk in the garden.'-J.G.) (Neither by using the constituent answer ('John and Mary'-J.G.)) He has to indicate explicitly the non-exhaustiveness of his answer. Nonetheless, they later (p. 278) appear to weaken considerably the force of their claim concerning a semantic basis for exhaustiveness by allowing contextual factors to nullify exhaustiveness.

applies. In fact, *any quantified or non-exhaustive instantiated answer, veridical or not, can be disquoted by (12b).*

An additional problem is that two interrogatives might intuitively appear to have distinct meanings yet necessarily have identical exhaustive answers. In such cases both Karttunen's and Groenendijk and Stokhof's accounts predict synonymy.[6] Thus, consider

(13) a. Which bachelors (here) are bachelors?

b. Which males (here) are bachelors?

(13a) is a self-answering question which one would not expect agents to wonder about or ask. (13b), on the other hand, is contentful: bachelor-seeking persons, for instance, might be expected to wonder about it, though often not to know the answer to it. It, thus, seems to be the case that neither of the following pairs of sentences are synonymous:

(14) a. Jill told me/knew/discovered which bachelors (here) are bachelors. (Namely, all of them are.)

b. Jill told me/knew/discovered which males (here) are bachelors. (Namely, Mike, Bill and Ted.)

Groenendijk and Stokhof 1993 acknowledge this problem but suggest it can be overcome by better enunciating the topic/focus structure of constituent interrogatives.[7]

Note though that the problem does not merely consist in individuating the meanings from each other; in addition, what is required is an explanation of the *a priori* nature of (13a), a characteristic which the exhaustive answer it defines on any given occasion does not reveal.[8] This point, in essence that the exhaustive answer does not in general constitute *the* optimal or appropriate information about a question, is one whose force will become more evident subsequently.

Karttunen and Groenendijk and Stokhof must be credited for recognising the importance of a resolvedness/exhaustiveness condition for interrogative uses. However, the condition they provide is *fixed* by the semantics, e.g. information resolving wh-questions is fixed to be information determining the extension of the queried predicate. We have, however, seen initial indications above, ones that will be exemplified in some detail below, that such a condition is fixed only relative to certain contextually provided parameters.

Summarising for the moment: my claim is that both Karttunen and Groenendijk and Stokhof's accounts conflate the aboutness and resolvedness relations specified by an interrogative use. Moreover, they build into the semantics of an interrogative a notion of exhaustiveness that cannot accommodate the required contextual flexibility.

In addition to Karttunen and Groenendijk and Stokhof there have been accounts that accommodate weaker notions of answerhood and exhaustiveness (see e.g. Hamblin 1973 as construed by Lahiri 1991, Higginbotham and May 1981, Belnap 1982, Hintikka 1983/Berman 1991.). These accounts contain important insights, some of which figure in my own proposal. Nonetheless, my claim concerning such accounts, detailed in the body of the paper, is that, on the one hand, the semantic notion of answerhood they offer is not inclusive enough, and that, on the other hand, a notion of exhaustiveness is an important characteristic of interrogative content.

[6] I owe this observation to Stanley Peters.

[7] In fact, the problem can arise with accounts that don't restrict answerhood to exhaustive answers: an account such as Hamblin's discussed below, unless it allows for sortally illicit instantiations, cannot distinguish wh-questions whose instantiation sets are identical. For instance:

(15) a. Which males over there are bachelors?

b. Which humans over there are bachelors?

c. $\lambda p \exists y$ [Male-over-there(y) $\wedge$ p = IS-A(bachelor,y)]

d. $\lambda p \exists y$[HUMAN-over-there(y) $\wedge$ p = IS-A(bachelor,y)]

[8] I owe this point to Robin Cooper.

This is also the juncture to point out the existence of a theory which stresses the contextual indeterminacy of resolvedness: Boër and Lycan 1985 offer a detailed account of the semantics of the construction 'knowing who is P' in which such factors as audience knowledge and purpose are incorporated. Very roughly, their account is centered on a *syntactic*, 'mentalese' characterisation of what constitutes an important predicate for an agent relative to a given purpose. Given that issues of mental representation are not the focus of the current work, I do not provide a comparison of the framework they propose with my own in the current work.[9]

1.3 An Alternative theory

What the discussion above suggests is that two *distinct* notions, the class of answers *about* a question and the class of answers that *resolve* that question, need to be associated with each possible use of an interrogative sentence: the first is what underlies the range of felicitous responses to queries. Which members of this class jointly constitute the *resolution* of the question can be determined only relative to a context.

In the body of the paper, I develop a view of questions that accommodates this bifurcation using some ideas of situation theory.

A key idea of situation theory is that information can be broken down into discrete units called states-of-affairs (SOA's) which serve to describe *situations*, parts of the world that serve as contexts. It is assumed that the class of SOA's is partially ordered by informational subsumption, which imposes algebraic structure on the SOA's. Propositions are viewed as relational entities, $(s_0!\sigma_0)$, defined by associating pairs comprising a situation s_0 and a SOA σ_0. This association involves predication that σ_0 factually describes the situation s_0.[10] How can this view be expanded to include questions?

An agent engaged in inquiry can be viewed via the following metaphor: the agent possesses a stack of snapshots, some complete, others possessing certain blurred features, all of which putatively pertain to a situation s_0 she is attempting to characterize. Posing a question involves associating a (possibly) partially blurred snapshot i_0 with s_0. Responding involves finding a snapshot that fills in, in fine or coarse grain, the blurred features of i_0 and predicating that it actually depicts s_0. The question defined by associating i_0 with s_0, $(s_0?i_0)$, is *resolved* if the stack contains at a point accessible to the agent a genuine snapshot of s_0 that fills in the blurred features of i_0 with a grain size appropriate to the agent's current purposes. The notion of *aboutness* that naturally emerges from this metaphor is one based on informational subsumption, whereas *resolvedness* is closely related to factuality.

This view ties both resolved questions and true propositions to the existence of certain factual states-of-affairs. This leads to the expectation that various commonalities between questions and propositions emerge. In the paper I demonstrate the existence of a variety of phenomena that indicate that this expectation is indeed met. Moreover, these phenomena provide an explanation of the source of the resolvedness condition associated with interrogative uses.

Thus, I show that a class of interrogative complement predicates e.g. *know, discover* and *tell* (henceforth 'resolutives'), require their interrogative complement to be *resolved* whereas others, e.g. *ask, wonder* and *investigate* do not. I will point to a number of striking parallels in this regard with other 'propositional entity' expression types including declaratives, 'concealed-question' NPs and gerunds. For instance, certain declarative embedding predicates require their complement to be *true* ('factives'), whereas others do not.

I will show, building on insights due to Austin and Vendler that whether a predicate is resolutive or non-resolutive, factive or non-factive, correlates with the nature of the propositional entities that it can predicate of: for instance, there is a class of predicates that inherently require their arguments to be *propositional*, in other words to have *truth* or *falsity* predicable of them. This class contains such predicates as *believe, claim, assert, allege*, will therefore not be applicable to

[9] See Cooper and Ginzburg(In progress) for such a proposal and comparison.

[10] An alternative notation for propositions commonly found in the literature is $(s_0 \models \sigma_0)$. I eschew this latter notation because of the potential confusion with the predication that s_0 is factually described by σ_0, commonly notated as: $s_0 \models \sigma_0$.

questions, of which truth *cannot* be predicated. This is the explanation I will offer for data such as the following which is pervasively consistent across languages:

(16) a. # It is believed/claimed/alleged/true which leader left the party early.

b. # It is believed/claimed/alleged/true whether Bill arrived early.

The rest of the paper proceeds as follows: in section 2, I discuss the extent to which a semantics for interrogatives can provide a basis for characterising natural language queries and their response space. In section 3, I provide detailed empirical descriptions of the notions of information *about* and information that *resolves* a question. In particular, I attempt to pin down the contextual factors underlying resolvedness. I also show that the emergent notion of resolvedness can be naturally extended to a notion of *partial* resolvedness. This can be utilised to provide an alternative analysis of phenomena that are problematic for recently offered accounts of the quantificational variability effect (QVE), a phenomenon involving adverbial modification of interrogative clauses. In section 4, I suggest that the source of resolutivity and factivity conditions certain predicates impose on their complements can be traced to the nature of propositional entities such predicates are applicable to. Various inference patterns that distinguish resolutive predicates from other predicates of questions and factive predicates from other predicates of propositions are put forward. In section 5 I provide a situation theoretic account of the semantic properties of questions. In an appendix, I offer further discussion of the QVE, given that it has been claimed to require positing certain intrinsic ambiguities among interrogatives, contrary to the uniform interrogative semantics I develop. I attempt to defuse this challenge. In so doing, I compare my account of interrogative complementation to a number of recent proposals.

2 Queries and Responses

One of the main motivations for coming up with a semantics for interrogatives, presumably, is the expectation that this will yield some insights into the nature of natural language queries (NLQ's). In this section I attempt to provide an informal characterisation of NLQ's, in particular to work out the extent to which the response space to a given query can be predicted on the basis of the identity of its descriptive content, *the question asked.*

The basic view of natural language queries I propose is this: consider a context c_0 in which the information associated with a particular question q_0 is not salient. An agent poses a query as an attempt to elicit a response which makes some of this information public.[11] Posing the query

[11] Formulating the preparatory condition for queries thus, as lack of information in the context, is intended to avoid an overly *epistemic* view of this condition. In particular, the assumption that either the speaker or hearer need lack the requisite information. In fact, it is quite easy to come up with examples that show that, in principle, ignorance at any level of iterated belief between speaker or hearer allows for the posing of queries. For instance, consider (i):

(i) A: When I think of women politicians, I don't think I can name a single compassionate one: Indira Gandhi, Golda Meir,...
B: Well, but who's your role model?
A: Petra Kelly.
B: That proves my point, doesn't it?

A plausible scenario underlying (i) is one in which B knows who A's role model is, knows that she knows who her own role model is, and assumes that she is not aware that he knows who her role model is.

What this suggests is looking towards *common knowledge*, or rather the lack thereof, is a promising direction for the basic preparatory condition. Even such a condition is probably too strong to accommodate cases such as barber/customer or cocktail party pleasantries where queries can be posed despite both participants' mutually possessing the requisite information. This suggests the requisite condition might be usefully stated in terms of a notion like 'common ground' (Stalnaker 1978) or '(linguistic) scoreboard' (Lewis 1979), built up incrementally as any discourse unfolds by the participants.

This view of the preparatory condition underlying queries, then, favours a departure from various well known epistemically based proposals such as those of Åqvist, Hintikka or Searle to a more "assertoric" conception as proposed from quite different perspectives by Lewis and Lewis 1975 and Carlson 1983.

alters the context by restricting severely the range of felicitous follow-up acts, illocutionary or otherwise, to which I will refer as *felicitous responses*.

What distinguishes queries from mere requests for responses is the fact that queries provide a specification of the information that responses should convey. Hence, the class of felicitous responses can, to a first approximation, be characterised as follows: a felicitous response either conveys information *about* the question asked,[12] or *explicitly opts out* of conveying such information. This latter class of responses, henceforth *meta-responses*, are not influenced by the particular content of the query. That is, they are applicable as responses to any query. This criterion is illustrated in (17):

(17) a. Q: When is the train leaving?

a1. Jill: At 2:58, 17.333398 seconds, according to our caesium clock/ At 2:58/ In about an hour/In a short while.

a2. Jill provided information (whose accuracy I will not vouch for) about when the train is leaving.

b1. Jill: I haven't got a clue./ We should be informed of this quite soon./ Why do you ask?

b2. Jill responded to the question, but could/did not provide any information about when the train is leaving.

Thus, responses that do *not* convey answers, even *helpful* responses cannot be described as providing information *about* the question, even if they can be described as suggesting how to obtain information about the question. Conversely, responses that provide information that need not be useful or even factual can be described as being *about* the question as long as their subject matter is "appropriate".

The characterisation of felicitous responsehood is, of course, too coarse as it stands: not all responses conveying information *about* the question asked will be (equally) felicitous. Conversely, not all meta-responses are equally applicable to any query.

To some extent, this second problem can be dealt with satisfactorily by exploiting general features of coherence and context change that are quite independent of querying. Thus, the fact that queries that arise in a context where the responder has been demonstrated to know the answer cannot be opted out by means of utterances that indicate the contrary, exemplified in (18), can be explained by the principle 'Do not contradict yourself.' or some such:

(18) a. A: I'm very tired. B: Sorry, you're very WHAT?

b. A: # Good question.

c. A: Oh never mind.

The only refinement cases like this require us to make to the initial generalisation is that the class of meta-responses that is potentially usable at any given point in dialogue is dependent on the state of the dialogue at that juncture. This does not require us to assume that this class is determined by the particular question asked.

On the face of it, the same cannot be said of responses such as those in (19b,c), which *are* determined to some extent at least by the particular question asked:

(19) a. A: When are you leaving with him?

b. B: Why do you think I intend leaving at all?

This preparatory condition for queries mandates that the common ground be a context that permits a strengthening of the commonly believed answers. Unless this condition is met, there will be no rationale for posing the query. In other words, if the point of a query is incrementation of the common ground with information of a certain, prespecified kind, the preparatory condition follows as a condition against requests for *vacuous* incrementation.

[12] 'concerning', 'on', 'as–to', and 'regarding' are close synonyms of this sense of 'about'.

c. B: With whom?

However, such clarificatory queries are possible as follow up acts to a variety of speech acts:

(20) a. I've heard you're leaving with him.

b. Leave with him please.

Which such queries are felicitous at a given point in a dialogue should, in principle, be determined by general principles of context change (any use of a referring NP changes the context into one where a potential 'ref-query' can be posed etc.) This class of responses, then, need not be viewed as an intrinsic problem for our characterisation of meta-responses as not being determined by the particular question asked once we qualify this by taking into account the context changing effect any speech act has.[13]

There is, nonetheless, a third, more intrinsically problematic class of meta-responses; the problem they raise ties in with the other problem I noted for my characterisation of felicitous responsehood, the fact that not all responses conveying information about a given question are (equally) felicitous.

Responses can be felicitous despite not conveying information about the question asked by virtue of the fact that they directly fulfill the goal which precipitated them. In (21), if A poses his query simply because he wants to get on the train, B's response would be a natural one to make, even if the resulting dialogue appears to be somewhat "shortcircuited":

(21) a. A: When is the train leaving?

b. B: Follow this porter, he'll put you on it.

Thus, while it is true to say that B's response does not convey information about the question, we would equally not wish to characterise it as a response generally applicable to queries in anything like the sense applicable to (19) or (18).

The conclusion this should lead us to, not surprisingly, is that a characterisation of the class of felicitous responses to a given query must involve the goals that lead the querier to pose her query and what she knows, believes, assumes etc. However, this cannot be the whole story: the goals that can be associated with a given query are widely divergent, as I shall demonstrate below. Regardless, speakers possess reliable intuitions about a range of responses that can be offered even when they are not attuned to the specific circumstances of the query.

This apparent dilemma is eliminated once we make ourselves aware that for any query more than one perspective is available. In other words, we distinguish between (at least) two construals a query can give rise to, which I refer to respectively as the *querier's intended* construal and the *minimal responder's* construal. [14]

The querier asks the particular question that she asks because she believes that information about that question, coupled with what she knows and believes, how her mental state is configured in short, will fulfill the goal she has.[15] In these terms we can characterize the illocutionary force of a query of a question q_0, the force the speaker intends it to have, to be denoted as $\mathrm{QUE}_{speaker--intended}$, relative to a particular goal g_0 and mental state ms_0 which she has:

(22) a. Speaker's intended construal of Query:
$q = QUE_{speaker-intended}(g_0, ms_0, q_0, speaker_0, hearer_0, now_0)$

[13] For a semantics for such 'reprise' uses of interrogatives see Ginzburg 1992a.

[14] One can view these two construals as instances of a phenomenon noted by Kaplan 1977 as characteristic of linguistic expressions, and generalized in the situation theoretic literature to information bearing signals (see e.g. Perry and Israel 1989, Perry 1987). This is the distinction between *general* and *singular* content one can associate with a signal: the latter is obtained by fixing certain contextual parameters that remain quantified away in the former.

[15] I assume, for simplicity, the existence of a single such goal.

b. Paraphrase: I (speaker$_0$) request you (hearer$_0$) to provide a response that conveys information about q_0 that fulfills g_0 relative to my mental state ms_0

What goal-fulfillment amounts to in formal terms will become clearer in section 3, when I characterize resolvedness, and ultimately in section 5, where I formalize the account: the intuition to bear in mind is that goals establish lower bounds of factual semantic strength ('at least such and such state-of-affairs is now the case...'), whereas aboutness fixes what type of subject matter is to be provided.

The *minimal* sense a responder can make of the same query is, I suggest, that he is being asked to provide information about q_0:

(23) a. Minimal responder's construal of query:
$q = QUE_{min-responder}(q_0, speaker_0, hearer_0, now_0)$

b. Paraphrase: I (speaker$_0$) request you (hearer$_0$) to provide now$_0$ a response that conveys information about q_0.

This construal is what underlies his ability to intuit that a response "coheres" with the query regardless of the facts of the matter, of the speaker's goal, her mental state etc. Of course such intuitions and the "thought experiments" that elicit them are somewhat artificial since in practice a responder will either guess or try to ascertain *why* he is being asked what he's being asked, and what the querier knows or believes. But even if he does figure out the querier's goal and mental state, it will not always be the case that the responder can or will oblige by providing a goal-fulfilling response. In such a case, assuming he does not utter a meta-response, his remaining option, assuming he actually decides to respond to the query, is to provide weaker information about the question, though the weaker he goes, the less satisfied the querier will become.

What, then, of responses exemplified by (21)? In light of (22), such responses can be analysed as parasitic on the accepted/desired means of response: the coherence of dialogues of which they form constituents is somewhat disrupted, even though they are acceptable, given that they do the primary job a response is intended to do, that is, fulfill a goal.

Let us summarise for the moment: a querier asks a particular question in the hope of eliciting a response that conveys information about the question that, relative to her mental state, can fulfill her goal. A responder, minimally, construes a query as eliciting a response that conveys information about the question. The closer he comes to fulfilling the goal, the closer he will come to provide a response of the type desired by the querier. Thus, the range of responses that can broadly be described as felicitous is really best seen as combining two classes: the *goal-fulfilling* responses desired by the querier and the *grammatically appropriate* responses with which a responder demonstrates his competence as a responder. This is summarised in figure 1.

The remaining issue here is how to construe the phrase *r conveys information.* Hitherto I have considered solely cases where this could be identified with *the literal content of r is.* But this will not be sufficient in general. This is because many responses are crucially dependent for their felicity on the context, in the sense that the felicity is not a function solely of their content, literal or otherwise. These include elliptical responses of various kinds and indirect responses. In an example such as the following, it is the intention underlying the act of pointing, coupled with the prevailing contextual conditions that result in an an answer being conveyed:

(24) a. Q: Who is Jill's best friend?

b. Response: [responder points to **Mike**.] (Conveys:) 'Mike is Jill's best friend.'

Note that this act can, with certain caveats discussed below, be disquoted using the interrogative sentence:

(25) (With that gesture) Bill indicated to me who Jill's best friend was.

Indirect responses, similarly, cannot be adjudged felicitous independently of specific contextual conditions that prevail:

Given a query q = $\text{QUE}_{speaker-intended}(g_0, ms_0, q_0, speaker_0, hearer_0, now_0)$ in context u_0,
r is a felicitous response if and only if
Either:
r conveys information about q_0 that fulfills g_0 relative to ms_0 (grammatically appropriate, goal fulfilling)
Or:
r conveys information that fulfills g_0 relative to ms_0 (grammatically inappropriate, goal fulfilling)
Or:
r conveys information about q_0 that does not fulfill g_0 relative to ms_0 (grammatically appropriate, not goal fulfilling)
Or:
$r \in$ Meta-Responses(u_0) (the class of meta-responses felicitous in context u_0) (grammatically appropriate, not goal fulfilling)

Figure 1: The range of felicitous responses

(26) a. Who committed the crime?

b. Jill: Well, put it this way: Dan Quayle was out of town.

(26b) is a response that would not be adjudged felicitous on a context independent basis. A reasonable reaction to (26b) might be 'You must have misheard me: I didn't ask *who was out of town*, I asked *who committed the crime.*' However, if, for instance, it is known that only George Bush or Dan Quayle could possibly have committed the crime, then the response can be taken to *implicate* that Dan Quayle did not commit the crime, or perhaps even that George Bush was the culprit. Hence, (26b) can make for a felicitous query/response discourse which can be disquoted using the original interrogative sentence:

(27) Jill was finally willing to inform me, albeit somewhat indirectly, who committed the crime.

There would seem to be two, not necessarily complementary, moves to reconstruing *r conveys* in such a way as to accommodate such responses. One involves a resort to a notion of *speaker meaning* by means of which one can relate a responder and the intention underlying a communicative act to how an answer gets conveyed. Arguably, such a move is needed for quite independent reasons in any model of natural language dialogue. The second option involves a change in the underlying *logic*: logically characterising *about* in section 17, will *inter alia* presuppose a notion of consequence among the states-of-affairs. Weakening consequence in certain ways, e.g. in the direction of defeasibility, allows us to construe *r conveys information* as *the content of r defeasibly entails*.

3 Enriching Answerhood: information about v. information resolving a question

3.1 Aboutness and Resolvedness

I started the previous section by asking what contribution a semantics for interrogatives could make towards characterising natural language queries and their responses. The analysis sketched in that section is that felicitous responses come in two essential varieties: those that convey information *about* the question asked, and an assortment of 'meta-responses' such as clarification queries and opt outs. I have offered some tentative indications that this latter variety can be characterised from first principles of communicative interaction and context change: the querier asks the responder to supply her with something (a response of a particular kind), the responder has the option of explaining that he can't, won't, who can and so forth, or of trying to discover more precisely what it is that he is being asked to supply. This in turn might cause him to ask for the resolution of a pronoun that occurred in the interrogative just used or to inquire about the goal underlying the original query. The implication, then, is that a theory of what *questions* are will not contribute to a further understanding of meta-responses, important though they are in any understanding of how *queries* work. This is my justification for not providing any further discussion of such responses in the current work.

Insofar as query uses go, this leaves us minimally with the task of characterising the range of information that can be described as *information about* a given question. Ranges of aboutness for questions arising out of yes/no-interrogative uses and simple[16] uses of unary wh-interrogatives are described in figure 2.[17]

(28) a. Jill: Is Millie leaving tomorrow?
Bill: Possibly/It's unlikely/Yes/No.

b. Bill provided information about whether Millie is leaving tomorrow. (We have no indication whether this information is reliable.)

(29) For a yes/no question q_0 (= 'whether p'), the range of information *about* q_0 includes all propositions 'mod p', where *mod* is a propositional modality.

For unary wh-interrogatives:

(30) a. Jill: Who is coming tonight?
Bill: Millie and Chuck/Several friends of mine./Few people I've heard of.

b. Bill provided information about who was coming that night. (We have no indication whether this information is reliable.)

(31) For a unary wh-question r_0 (= $q(x)$) the range of information *about* r_0 includes includes all instantiations $q(c)$ and quantifications $Quant(N, q(x))$

Figure 2: aboutness ranges of yes/no and unary wh-questions

As (28b) and (30b) illustrate, the fact that information σ_0 is *about* a question entails nothing about σ_0's factuality or semantic strength. Thus, merely providing a theory of aboutness leaves us a significant distance away from being able to predict which responses about a question are differentially favoured for a particular asking of that question. Reiterating what I stated in the previous section, what would be optimal from the querier's point of view is to elicit information that is not only about the question but, coupled with her mental state, can fulfill her goal. Now an analysis of goal fulfillment, while obviously important for the pragmatics of querying might seem outside the province of a semantic analysis of interrogatives. What I will attempt to demonstrate in this section is that the issue of when information counts as *resolving* a question is required in order to adequately characterise the *truth conditions* of certain classes of embedded interrogatives and that this notion of resolvedness is related to the notion of goal fulfillment. More specifically, resolvedness is a *relative* notion—whether information resolves a question is relative

[16] 'simple' in the sense that functional/pair-list/reprise uses are ignored.

[17] The ranges described in this figure should probably be viewed as base cases, since, for instance, if p constitutes information about q_0, it would appear that (p, if r) does too:
(i) A: Will Mary come? B: She probably will, if it isn't raining.
I owe this point to David Milward.

to a *goal* and a *mental state*, and the world, since the information must be factual.[18] In this regard resolvedness contrasts with aboutness, *aboutness* is absolute—a given question determines on its own the information that is about it. Thus, our judgements that (28a) and (30a) can be disquoted by (28b) and (30b) respectively can be made without attunement to various contextual factors or knowledge of the relevant facts.

My claim about the nature of resolvedness is controversial in that it will imply, for instance, that determining whether the inference patterns in (32) and (33) are correct or not cannot be ascertained without, roughly, establishing what goal and what available informational means are salient in the context:

(32) Bill told Mike who works in the institute.
Millie works in the institute.
Hence, Bill told Mike that Millie works in the institute.

(33) Bill told Mike that Jill and Millie work in the institute.
In fact, Jill and Millie do work in the institute. No one else does.
Hence, Bill told Mike who works in the institute.

A similar perspective, formulated in somewhat different terms, is one emphasised and exemplified in detail by Boër and Lycan 1985 in their insightful account of 'knowing who is P'. In contrast, a number of accounts, Karttunen 1977 and Groenendijk and Stokhof 1984, 1993 among them, assume the validity of such inference patterns. They identify the *meaning* of such an interrogative with (an entity determining) the exhaustive answer, the content of Bill's claim in (33); equivalently, the strongest proposition that could (putatively) play the role the intermediate assumption plays in the argument in (32).

If my claim is correct, however, then factors extrinsic to a given interrogative denotation go into determining whether that interrogative can be used to disquote. After attempting to establish the claim, I will move to examine how the contextual parameters I have isolated can be used to characterise what information counts as *potentially* resolving a given question. The emergent relation will turn out to be somewhat more restrictive than *aboutness*, though it will still require a richer relation than the notions of answerhood entertained in most past accounts.

3.2 Goals

It is a familiar point that information disquoted by certain interrogative complement predicates is restricted to be true and complete in some sense. Let us call such information *resolving information.*

Consider first examples (34) and (35). They illustrate, respectively, how a particular proposition serves as resolving information in the one context, but no longer does so in the other context:

(34) a. [Context: Jill about to step off plane in Helsinki.]
Flight attendant: Do you know where you are?
Jill: Helsinki.

b. Flight attendant: Ah ok. Jill knows where she is.

[18] Although I will offer an analysis of the role these parameters play in determining resolvedness, scant attention is paid here to integrating the account in a more general framework of mental representation. This issue is taken up in Cooper and Ginzburg (In progress).

(35) a. [Context: (Based on a scene from Jim Jarmusch's 'Night on Earth'; quoted without permission of MGM.) Jill about to step out of taxi in Helsinki.]

Driver: Do you know where you are?

Jill: Helsinki.

b. Driver: Oh dear. Jill doesn't (really) know where she is.

It seems that in each of the contexts above the flight attendant and taxi-driver can truthfully make the statements in (34b) and (35b) respectively. Assuming Jill's knowledge state remains constant across the two contexts, this means that a single proposition 'Jill is in Helsinki.' can provide grounds for asserting two contradictory statements with regards to Jill's knowing where she is.[19] This is incompatible with any account in which resolvedness is a *property* of propositions, as exhaustiveness is taken to be, and indicates that additional parameters must be involved.

This particular case highlights the fact that the causal role which the interrogatively disquoted information is to play, its underlying *goal*, is a parameter of resolvedness: in the former case the information has no role beyond confirming that Jill has arrived at the right destination; in the latter case the information would not in and of itself be sufficient to enable Jill to proceed to any one destination in the city.

The implication would appear to be the following: we cannot in general assume that each question is associated once and for all with a *fixed* propositional condition that constitutes a lower bound of resolvedness, for instance the exhaustive answer defined by the question. Instead, this lower bound should be seen as floating, fixed in particular context to a level identified by the goal.

Such vagueness in the resolvedness conditions is one that is particularly evident in questions for which the underlying answer-domain is mass-like: 'where-questions' can involve finer and finer subdivisions (universe, continent, country, town, neighbourhood and so forth.) and which is the appropriate level of grain can only be decided relative to the underlying goal. Similar remarks apply *mutatis mutandis* to 'when-questions'. The vagueness of the resolvedness conditions of 'why-questions', e.g. (1), is probably even more pronounced, in part at least because of multiplicity of factors that can be viewed as *causes* of a particular eventuality.

As a simplifying assumption, I restrict my attention to goals that can be described either by propositions or by questions. For instance:

(36) a. A: I'd like to know where Jill lives nowadays.

B: Why do you ask?

b. A: I need *to find her house this afternoon.*

c. A: Oh. I'm curious *what city she's chosen to live in.*

Furthermore, I assume that once a goal is provided, the lower bound of resolvedness *is* fixed. Concretely, this assumption amounts to the following:[20]

(37) a. When a goal is described by a proposition p, then p constitutes the lower bound for resolvedness.

b. When a goal is described by a question q, then the exhaustive answer defined by q constitutes the lower bound for resolvedness.

Notice, then, that this assumption means that a question q_0 still has what one might call a 'default' goal associated with it, namely the exhaustive answer it determines. I am, nonetheless,

[19] See below for discussion of the role the optional hedge *really* plays in such statements.

[20] The first case here, where the goal is described by a proposition, corresponds to the assumption concerning the modelling of goals within a body of work in the AI community. Cohen and Levesque 1990, for instance, model an agent's goal by means of (possible worlds) propositions; informally, those worlds in which the goal desired by the agent is fulfilled.

assuming that it can also be the case that goals distinct from the exhaustive answer get associated with uses of q_0.

Within these terms the contrast displayed in examples (34) and 35) above could be reduced to the following: whereas the underlying goal associated with Jill in the setup of example (34) might be described by (the content of a use of) 'What destination has Jill arrived at', the goal in (35) might be described as (the content of a use of) 'In what neighbourhood is Jill.' Then, the proposition p_1 = 'Jill is in Helsinki' entails the exhaustive answer to 'What destination has Jill arrived at'. However, p_1 does *not* entail the exhaustive answer to 'In what neighbourhood is Jill.'

3.3 Epistemic States

The data examined in the previous section motivated one refinement the traditional notion of *exhaustiveness*: instead of assuming the lower bound of information constituting a "complete answer" to be determined by the question, we relativise it to a level determined by a contextually provided goal. I now suggest that the relevant notion of *informational consequence* needs to be agent relative.

Consider (38):[21]

(38) a. [Querier asks the question at 11:10.] Q: How do I get from London to Oxford?

A: Take the 11:24 from Paddington.

b. (Querier, Jane, is knowledgable about London trains) Jane: I asked a stranger how I should get from London to Oxford, and without batting an eyelid he told me.

c. (Querier, Ileana, is a foreigner) Ileana: I asked a stranger how I should get from London to Oxford, and he provided me only with a vague indication.

Assume for concreteness that the goal associated with both agents can be described by each agent as 'I possess information enabling me to get to Oxford from my current destination within two hours of asking.' Once again, it would seem that both agents are justified in their contradictory claims: the informational update caused by the proposition 'Taking the 11:24 (train) from Paddington is a way of getting from London to Oxford.' can count as 'telling how one can get from London to Oxford' for an agent with sufficient background knowledge. Equally, for an agent lacking appropriate background knowledge, a foreigner say, the update caused by this same proposition will not count as 'telling how one can get from London to Oxford.'[22]

One natural diagnosis of the problem here is, as hinted above, relativisation of informational consequence to particular agents. Specifically, (39b) rather than (39a) could be taken to be a necessary condition for resolvedness:

(39) a. p_1 entails the goal-condition.

b. p_1 entails the goal-condition, relative to the resources available to mental-state ms_0.

3.4 Combining goals and epistemic states

In the examples considered above, I have attempted to illustrate that certain contextual parameters point to the need for a richer notion than that provided by *exhaustiveness*. Let us now note that, in fact, once we attend to such contextual factors, it is possible to uncover contexts in which an exhaustive answer to a wh-question, that is, information providing the positive extension of the predicate, does *not* count as a resolving answer.

Consider (40):

[21] A variant of the sentence in (38) was originally used by Hintikka to argue that certain embedded questions do not carry an exhaustive force.

[22] Of course, in a different context, one where the goal is distinct, Ileana would not react as she does here: if Ileana is asking the same question at a party in Budapest, she might be quite content with such information since she can supplement it close to the time of execution by checking in a guide-book.

(40) a. Q: Who currently works in this institute?
Jill: (Provides list of names)

b. [Querier is a researcher in the field covered by the institute.] I asked Jill who works in this institute, and she told me.

c. [Querier is a high ranking EC politician.] A tour was conducted for me in an institute. I asked the director who worked there. She didn't really tell me. All she did was recite a list of names, none of which meant much to me.

Assume the proposition Jill communicates, p_0, is indeed the exhaustive answer determined by the question. Given a politician's usual interests ('Should I give some money to this institute') and his presumed ignorance of the field in question, e.g. what properties the practitioners of the field possess, he seems quite justified in his report of the dialogue, even when, for instance, the band of researchers is standing to attention at the entrance to the institute. (Of course, had the politician asked his question with the purpose of physically identifying institute workers, he would not react in this way, but rather, *would* accept p_0 as a resolving answer.) The politician's refusal to accept p_0 as constituting 'telling who works in the institute' (or as providing him with the justification to say he knows who works in the institute.) is due to the fact that he is not *relevantly* connected to the referents that are constituents of the singular proposition that is p_0.

One might try and explain away (40) by appealing to a kind/individual ambiguity in the wh-phrase 'who'. On this line, the politician was using 'who' in the kind sense, whereas the researcher was using the individual sense. It seems much harder to explain away the following variant example using the same tack.

(41) a. Q: Who currently works in this institute?

b. [Querier is the high ranking EC politician.] Jill: A number of linguists and psychologists.

c. [Querier is the researcher in the field covered by the institute.] Jill: A number of cognitive phoneticians and Willshaw-net experts.

d. I asked the director who worked there at present and she told me.

e. I asked the director who worked there at present, but no, she didn't really tell me.

The responses provided in (41), neither of which intrinsically convey instantiations, are tailor–made for each querier; both queriers would appear to be justified in report the exchange by using (41d). If the responses are permuted, however, then given their differing knowledge states and purposes, we would no longer expect either querier to be satisfied enough to use (41d). Instead, we might find (41e) being used as the report.

Similar examples can be constructed with 'which phrases':

(42) Jill: Which exits lead to your place?
Bill: All exits adjoining the Mass Pike after crossing the bridge.

Thus, Phil, sitting anxiously by Jill's side as she drives along, might ask her:

(43) Do you remember which exits lead to Bill's place?

To which she responds:

(44) Sure I do. All the ones adjoining the Mass Pike after crossing the bridge.

Jill takes some random exit, say, the Andover exit, but not the Worcester exit. But apparently we can say:

(45) Jill remembers/knows which exits lead to Bill's place though she doesn't know/remember that the Worcester exit does.

And while this latter statement might not be clear cut in establishing the point, given equivocation about tacit knowledge/memory,[23] it seems far less controversial to say that:

(46) Bill told Jill which exits lead to his place though he didn't tell her that the Worcester exit does or the Andover or....

In claiming that the purposes underlying the exchange come into evaluating whether information is resolving, I am not, of course, assuming that this parameter is always explicitly recognized or fixed to a specific level. Disagreements can arise requiring negotiation between the interlocuters:

(47) A: I asked Bill who works in this institute, and so he told me. So now I know.

B: What did he tell you?

A: What he said basically was linguists, psychologists and philosophers, mainly with a Deconstructionist bent. A couple of students of Lacan. Well funded.

B: Oh but did he tell you in detail about each person who is there, their publication record, that kind of stuff.

A: No, we didn't go into that level of detail.

B: Ah ok, so you don't really know who works there, you know only in a rough kind of way.

3.5 Potential Resolvedness

In the previous sections, I have provided evidence for the importance of an intrinsically *relative* notion of *resolvedness*: information *resolves* a given question relative to a goal and a mental-state. That is, a given question defines a class of propositions which can each *potentially* be resolving: a subset of those true propositions that are about the question. Whether a given member of this class, p, is actually a resolving answer *in a given context* depends on two additional factors: the goal g_0, which determines a lower bound for p, and the mental state, ms_0, which determines the resources relative to which p has g_0 as a consequence:

(48) I_0 is information resolving q_0 relative to a goal condition g_0 and mental state ms_0 if and only if I_0 is factual, is informationally stronger than g_0 relative to the informational resources of ms_0, and is about q_0.

In fact, (48) requires a slight refinement, one that illustrates a difference between the notions of *goal fulfilling* and *resolving* information. Thus, in (49) Bill's second response is perfectly felicitous in that it fulfills Jill's goal and is about the question. Nonetheless, it does not appear to constitute *fully* resolving information, hence cannot be disquoted under *tell* or *explain*. It does constitute partially resolving information and hence can be disquoted by (49d,e):

(49) a. Jill: Who is coming tonight?

Bill: Why do you ask?

Jill: Well after the last party and my antics there I'm anxious.

Bill: Oh well, no cause for worry: few people who saw you at the last party.

b. # Following Bill's response, the issue of who was coming that night was resolved.

c. (as report of the dialogue): # Bill told/explained-to Jill who was coming that night.

[23] Someone might object that in the above case Jill *does* tacitly know that the Worcester exit leads to Bill's place.

d. Bill's response indicated to some extent who was coming that night.

e. Bill explained to Jill only to a limited extent who was coming that night.

Given the data we have seen above (see e.g. examples 34, 38, 41, 42) I assume that:[24]

(50) For for a unary wh-interrogative $q(x)$ the range of *potentially resolving* information is constituted by all information that entails instantiations $q(c)$ and quantifications $Quant(N, q(x))$, where $Quant$ is either a monotone increasing quantificational force, or the pure negative existential ('No one'/'Nothing').

A similar point applies to yes/no interrogatives: in (51) Bill's response is goal fulfilling and about the question but does not appear to constitute *fully* resolving information:

(51) a. Jill: If there's a likelihood that Millie will come, I'll bake a cake. Could you tell me: is Millie coming tomorrow?

Bill: She's not overworked, so I'd say it is quite possible.

b. # Following Bill's response, the issue of whether Millie would be coming the following day was resolved.

c. (as report of the dialogue): # Bill told Jill whether Millie would be coming tomorrow.

d. Bill's response indicated to a certain extent whether Millie would be coming tomorrow.

[24] It is commonly assumed that wh-interrogatives *presuppose* the existence of an instantiator. I believe that this "presupposition" is a (generalized) conversational implicature: negative universal quantifications do constitute information about a given unary wh-interrogative. Hence, they belong in the range of conveyable answers. Arguably, such quantifications constitute potentially resolving information.

Thus, in most circumstances when I ask my apartment-mate

(i) What should I buy at the store?

it is quite clear that I am moved to pose this query by a belief that

(ii) There exists something that I should buy at the store.

Nonetheless, it is possible to explicitly cancel the suspected presupposition without resulting infelicity:

(iii) What, if anything, should I buy at the store?

(iii) can be uttered felicitously. In contrast to (i), uttering (iii) does not obviously suggest that the querier believes (ii). If my friend responds with (iv), we would not hesitate to report that as (v):

(iv) Jill: Oh, nothing.

(v) Jill provided information about what I should buy at the store (namely, nothing.)

In fact, after further reflection it is possible to discover sentences the utterance of which under natural circumstances, even without explicit cancellation, does not seem to involve a belief of the type exemplified by (i):

(vi) Who is in favour of amending the Bill of Rights?

The Speaker of the House can felicitously utter the sentence in (vi) before a vote without a necessity that he *believe* (or think anyone else believes) that anyone supports amending the Bill.

(vii) What did you have for dinner last night?

This last sentence tends to suggest the existential assumption, though is clearly usable by a worried parent addressing an overworked son or daughter.

The fact that the subject matter of the question seems to influence the strength of the association of the implication is suggestive of its status as a conversational implicature. Further suggestive evidence comes from calculability, though as with any Gricean explanation, this feature must be taken with a grain of salt in the absence of a formal pragmatic calculus. An addressee might reason as follows: 'Why did the speaker use (vi) when the neutral 'Is anyone in favour of amending the Bill of Rights.?' could have been used? The speaker must have had grounds for using a form in which the role of 'person in favour of amending the bill of rights' is highlighted. Hence, he must have grounds for believing that, indeed, there must exist instantiators of this role.' etc.

Whether such quantifications constitute potentially resolving information is not entirely clear cut, though the data seems to tend towards an affirmative answer. Assume a certain issue is under debate, say the issue of who has worked on the problem, and Joanna is the local know-all. I am referred to her:

(viii) Joanna must know who has worked on the problem.

If Joanna reveals to me that no one has, in fact, worked on the problem, I would not be tempted to accuse the person who uttered (viii) of having uttered a false statement or even of having been misleading. It would be quite misleading of me, nonetheless, to utter (xi) at such a juncture. (x) is felicitous though witty; it seems a reasonable expectation that we can explain this wittiness as arising from the effects of defeased expectation rather than from blatantly violating a semantic felicity condition, but I will not try to resolve this here.

(xi) Yeah, so she told me who has worked on this problem and so I now know.

(x) I can now reveal to you who has worked on this problem, to wit no one.

Consequently, I assume that:

(52) for a yes/no interrogative 'whether p' the range of *potentially resolving* information is constituted by all information that entails one of the polar options p or $\neg p$.

In section 5 I will show how most of the empirical generalisations concerning aboutness posited in (29) and (31) as well as those concerning potential resolvedness in (50), (52) can be uniformly characterised within an algebraic framework of informational items.

3.6 Excursus on partial resolvedness and the QVE

The discussion in the previous subsection has implicitly indicated what the notion of *partial* resolvedness amounts to. Intuitively, information I_0 is partially resolving iff it "contains" some of the information that is required to be resolving, and is factual and about the question. In other words:

(53) I_0 partially resolves q_0 relative to g_0 and ms_0 iff I_0 is factual, about q_0 and there exists I_1 that resolves q_0 relative to g_0 and ms_0 such that I_1 informationally subsumes I_0.

More generally, for a quantificational force Q:

(54) I_0 to Q-extent resolves q_0 relative to g_0 and ms_0 iff I_0 is factual, about q_0 and there exists I_1 that resolves q_0 relative to g_0 and ms_0 such that **for Q-many informational items μ that are about q_0 and such that I_1 informationally subsumes μ, it is also the case that I_0 subsumes μ.**

Apart from possessing some interest of its own, I develop this notion here given assumptions in three recent works, Berman 1991, Lahiri 1991 and Groenendijk and Stokhof 1993, concerning the readings triggered by adverbial modification of interrogative clauses, the quantificational variability effect (QVE). I defer more detailed discussion of the phenomenon, most particularly which interrogative embedding predicates display the reading, to the appendix.

The issue I do want to consider here is whether the paraphrase Berman proposes for this reading, which his account is designed to provide, and which both Groenendijk and Stokhof and Lahiri in their distinct ways also provide, is, in fact, correct. On the quantificational variability approach, what the adverb in examples such as (55) is affecting is quantification over the role associated with the wh-phrase.[25]

(55) a. Bill for the most part knows who came to the party.

b. Bill remembers to some extent which students failed the exam.

Thus, on this approach these sentences are assumed to involve the following logical forms respectively:

(56) a. For most x, x a human that came to the party Bill knows that x came to the party.

b. For some students x that failed the exam, Bill remembers that x failed the exam.

My claim is simply this: the paraphrases typified in (56) are *incorrect*; rather, I suggest that the effect of the adverbial modification is to require information so disquoted to be partially resolving.

To see this consider first example (57):

(57) Celia: All I know is that some rather unruly linguists showed up, though I don't know who.

[25] This description reflects, in broad terms, the intuition underlying both Berman's and Groenendijk and Stokhof's DRT and DMG accounts. However, although a similar effect is achieved by Lahiri's account, the underlying intuition is quite different. In fact, the notion of Q-extent resolvedness proposed here can be viewed as contextually parametrising his notion of an answer being Q-extent exhaustive. See the appendix for further details.

(57) would appear to license the following inferences:

(58) a. Celia could tell me (only) to some extent/ to a limited extent who showed up last night.

b. Celia knew (only) to some extent/to a limited extent who showed up last night.

Nonetheless, given the context of (57), it is clear that the *de re* nature of the paraphrase in (56) is not warranted.

Second, consider (59):

(59) Bill and Jill know which bachelors are bachelors, namely that every single one of them is a bachelor of course.

(59) ascribes rather trivial knowledge to Bill and Jill: essentially that they are rational people who are aware of a certain tautology. This knowledge can be ascribed to them even in the somewhat unlikely circumstance in which they are unacquainted with a single bachelor. Even if one wishes to question whether this knowledge constitutes a fully resolving answer to the question, it seems far less open to question that such information constitutes at least a partial resolving answer:

(60) Anyone can be said to know at least to some extent which bachelors are bachelors, namely that every single one of them is a bachelor of course.

Third, consider the following variant of example (35):

(61) a. [Jill about to step out of taxi in Helsinki.]

Driver: Do you know where you are?

Jill: South West Helsinki.

b. Driver: Ok. Jill knows for the most part where she is.

c. For most places x where Jill is, Jill knows that she is in x.

Once again, the paraphrase (61c) of (61b) seems clearly incorrect.

Reconsider (61). If we instantiate the force Q to 'most' in the definition (54), then in order that the information conveyed by Jill's response, I_0, count as for the most part resolving the question, it should be the case that *most* of the information that would constitute resolving information is subsumed by I_0. Given the goal plausible for this context, say that Jill be able to find her way from where she alights, the claim made by my notion of partial resolvedness is that the driver claims that:

(62) Jill knowing that she is South West Helsinki constitutes most of the information needed for her to be able to find her way once she alights.

Applying similar reasoning to example (57,58), and assuming the goal in this case is describable as 'what type of person showed up', then on the current view, asserting (58a) amounts to:

(63) Celia telling us that some rather unruly linguists showed up constitutes (only) some of the information needed to ascertain what type of person showed up.

3.7 Enriching answerhood and existing views of answerhood

The data I have provided in this section demonstrate the existence of two dimensions along which a semantics for interrogatives needs to be enriched relative to existing accounts, both in order to provide an adequate account of query/response pairs and to characterise interrogative disquotability: these concern, respectively, the notions I have dubbed *aboutness* and *resolvedness*. First, a wider range of information needs to be associated with any given interrogative use: Hamblin's 1973 semantics provides as denotation for a unary wh-interrogative its set of instantiations under the assumption that this set constitutes the set of possible answers. This idea has undergone a number of refinements in the accounts of Belnap 1982, Higginbotham and May 1981 or Lahiri 1991, so that in effect the set of all answers is seen to be the power set of the Hamblin answer–set. None of these accounts countenance quantified answers as such. These, as we have seen, are needed since they constitute information about and, in the case of monotone increasing forces, potentially resolve the questions that are contents of wh-interrogatives. Similar remarks apply to yes/no-interrogatives: Hamblin's account, and others that have followed him, associate with a yes/no interrogative a denotation set consisting of the two polar options, whereas I have suggested that a wider range, that includes at least all intermediate propositional modal answers, is required.

Second, I have shown that the "completeness" of an answer can only be determined relative to certain certain factors most naturally viewed as *extrinsic* to the (content of the) given interrogative form used. Given the need to associate with each question a class of resolving answers rather than a unique exhaustive answer, the motivation to *identify* interrogative content with (an entity determining) the exhaustive answer would appear to be significantly diminished.

4 Resolutive, Propositional and Question predicates

4.1 Introduction

Sofar, in my bid to characterise *questions*, the contents of interrogative uses, the focus has been on characterising a number of different ways in which *information* can be connected to a question: most particularly, I have given informal descriptions of when information can be described as being *about* and when it can be described as *resolving* a given question. This still leaves unresolved the basic issue of *what kind of an entity is a question.* For instance, do we want to locate questions as a subclass of the class of propositional entities?

The answer I offer to this last question is no and yes: on the one hand, I will point out a number of properties that argue strongly for the need to distinguish propositions and questions. On the other hand, we will see that both classes have similar roles as entities that serve to classify *factual* information: this will serve as motivation for developing a conception, formalised in section 5, that while distinguishing between questions and propositions individuates them both in terms of situations and states-of-affairs. Within this conception, truth of a proposition and resolvedness of a question find a common explication.

4.2 Reasserting questions

Let us first note that interrogative sentences cannot be used to make assertions:

(64) # I assert/claim the following: who left yesterday.

This illocutionary fact has a correlate in the domain of descriptive content in that predicating truth or falsity of an interrogative is infelicitous:[26]

[26] One response to this, due to Lewis 1972, has been to deny that interrogative sentences lack truth values, but rather that pragmatic facts lead to this impression. Lewis' basic intent, to show that the enterprise of characterising truth conditions can be generalised to define success conditions for any act, assertive, interrogatory or car-cleansing-ish, is reasonable enough. However, Lewis' claim concerning the truth values of interrogative sentences is not convincing and seems to involve lack of attention to descriptive/illocutionary content distinctions. One might wish to maintain that the content of a query is 'true' in some sense if it is successfully completed and that the reason we feel disobliged to intuit that is, as Lewis says, that it is self verifying. Even if this argument is convincing, it does not mean that the *descriptive* content of the query, the denotation of (any use of) an interrogative sentence is an object to which truth is applicable. In fact, Lewis' argument is equally applicable to assertions, as opposed to their descriptive content:

(65) a. I claim the following: Bill made a big mess of things.

b. That's true/false.

Here *that* does *not* apply to the fact that a claim has been made since that is undeniable. Rather, the possible source of disagreement is about the content of the claim.

(66) a. # It is false/true who committed the crime.

b. # It is false/true whether Zhang attacked Xie.

Nonetheless in certain contexts it is possible to use interrogatives to highlight the information that serves to resolve the issue described by the interrogative. Such speech acts are often known as a 'rhetorical questions', though given that I reserve the term 'question' for semantic entities, I introduce the term *reassertion*. These can be performed for any of a wide range of auxiliary purposes: suggestions, commands and so forth. There appears to exist both a 'generalised' mechanism for this use, as well as a more context-sensitive one.

Consider unary wh-questions. A necessary condition for a context c_0 to resolve a unary wh-question $q(x)$ is that the context either entail that $q(x)$ is instantiated, or it entails that there do not exist instantiators for $q(x)$.

In the first case this involves there being some entity (or set of entities) c such that $q(c)$ holds. Unless $q(x)$ is in some sense self-answering, there will be nothing *per se* about an utterance whose content is $q(x)$ to suggest that $q(c)$ is the resolving answer.[27] So, if the context does contain this information, it must have arisen through some previous utterance, or be a fact well known or easily inferrable enough to be assumed to be in that context. Cases such as these are typified in exchanges such as the following:

(67) a. A: Well let's put Max next to Cinderella.

B: Oh, but who did I say Max likes to sit next to?!

A: You're quite right. Then we should change the sitting arrangements.

b. A: I can't see the boss here tonight.

B: Where do you think he is?!

A: Geeze, that's incredible.

In neither of these cases does an answer–conveying response get elicited. In (67a) the utterance by B gets affirmed by A, indicating that B has succeeded to highlight some propositional content. In (67b), a propositional content deriving from B's utterance is embedded by the factive predicate *incredible*. In order for these discourses to work, however, both participants must assume they have common knowledge of the answer. Otherwise, obvious breakdowns will ensue. Respectively:

(68) a. (Frown). No, I don't remember you mentioning Max's neighbourly preferences. OK, remind me...

b. Sorry pal, what the devil are you insinuating about our beloved boss?

This type of use, then, depends on highly particularized information. Now consider the second type of resolving context, one where $\forall x \neg q(x)$. Since it does not involve acquaintance with particulars, this option is one that is quite simple to *accommodate* to, in the sense of Lewis 1979: if the speaker utters a wh-interrogative sentence which the addressee sees no reason she should know a supporting instantiation for, and furthermore for which it is obvious to the addressee that the speaker is aware of this fact, what she can assume is that the speaker is exploiting the utterance of the interrogative to point out that, in fact, there *are* no grounds to assume that any such instantiation exists. Of course, it is even simpler for such a case to work if it is widely known that nothing instantiates the question:

(69) a. A: What papers has he published recently, anyway?!

B: (Scratches head) Hmm, that's true I suppose.

Hausser 1983 argues that from a Montogovian perspective there are no reasons that militate against assuming that sentences denote objects of a type other than t.

[27] I am restricting myself here, solely for simplicity, to resolving answers that are instantiations. Entirely analogous reasoning applies for monotone increasing quantified answers exemplified in the previous section.

b. A: Well, like, who believes what Billy Graham says anyway?!

B: Yeah, I guess you got a point there.

(69a) provides an example of the accommodation kind, whereas (69b) is an instance of the 'obvious lack of instantiators' cases. As with the other type of use, this can also misfire:

(70) a. Well, I think he has published some. Let me see...

b. Like, I think he's a fine and profound preacher.[28]

Summing up, it seems we can say the following: a use of an interrogative i_0 in context u_0 is construed as a reassertion if and only if the question q_0 that serves as the content of i_0 in u_0 is *resolved* relative to (contextual parameters provided by) u_0.

4.3 Describing facts

We have seen now that, despite being inapplicable to *truth* and being inassertible, in contexts relative to which the question provided by the interrogative is *resolved* a use of the interrogative gives rise to a reassertion of the resolving information. Similarly, in section 3, we saw that various predicates could be used to disquote only *resolving information.* In what follows, I relate and attempt to pin down the source of these two sets of phenomena. I demonstrate that interrogative complement predicates are sensitive to the existence of the two types of contexts that can be associated with a question: certain predicates require the denoted question to be resolved e.g. *know, discover* and *tell* (henceforth 'resolutives'), whereas others, e.g. *ask, wonder* and *investigate* do not. I will point to a number of striking parallels in this regard displayed by other 'propositional entity' expression types including declaratives, 'concealed question' NP's and gerunds. Thus, certain declarative complement predicates require the proposition denoted by the complement to be true ('factives'), whereas others do not.

What then is the source for these conditions and what do they tell us about the kind of objects required to provide a semantics for these expressions?

My account builds on insights due to Austin 1950, 1954 and Vendler 1967, 1972. Austin 1950 presents a theory of truth in which propositions are viewed relationally: roughly, asserting a proposition involves predicating of a state-of-affairs (a type-like entity) that it is a *fact* pertaining to a certain situation (a part of the world). In Austin 1954, he argues at some length against conflating facts with true propositions, a position Vendler 1967 motivates further. Vendler 1972 assembles a variety of evidence that partitions the declarative complement predicates into two main categories. He uses this data to argue for a pervasive ambiguity among these complements, between fact-embedding and proposition-embedding predicates.

I show that an analogous bifurcation exists with interrogative complements, which in Vendler's terms would amount to positing a pervasive ambiguity between fact–embedding and question–embedding predicates. And indeed I will suggest the need to recognize three pairwise disjoint classes of "propositional entities": questions, which can resolved or unresolved; propositions, which can be true or false; and states-of-affairs, which can be factual (are *facts*) or non-factual relative to a situation they (potentially) depict.[29]

[28] Similar remarks apply to yes/no questions: a context is resolving if and only if it entails one of the polar options. Various stock phrases exist reasserting either the positive option:
(i) Does a bear shit in the woods?!
(ii) Is the Pope catholic?!
or the negative option:
(iii) Do I ever lie?! Well then, don't worry.
(iv) Do bagels wear bikinis?! (Jerry Morgan)
As usual, these cases can misfire, if the addressee lacks the relevant knowledge concerning the obviousness of the proposition or its negation. Someone not aware of the facts of NBA basketball would not be able to understand how the following reassertion is supposed to work:
(v) Yeah well, would Mugsy Bogues beat Manute Bol in a jump off?!

[29] In fact, the conception I develop starts out with a context independent notion for questions, *decidedness,* just like truth is for propositions. Resolvedness emerges as a relativisation of decidedness. A question I do not enter into here is—what is the contextually relativised analogue for truth.

Following Vendler's tack, a line pursued in Ginzburg 1992a,b, requires positing a fairly wide array of ambiguities throughout the domain of propositional expressions. Instead, I will suggest a somewhat different strategy inspired by Austin 1954. On the conception developed, truth for propositions and resolvedness for questions involve the existence of a state-of-affairs that is factual relative to a given situation. Certain predicates, the fact seeking ones, can use propositions or questions to classify their argument roles *on the assumption the propositions are true, or the questions are resolved.* This is the source of the factivity/resolutivity presuppositions such predicates carry. An analogy Austin suggests in this regard is between making a statement and stating a fact on the one hand, and making a signal with a flag and signalling a target on the other hand. If the signal is a correct one, then one has succeeded in signalling a target. *What has been signalled* is (1) correct (a correct signal), and equally (2) a target, but no contradiction ensues nor a temptation to identify targets with correct signals. By the same token, Austin argues, true statements (propositions in our parlance) and facts should not be identified even if by making a true statement the speaker stated a fact. The analogy can be extended to resolved questions and facts. Apart from considerations of parsimony, this ambiguity avoiding strategy is more promising in the light of the wide range of "idiosyncrasy" we will encounter among the various predicates (non/semi/conditional/full factivity/resolutivity) and in light of the semantic and cross-linguistic uniformity across distinct syntactic expressions.

The following subsections are, given their taxonomic intent, quite detailed datawise. Those not wishing to wallow in the empirical mud can turn to section 4.7 where the results are summarised in tabular form.

4.4 Question predicates: resolutive v. non-resolutive predicates

I start by providing some criteria that distinguish among predicates that take questions as arguments between those which require the question argument to be resolved and those which do not. I refer to the former as resolutive interrogative predicates (RI), to the latter as question interrogative predicates (QI). Table 1 provides a sample list of predicates from both categories.

RI		QI
discover	report	ask
find out	tell	wonder
forget	announce	weigh–in–self's–mind
guess	state	investigate
predict	reveal	discuss, talk about
know	remember	over
determine	show	about

Table 1: Resolutive and Question predicates

4.4.1 Resolving facts can be described by question resolved

... list of facts ...
These are the facts that resolve the following question: q_0
V these facts
————————————————————
V q_0

Figure 3: (res)

RI predicates validate (res) (figure 3), whereas QI predicates either do not, or are actually *inapplicable* to 'fact-NP's':

(71) a. These are the facts that settle the following question: who will Jill invite over?

b. Bill reported these facts to me. *Hence,* Bill reported to me who Jill will invite over.

c. Bill discussed/investigated these facts. # *Hence,* Bill discussed/investigated who Jill will invite over.

(72) a. These are the facts that settle/resolve the following question/issue: Who attacked whom?

b. Bill had already guessed these facts. *Hence,* Bill had already guessed who attacked whom.

c. # Bill asked those facts.

d. Bill has some beliefs about these facts. # *Hence,* Bill has some beliefs about who attacked whom.

4.4.2 Resolutive predicates predicate of resolved questions

The question was q_0
————————————————
If V q_0, then that question must be resolved.

Figure 4: (unres)

RI predicates validate (unres) displayed in figure 4:

(73) a. The question was who had committed the crime. If Jill discovered/told you who had committed the crime, then that question must have been resolved.

b. The issue was whether to apply for the grant. If Jill decided whether to apply for the grant, then that issue must have been resolved.

c. The issue was who Mary chose as her partner. If Jill was distressed by who Mary chose as her partner, then that issue must have been resolved (by now).

More intricacy is needed for a number of predicates that pattern naturally with the class of resolutives, as we shall see below. Consider dependency predicates such as *depend-on, is-a-function-of* or *determine*.[30] For them, a variant (unres-dep) applies:

The first question/issue was q_0
The second question/issue was q_1
q_0 V q_1
q_0 is resolved
————————————-
q_1 is resolved

Figure 5: (unres-dep)

(74) a. The first issue was who would show up. The second issue was how long our food would last. How long our food would last depended-on/was determined by who would show up. Who would show up was resolved (quite soon). Hence, how long our food became a resolved issue.

QI predicates do not validate (unres):

[30] The basic insight about such predicates should be attributed to Karttunen 1977.

(75) a. The question was who had committed the crime. If Jill wondered who had committed the crime, # then, that question must have been resolved (by now). (In fact it follows: For Jill, the issue was an open one.)

b. The issue was whether to apply for the grant. If Jill asked me whether to apply for the grant, # then that issue must have been resolved (by now).

4.4.3 Transparent embedding of questions

Various common-noun phrases denote entities of which one can predicate unresolvedness, openness and so forth:

(76) a. question, issue, problem

b. The question/problem/issue remains unresolved.

c. The question/problem/issue is still an open one.

QI predicates validate an inference schema *(transparent-question-pred)* in which the denoted question is *not* stipulated to be resolved:

The question/issue/problem is q_0 V that question —————————————— V q_0

Figure 6: (transparent-question-pred)

(77) a. Jill asked/reflected over an interesting question. The question was who left yesterday. Hence: Jill asked/reflected over who left yesterday.

b. Bill investigated/discussed that issue. The issue was whether Jill would arrive. Hence: Bill investigated/discussed whether Jill would arrive.

RI predicates do not validate (transparent-question-pred):

(78) a. Jill discovered/revealed an interesting question. The question was who left yesterday. It does *not follow* that: Jill discovered/revealed who left yesterday.

b. Bill reported/was aware of the issue. The issue was whether Jill would arrive. It does *not follow* that: Bill reported/was aware of whether Jill would arrive.

QI predicates do not embed declaratives, possibly because these latter denote propositions of which unresolvedness/openness etc cannot be predicated:

(79) a. # Xiaokang asked/wondered/investigated/weighed-in-his-mind that Jill likes Bongo drumming.

b. # It is open/unresolved that Jill likes Bongo drumming.

4.4.4 Concealed questions

It is worth noting that the schemas described above do not depend on the syntactic form of the question or issue denoting expression. And in fact, the same inferences are obtained for so called 'concealed questions'.

(res):

(80) a. These are the facts that settle/resolve an issue that has intrigued me for some time: the source of Bill's wealth. Jill revealed these facts to me. *Hence,* Jill revealed to me the source of Bill's wealth.

b. These are the facts that settle/resolve an intriguing question: Lennox's current weight. Bill is aware of these facts. *Hence,* Bill is aware of Lennox's current weight.

(unres):

(81) The source of Bill's wealth is an intriguing question. If Jill has managed to guess the source of Bill's wealth. then that issue must be resolved.

(transparent-question-pred):

(82) a. Jill asked/reflected over an interesting question. The question was the source of Bill's wealth. Hence: Jill asked/reflected over the source of Bill's wealth.

b. Jill discovered an interesting question. The question was the source of Bill's wealth. # Hence: Jill discovered the source of Bill's wealth.

4.4.5 Resolutive/Non-resolutive predicates: conclusion

In this subsection we have seen three test schemas that distinguish resolutive from question predicates. The first shows that V'ing of facts that constitute resolution of a question, constitutes V'ing that question. The second is a converse schema showing that V'ing a question for resolutives involves that question being resolved. The final schema, one validated by question predicates, sets up a context in which the question need not be resolved. Hence, in such cases, the question cannot be used to classify the V'ing by the resolutive predicates. We also saw data from concealed questions that indicates that the resolutive properties of predicates are independent of the (surface) syntactic, more precisely categorial, manifestation of the question denoting expression. We will see below that concealed questions show other semantically identical properties to interrogatively denoted questions.

4.5 Factive/Resolutive v. Propositional predicates

I move now to consider an analogous set of facts concerning declarative complement predicates,a representative listing of which can be found in table 2.

TF		**RI**
	Factives	**Non-Factives**
claim	discover	report
allege	find out	tell
assert	forget	announce
believe	reveal	state
assume	remember	guess
accept	know	predict
deny	determine	inform

Table 2: Resolutive and Propositional predicates

Here, I suggest, following Vendler, that there is a basic dichotomy between predicates whose arguments must be propositional and those for which this need not hold, ('propositional' here in the sense that truth or falsity must be predicable of them.). I dub the former class **TF** (for truth/falsity) predicates. Resolutive predicates are disjoint from **TF** and apparently display one important bifurcation: those predicates whose arguments can have truth/falsity predicated of them do not require their propositional arguments to be true.

4.5.1 Truth-demonstrating facts can be described by proposition made true

RI predicates validate the propositional analogue of (res), whereas TF predicates are inapplicable to facts:

(83) a. These are the facts that demonstrate the truth of the following belief: Jill left late last month.

b. Bill had already guessed/revealed these facts. *Hence,* Bill had already guessed that Jill left late last month.

c. # Bill asserted/claimed these facts. # *Hence,* Bill asserted/claimed that Jill left late last month.

4.5.2 Factive predicates predicate of true propositions

An analogue of (unres) above is (unfac) displayed in figure 7.

The claim was c_0
————————-
If V c_0, then that claim must be true
————————————————-
V a fact.

Figure 7: (unfac)

Factive predicates validate this schema including the intermediate step. Resolutive non-factives *require* the conclusion of this step as an additional assumption:[31]

(84) The claim was that Jill invited Millie over.

a. If Bill has revealed that Jill had invited Millie over, then the claim must be true. Hence, Bill has revealed a fact.

b. Bill stated that Jill had invited Millie over. (It turned out that) the claim was true. Hence, Bill had stated a fact.

This difference apart, the factive and non-factive resolutives do display identical characteristics with propositional arguments, as the following tests indicate.

[31] This distinction is reflected by the fact that the factives cannot have truth/falsity predicable of their arguments, whereas the non-factives can:
(i) What Jill reported to you (to be the case) is false.
(ii) I have few doubts that what he told you is true.
(iii) Unfortunately, what you just stated (to be the case) is untrue.
Nonetheless, with intrinsically veridical verbs, predicating truth is problematic:
(iv) # What he discovered (to be the case) is, evidently, true.
(v) # What Bill forgot was true.
(vi) # What you're aware of is true/false.
It seems that this is an infelicity rather than tautology/contradiction. For one, the following appear to be acceptable:
(vii) Of course that red book is red.
(viii) Evidently a bachelor is unmarried.
Moreover, revelations or regrets can be contingent. Even in such cases, predicating truth or falsity is infelicitous:
(ix) Had Mary bought the same dress as Jill, she might have regretted buying a dress of the same colour as Jill's. However, she didn't buy the same dress. # What she might have regretted is false.
(x) If the Minister were found lying again, his secretary might have revealed it. He wasn't found lying this time though. # What the secretary might have revealed is false.

4.5.3 Transparent truth predication

Various common-noun phrases denote entities of which one can predicate truth or falsity:

(85) a. theory, claim, report, forecast, allegation, prediction, charges, hypothesis, conjecture.

The following generalisation emerges: *T-Pred* is valid for TF predicates, whenever the antecedent is a felicitous predication. It does not hold for predicates of the other classes. This test is based on an insight of Vendler 1972.

V the N' ———- V that the N' is true.

Figure 8: (T-pred)

(86) a. Bill believes/accepts Mary's theory/ the Fed's forecast/the recently published report.

Hence, Bill believes/accepts that Mary's theory/the Fed's forecast/the recently published report is true.

(87) a. Jill discovered/revealed Bill's hypothesis/claim/conjecture.

It does not follow that: Jill discovered/revealed that Bill's hypothesis/claim/conjecture is true.

The TF predicates validate the obvious analogue to (transparent-question-pred). Resolutive/factive predicates do not:

(88) a. The Fed's forecast was that gold reserves would be depleted by the year 2000.

b. Bill believes/accepts the Fed's forecast. Hence, Bill believes that gold reserves would be depleted by the year 2000.

c.

d. Bill reported/was aware of the Fed's forecast. It does *not follow* that: Bill reported/was aware that gold reserves would be depleted by the year 2000.

4.5.4 Inapplicability to non-propositional entities

I noted above that truth or falsity is not predicable of questions. Given the characteristics we have just seen of TF predicates this would seem to account for the following: TF predicates are inapplicable to questions, regardless of whether (there are indications that) the question is resolved. The data provided here is based solely on English, however these facts appear to have much wider validity: they extend to the approximate equivalents of these predicates in Modern Hebrew, Japanese, and Turkish.[32], [33]

[32] I am indebted to Yo Matsumoto (p.c.) and Guven Guzeldere (p.c.) for providing the Japanese and Turkish data, respectively. The corresponding judgements on Hebrew are my own.

[33] Emotive factives are incompatible with yes/no interrogatives, though apparently felicitous with wh-questions:
(ia) John was disgusted at/really regretted who they picked for the job.
(ib) # John was disgusted at/really regretted whether they picked Mary for the job.
(ic) It's astounding who wins what in competitions these days.
(ic) # It's astounding whether Ben Johnson wins these days.
(id) You would be surprised who showed up at the party.
(id) # You would be surprised whether Mary showed up at the party.
I do not at present have an account of this, but believe that a promising direction to explore concerns a clash between the potentially indefinite nature of the information characterised by the interrogative complement and a basic requirement on emotive predicates that it be possible to deduce what *preference state* the cognizer prefer

(89) a. Q: Who came yesterday?

Bill: I believe/hope Mike did.

In fact, it was Mike who came yesterday.

b. # Bill believes/ hopes who came yesterday.[34]

(90) a. Q: Which pitcher will do what tomorrow?

Basil: I suppose/assume Gallego will pitch a no hitter, though Doc Gooden will be retired after 3 innings.

In fact, Gallego will pitch a no hitter, though Doc Gooden will be retired after 3 innings.

Basil supposes/ assumes which pitcher will do what tomorrow.

(91) a. Q: Who came yesterday?

Bill: I'd like to persuade you that Mike did.

In fact, it was Mike who came yesterday.

b. # Bill claimed/argued who came yesterday.

Similar facts hold for concealed questions:

(92) a. # Jack believed/doubted/assumed Bill's weight./my phone number.

b. Jill believed/doubted/assumed Bill's story/ the claim. (Paraphasable as 'Jill believed/doubted/assumed *the veracity* of Bill's story/ the claim.' Does not mean 'Jill believed/doubted/assumed what Bill's story/the claim was.')

Vendler 1967 and and Bennett 1988 provide extensive evidence that POSS[essor]-gerunds have a use which denotes facts:[35]

As expected, given the non-propositional nature of POSS-gerunds, TF predicates do not embed them:

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to be in. Since the resolutivity condition for yes/no questions need not indicate which polar option is preferred, whereas it is *a priori* obvious that one of the outcomes *is preferred*, they yield *infelicitous* predications.

The idea, then, is that the infelicity of (ii)

(ii) # Bill regrets/was saddened/was amazed/was made hysterical by whether Jill showed up to the party.

is of a similar ilk to that of statements like the following:

(iiia) [Context makes clear that a draw is nor could be a possible outcome.] # Bill regrets/was saddened that some candidate or other won the election.

(iiib) # Bill regrets/was saddened that the coin showed heads or tails. (Example due to David Beaver.)

I owe the notion of *preference state* to Katz 1991, who employs such a notion in an account of the contrasts among certain emotive predicates in licensing complements containing negative polarity items.

[34] In certain environments *believe* does have a factive, "emotive" use where it comes to mean something like 'be reconciled with':

(i) She can't BELIEVE that line-call.

This use enables *believe* to predicate of wh-questions:

(ii)You won't BELIEVE who showed up last night.

or NP's:

(iii) You won't BELIEVE that fact.

Note that this use seems to require stressing the verb. Moreover, as David Milward has pointed out to me, unambiguously propositional negation does not license such predications:

(iv) # It is not the case that you will believe who showed up last night.

This suggests that it is modification at the level of the verb that is involved here. Hence, whatever the precise nature of the phenomenon, we need not suspect that, via some process of presupposition projection, the "normal" sense of *believe* is applicable to questions or facts.

[35] Bennett's arguments, taken from chapters 1 and 2 of his 1988, include the following: POSS-gerunds are veridical, though not truth–predicable, lack duration, are virtually interchangeable with 'the fact that' nominals and, individuate with as fine a grain as (singular/Russellian) propositions.

(93) # Bill's arriving yesterday is false/true/dubious. (Inherently veridical; truth is not predicable.)

The nominal gerund exhibits behaviour appropriate to a located particular:

(94) a. Quisling's betrayal of Norway was instantaneous.

b. Quisling's betrayal of Norway occurred in late 1940.

(98) a. # Bill believed/alleged /assumed/doubted/claimed Jill's having discovered a new ontological distinction.

b. # Bill believed/alleged/assumed/doubted/claimed Jill's finding the treasure much before anyone else did.

Resolutive predicates including dependency predicates embed POSS gerunds, though there are some exceptions:[36]

(99) a. Bill revealed/predicted/guessed Jill's having discovered a new ontological distinction.

b. Bill's arriving on time depends on/will be determined by whether Mary drives him over.

c. Bill guessed/told us of/mentioned/predicted Jill's finding the treasure much before anyone else did.

(100) a. Jill's finding the treasure was announced/reported/# told (to us) widely.

b. Bill is aware of/knew #(of) Jill's having made a big discovery.

Stalnaker 1974, 1978 and Lewis 1979 have persuasively argued for the utility of a notion of presupposition as conversationally accepted information. However, assuming such a notion of presupposition, means that serious problems will be encountered by any attempt to invoke presuppositions whose function is the enforcing of 'epistemic weakness' or 'conversational controversiality' to the arguments of TF predicates. In other words, it is problematic to assume that the inapplicability of TF predicates to the veridical entities made available by resolved questions, fact nominals, POSS-gerunds etc derive from a prohibition of the following kind: *do not fill the cognitive argument of a TF predicate with material present in the conversational record.* Data such as the following would appear to fly in the face of such a prohibition:

(101) a. Bill is usually so wrong headed, but for once he actually believes something we all accept without batting an eyelid, namely that the sun will rise tomorrow.

b. Now that she's been shown the evidence, and let me assure you it conclusively establishes his guilt, Jill won't deny that Bill could have committed the crime.

(102) a. For a long time there had been allegations that Dave was seeing a certain actress. It's turned out that the allegations are well founded. Thus, even though we all know they're true, John, staunchly loyal, doesn't accept the allegations.

b. Bill's claim was that Mary was ill. I discovered that, in fact, Mary was ill. After that, everyone accepted the claim.

Any adjusting of the condition to hold not of the conversational record, but of the agent whose mental state is reported is confounded by examples such as the following:

The POSS-gerund on the other hand does not behave like a located particular:

(95) a. # Quisling's betraying Norway was instantaneous.

b. # Quisling's betraying Norway occurred in late 1940.

(96) The fact that Bill arrived yesterday/Bill's arriving yesterday was a relief to us all. (Interchangeable with 'the fact that' nominals.)

(97) (Due to Jaegwon Kim:) Bill journeyed to Calais once in his life, by swimming the channel. Bill's journeying to Calais did not surprise me, though his swimming the channel did. (finely grained as propositions.)

[36] Contrasts such as these have been noted in Kiparsky and Kiparsky 1971. The Kiparskys view ability to take a POSS complement as a sign of *factivity*, whereas I would maintain that it is the POSS gerund itself that is the source of the veridicality, given the ability of (declaratively) non-factive predicates such as 'report', 'guess' and 'predict' to embed such complements in a way that maintains the veridicality.

(103) Jill believes that John was on MDA last night, in fact she knows it.

(104) # Bill knows that, but he doesn't believe it. (*believe* can only be understood here in the sense of 'be reconciled with'.)

Thus, building into *believe* or other TF predicates a requirement that its complement is *not known* will result in contradiction.

4.5.5 Factive/Non-factive predicates: conclusions

In this subsection a number of criteria were proposed for distinguishing TF predicates, a class of predicates whose arguments are required to be truth predicable, from other predicates which are also applicable to declarative complements. It was suggested that the inapplicability of TF predicates to questions and POSS-gerunds is a consequence of the requirement for propositionhood of their arguments.

4.6 Resolutivity and Factivity compared

In the previous two subsections we have seen that both questions and propositions afford two main classes of embedding. Somewhat loosely we might describe the two dichotomies as follows: For questions, the dichotomy concerns whether or not the question is being used to describe the facts that constitute its resolution. Those predicates which it does not—QI predicates—transparently embed questions. For propositions the dichotomy concerns whether or not the proposition is (factives) or can be (non-factive resolutives) used to convey the factuality of its descriptive condition. Those predicates which it does not—TF predicates—transparently embed propositions.

What, then, is the relationship between resolutivity and factivity? On the one hand, it seems clear that both notions are independently needed. Resolutivity is required, in part, if we are to offer a description of the semantic characteristics of QI predicates and dependency predicates, which are inapplicable to propositions. Conversely, TF predicates are inapplicable to questions in general, whereas, as noted in footnote 33, emotives are inapplicable to yes/no questions. Hence the need for factivity.

Nonetheless, I suggest that there is a fundamental commonality to the two properties: both provide mechanisms through which predications involving *facts* can take place. In other words, both resolved questions and true propositions can be *used* to classify argument roles which must or can be associated with facts. In order to be factive or resolutive, a predicate must be applicable and transparently embed facts: Certain common-noun phrases, like those in (105) denote entities which refer or describe facts, events, or other states of affairs that obtain:

(105) truth-about, outcome, result, important fact about, earthquake, King's coronation

We note first that truth or falsity cannot be predicated of the entities referred or described by such expressions:

(106) # The truth about that event/the outcome of the competition/this fact/that earthquake is true/false.

Resolutive/factive predicates are applicable to subsets of NP's containing these nominals:

(107) a. Jill is aware of/reported/revealed this fact.

b. Bill guessed/could have predicted/discovered these basic truths about Bill.

c. Jill regrets/remembers well a particularly gruesome outcome of Bill's pronouncement.

d. If you work hard, you will surely be able to discover some important facts characterising his behaviour.

Furthermore, this predication can be transparent:

(108) a. Jill is aware of/reported/revealed that fact. That fact is that Bill has been working hard to destroy the company. Hence, Jill is aware/reported/revealed that Bill has been working hard to destroy the company.

b. Jill guessed/could have predicted/discovered these basic truths about Bill. One of these is that Bill never finishes writing up. Hence, Jill guessed/could have predicted/discovered that Bill never finishes writing up.

c. Jill regrets/remembers well a particularly gruesome outcome of Bill's pronouncement. That particularly gruesome outcome of Bill's pronouncement was that everyone was required to sign the pledge. Hence, Jill regrets/remembers well that everyone was required to sign the pledge.

The conclusion this data points to is simply this: resolutive/factive predicates, in contrast to TF predicates, have arguments of which truth cannot be predicated. Example (106) suggests that truth is inapplicable to facts and events. Those examples concerning transparent predication, (108), indicate that facts and events can be genuine arguments of resolutive predicates.

Finally, we note that resolutivity and factivity display identical projection properties. Some factives, 'full factives', preserve the factuality of their complement when negated, conditionalised and questioned. Others, 'semi factives', do not. These same projection properties apply to these predicates with respect to their question arguments and resolvedness:

The question/issue was q_0
not V q_0; if V q_0, then I'll be surprised; Does V q_0?
———————————————
That question must be resolved

Figure 9: (full resolutivity)

The claim was c_0
not V c_0; if V c_0, then I'll be surprised; Does V c_0?
———————————————
That claim must be true

Figure 10: (full factivity)

(109) a. The question was who had committed the crime.

b. Jill did not discover who had committed the crime./If Jill discovers who had committed the crime, I'll be surprised./ Did Jill discover who had committed the crime?

\# Hence, that question must be resolved.

c. Jill was not distressed by who had committed the crime./If Jill is distressed by who had committed the crime, I'll be surprised./ Is Jill distressed by who had committed the crime?

Hence, that question must be resolved.

Similar patterns emerge for factivity:

(110) a. The claim was that Millie had committed the crime.

b. Jill did not discover that Millie had committed the crime./If Jill discovers that Millie had committed the crime, I'll be surprised./ Did Jill discover that Millie had committed the crime?

Hence, the claim must be true.

c. Jill was not distressed that Millie had committed the crime./If Jill is distressed that Millie had committed the crime, I'll be surprised./ Is Jill distressed that Millie had committed the crime?

Hence, the claim must be true.

4.7 Conclusion: question, proposition and fact predicates

How the current approach fits in with existing accounts of 'pragmatic presupposition' is not a topic I will enter here. The current proposal addresses the *source* of the factivity and resolutivity conditions, whereas, roughly, pragmatic presuppositional views assume the condition as given and are in the business of explaining how such conditions can be enforced and maintained in discourse. Thus, in principle, there is no conflict. Nonetheless, explicating the source of the condition in the way I have, motivating *inter alia* the fact/true proposition distinction, provides a straightforward account for cases where a conflict arises between the potential informativeness of factive complements and the (putative) need for presupposed information to be in the common ground. For instance:

(111) The management regrets that as of 1 September this service will be discontinued.

On the current account, factivity amounts to the complement being required to be a fact. A sufficient, though not necessary, condition for this is that a (justified) assertion to this effect has been encountered.

Tables 3 and 4 summarise the data discussed in this section:

R/F	0.5 R/F	R	Dep	TF	QI
forget	discover	tell	depend	claim	ask
odd	know	report	determined	believe	wonder
surprised	be-aware	announce	be-a-	assert	discuss
regret	remember	guess	function-	accept	investigate
sorry	find out	predict	of	deny	mystery
interesting	realize	state		assume	about

Table 3: Fully resolutive/factive, Semi resolutive/factive, Resolutive, Dependency, Propositional, Question predicates

R/F	0.5	D	R	TF	QI	Criterion
+	+	+	+	-	+	Applicable to question/issue denoting expressions
+	+	-	+	+	?	Applicable to claim/belief/theory denoting expressions
-	-	-	-	NA	+	Transparently embed question/issue denoting expressions
-	-	NA	-	+	NA	Transparently embed claim/belief denoting expressions
+	+	+*	+	NA	-	Resolving facts describable by question they resolve
+	+	NA	+	-	NA	Truth establishing facts describ. by claim whose truth established
+	+	+*	+	NA	-	Positive Predications are of resolved questions
+	+	NA	-	-	NA	Positive Predications are of true claims
+	-	-	-	NA	NA	Resolutivity survives projection under negation, questions, conditionals
+	-	NA	NA	NA	NA	Factivity survives projection under negation, questions, conditionals
+	+	+	+	-	?	Applicable to fact/ event denoting expressions

Table 4: Summary of characteristics discussed above

+	yes
-	no
?	mixed
NA	not applicable
+*	yes with modifications

5 A Semantic Theory of Questions

5.1 Introduction

Let us take stock: in section 3 I pointed out the importance of two independent dimensions relating information to questions, namely *aboutness* and *resolvedness*. In the previous section I demonstrated a variety of parallels exhibited by questions and propositions, in particular that both a resolved question and a true proposition can be used to classify *facts*. In this section I will offer a formal theory of questions which can accommodate the desiderata gathered along the way concerning aboutness, resolvedness and factuality. The theory I provide uses situation theory as logical framework and involves a relatively straightforward extension to the existing situation theoretic ontology of propositional entities designed to provide a theory of relations, states-of-affairs and propositions.

The theory developed here is intended to serve as a theory of *content* for "question-denoting" expressions: the semantic framework I presuppose is situation semantics (see e.g. Barwise and

Perry 1983, Gawron and Peters 1990). On the situation semantics strategy propositional *contents* are already fine grained objects; there is no move equivalent to the Fregean strategy of assuming a coarse grained level of denotation/extension and "blurring" it on the level of sense/intension. More generally, a distinction is assumed between the meaning of an expression and its content on a use in a context. Roughly, the *meaning* of an expression is a mapping from contexts in which it can be used to *contents*, (some characterisation of) objects that the use introduces. Here the phrase 'contexts in which it can be used' is to be taken in a broad sense that includes 'fixes all parameters left indeterminate by the language' (e.g. picks out referents of deictic expressions, resolves domains over which quantifications ensue or within which uniqueness presuppositions are to be satisfied etc.) Thus, the meaning of an expression has a supra-contextual nature, or in Kaplan's term *character*, and a *content* that arises by fixing the discourse parameters on a particular use. The reader is referred to Ginzburg 1992a for a detailed account of the semantics of wh-phrases, in particular a set of compositionally specified meaning descriptions from which interrogative sentential contents of the kind specified in the current work can arise.[37]

The theory provided here takes as its starting point an approach to propositional entities that originates with Russell, one that postulates the existence of a class of 'Russellian' or 'singular' propositional entities. This approach has recently gained renewed interest particularly for purposes of cognitive representation through works such as Kaplan 1977, Soames 1987, Richard 1990 and Crimmins 1993, as well as works in situation theory originating with Barwise and Perry 1983, further developed in Barwise 1989, Barwise and Etchemendy 1987,1990, Barwise and Cooper 1991 and modelled by Westerståhl 1990, Fernando 1991, Aczel and Lunnon 1991. My own conception and exposition derives from the situation theoretic perspective to which I refer the reader for developments of a mathematical theory.

5.2 An intuitive picture of the Ontology

In section 1.3 I proposed a metaphor for an agent engaged in inquiry in terms of a stack of snapshots, some complete, others possessing certain blurred features ("holes"), all of which putatively pertain to a situation s_0 she is attempting to characterize. I expand this here slightly in light of the phenomena encountered in the previous two sections.

On the basis of these "basic" entities, scenes and snapshots, a relational view of questions and propositions can emerge. Given a scene s_0 and a snapshot $pict_1(hole_1, \ldots, hole_n)$, the question $(s_0?pict_1(hole_1, \ldots, hole_n))$ arises: does the stack of snapshots contain a (complete) snapshot that is about $pict_1$ (i.e. has the features blurred in the latter filled in) of the grain size appropriate to the agent's current purposes and factually depicts s_0? (As a special case, when the snapshot has no "holes", we have a yes/no-question.) Any putative such snapshot can lead to the assertion of a proposition $(s_0!\sigma_0)$, namely that σ_0 factually depicts s_0. If $(s_0!\sigma_0)$ is true, then σ_0 is a fact that has been acquired. Is $(s_0?pict_1(hole_1, \ldots, hole_n))$ a resolved question? That depends on how informationally strong σ_0 is. It will be so iff σ_0 is informationally stronger than the appropriate level of exhaustiveness. If that is in fact the case, then what has been learned can be described as $(s_0?pict_1(hole_1, \ldots, hole_n))$.

The present account is intended as an alternative to the familiar metaphor of question objects as representing *choices* of possible answers. Rather, the metaphor here is that a question provides an underspecified informational item. Of course the two metaphors are not unrelated: any choice

[37] The theory of questions presented here differs from that of Ginzburg 1992a in the following way: in the latter work all interrogative sentences were argued to be ambiguous. One use, dubbed *the QI use*, was identified with 'question uses' (descriptive contents of queries, complements of *ask, wonder, investigate,...*). A second use, dubbed *the RI use*, was identified with 'answer uses' (complements of *know, tell, forget,...*). Within the current theory, the existence of such an ambiguity is no longer assumed for reasons already discussed in the previous section.

The modification required for the fragment defined in chapter 6 of Ginzburg 1992a is the following: in the latter, *a QI use* of a wh-interrogative i_0 was assumed to denote what was called there an *unresolved* SOA, say σ_0. In the current theory, as explained in section 5.4, unresolved SOA's are identified with n-ary abstracts. In addition, as explained in the text, questions are now viewed as individuated not just by abstracts but also by situations. Hence, this same i_0 on a given use unambiguously denotes $?(s_0, \sigma_0)$, an object defined on the basis of σ_0 and a contextually provided situation s_0.

situation can be represented as an underspecified informational item, conjoined with a disjunction over the members of the choice sequence. Conversely, one can conceive of underspecifications as setting up a choice in some sense, since information is implicitly carried about the *potential* resolutions of the underspecification relative to a domain of candidate fillers. The crucial difference, however, is that *questions* here are fixed by a SOA–abstracts and a situation, *without* the requirement that any information about what the range of possible specifications is. Hence, the metaphor can also accommodate query situations in which the agent is not aware of the range of choices available to her ('what is the word for sunshine in Chukotian', 'how can one prove this theorem' etc.).

I proceed now to embed the informal picture within a somewhat expanded situation theoretic ontology.

5.3 SOA's, situations and SOA algebras

SOA's are structured objects, $\langle$ R,f;i $\rangle$, individuated in terms of a relation R, a mapping f assigning entities to the argument roles of the R, and a polarity i, where $i \in \{+, -\}$.[38]

Assume as given a relation R endowed with a set of argument roles $r_1, r_2, \ldots, r_n$. When appropriate objects $a_1, a_2, \ldots, a_n$ are assigned to all the argument roles of R an issue arises: do these assigned objects stand in the relation R or do they not? The former possibility is represented by the SOA σ

(112) a. $\sigma = \langle$ R, $r_1 : a_1, r_2 : a_2, \ldots, r_n : a_n; + \rangle$

while the latter possibility is represented by the SOA $\overline{\sigma}$

b. $\overline{\sigma} = \langle$ R, $r_1 : a_1, r_2 : a_2, \ldots, r_n : a_n; - \rangle$

$\overline{\sigma}$ is referred to as the *dual* of σ. I follow the established convention of omitting the *polarity* '+', where no confusion arises

In (113) two SOA's are depicted: [39]

(113) a. $\langle$ **LIKE, liker:jill, likee:bill**; + $\rangle$

b. $\langle$ **HOT, location: cordura-hall, time: 3:45 pdt**; – $\rangle$

If the possibility represented by some SOA σ is realised, the assumption is that there must be some situation s_0 in the world that supports the factuality of σ. This is denoted

(114) $s_0 \models \sigma_0$

The ontology developed here makes a clear distinction between "subject matter", represented by SOA's, and that which the subject matter pertains to, the situations. Both questions and propositions, however, are relational, that is involve a certain relationship between the two types of entities. Before introducing them, it will be convenient to allow ourselves some algebraic structure.

In what follows I assume the framework of Barwise and Etchemendy 1991, specifically their idea that an appropriate algebraic structure for explicating information content is a *SOA algebra*, SOA-ALG$_0$ = $< Sit_0, SOA_0, \rightarrow, \models, 0, 1 >$: a non-empty collection of objects Sit_0 called situations, together with a Heyting algebra of SOA's $< SOA_0, \rightarrow>$ with distinguished members **0**, **1**, and a relation $\models$ on Sit_0 x SOA_0.[40] This means that:

[38] '+/-' are variously notated as '1/0' or 'yes/no'.

[39] It is worth emphasisising that these are solely *depictions* of SOA's, because SOA's are taken to be non-linguistic (abstractions), individuated in terms of real-world objects. They are not sentences in a formal language, though some of them can be profitably thought of as contents of uses of sentences. I use bold-face type when the non-linguistic nature of entities is to be emphasised.

[40] The conditions on a sextuple $< Sit_0, SOA_0, \rightarrow, \models, 0, 1 >$ required in order that it be a SOA algebra are:

- Given any not necessarily finite set of SOA's Σ, there exists a SOA $\bigwedge \Sigma$ ('the informational meet of Σ'), a SOA that represents the combined information in Σ.
- Given any not necessarily finite set of SOA's Σ, there exists a SOA $\bigvee \Sigma$ ('the informational join of Σ'), a SOA that represents the weakest information specified by Σ.
- The domain of SOA's is partially ordered by $\rightarrow$: $\sigma \rightarrow \tau$ is to be read as 'σ is informationally stronger than τ'.
- Given any SOA σ, there exists a SOA $\overline{\sigma}$ such that $\sigma \wedge \overline{\sigma} = \mathbf{0}$, and for any τ such that $\tau \wedge \sigma = \mathbf{0}$, it is the case that $\tau \rightarrow \overline{\sigma}$ ('$\overline{\sigma}$ is the weakest piece of information incompatible with σ.) In fact, in what follows, I will restrict attention to *coherent* SOA algebras. This means that for no situation $s_0 \in SIT_0$ and SOA $\sigma_0 \in SOA_0$ is it the case that $s_0 \models \sigma_0$ and also $s_0 \models \overline{\sigma_0}$.

An important feature of the SOA algebra that will be exploited below is the fact that it is **not** in general the case that for a SOA σ:

(115) $\quad \sigma \vee \overline{\sigma} = 1$

That is, given a SOA σ and a situation s_0, it is not guaranteed that $s_0 \models \sigma$ *or* $s_0 \models \overline{\sigma}$.[41]

By the same token one might ask why within this framework all meets of the form $\sigma \wedge \overline{\sigma}$ collapse to a unique bottom element 0.[42] I believe this is a legitimate question which might lead one to adopt an algebraic structure somewhat weaker than assumed here. In the current work, I will not explore the issue further.[43]

5.4 Questions and Propositions

In what follows let us assume a fixed SOA algebra SOA-ALG$_0$ $=< Sit_0, SOA_0, \rightarrow, \models, 0, 1 >$. Questions and propositions will not be analysed *reductively*: I will postulate a universe which contains for any situation-SOA (s_0, σ_0) pair in Sit_0 x SOA_0 a question, the question *whether* σ_0 *is a fact of* s_0, notated as $(s_0?\sigma_0)$ and a proposition, the proposition/claim *that* σ_0 *factually describes* s_0 will be notated as $(s_0!\sigma_0)$. What the situation/SOA components provide us with are the means for characterising truth and decidedness, a context independent notion for questions from which resolvedness will later emerge by appropriate relativisation:

- $(s_0?\sigma_0)$ is *decided* iff $s_0 \models \sigma_0$ or $s_0 \models \overline{\sigma_0}$.
- $(s_0!\sigma_0)$ is *true* iff $s_0 \models \sigma_0$.

---

1. If $s \models \sigma$ and $\sigma \rightarrow \tau$, then $s \models \tau$.
2. $s \not\models 0$, $s \models 1$.
3. If Σ is any finite set of infons, then $s \models \bigwedge \Sigma$ iff $s \models \sigma$ for each $\sigma \in \Sigma$.
4. If Σ is any finite set of infons, then $s \models \bigvee \Sigma$ iff $s \models \sigma$ for some $\sigma \in \Sigma$.

Barwise and Etchemendy actually allow that the algebraic structure on the SOA's be weaker than Heyting, though for our purposes closure under arbitrary meets and joins is important.

[41] One illustration of this, originally due to Barwise, concerns direct perception reports. Barwise's claim was that the objects of perception in these cases are partial segments of the world. Hence the report (ia) describes Jill as seeing a situation s_0 in which the SOA
$\langle$ WALK, walker: **bill**;+ $\rangle$ is factual. However, the question (s$_0$? $\langle$ TALK, talker: **mike**;+ $\rangle$) need not be resolved, since e.g. **mike** might be an entity external to s_0. Hence, the inference from (ia) to (ib) is not licensed (although the reverse direction is licit.):

(ia) Jill saw Bill walk.

(ib) Jill saw Bill walk and Mike talk or Mike not talk.

[42] For instance, if we want the SOA's to represent contents of cognitive states, it seems plausible to require different kinds of contradictory states to be individuated.

[43] This point was brought to my attention by Gennaro Chierchia.

It is at this point that the partiality of situation theory is essentially exploited: given a SOA σ and a situation s_0, it is not guaranteed that $s_0 \models \sigma$ *or* $s_0 \models \overline{\sigma}$. A given situation need not, in fact in most cases will not, decide or settle all *questions.* Equally, if a proposition $(s_0!\sigma_0)$ is false it does not, on this view, follow that σ_0 represents non-veridical information, rather it follows that s_0 lacks "positive proof" of σ_0's accuracy ('the snapshot chosen does not pertain to this scene, without necessarily being fake.')

Sofar we have accommodated propositions and yes-no questions "on top of" a basic ontology containing situations and SOA's. However, given the intuition described above concerning the nature of questions, the general schema for questions involves associating "SOA's" containing n holes with a situation. How to conceive of these "holey" SOA's? Here we can take two tacks: the first is to expand the class of SOA's by allowing in a new kind of SOA, dubbed *partial* in Crimmins 1991 and (confusingly from the current point of view!) *unresolved* in Ginzburg 1992a. These SOA's differ from the ones described above in that the argument-role to entity assignment component of the SOA is a strictly *partial* mapping: for instance in (116) the argument-roles assigned a '–' do not get an entity associated with them:

(116) a. $\langle$ **LIKE, liker:jill, likee:**–; + $\rangle$

b. $\langle$ **HOT, location:**–, **time:** –; + $\rangle$

The second tack, one which I will adopt in the current work, is, in some sense, more ontologically conservative.[44] I identify "holey" SOA's with n-ary abstracts. Thus, each "hole" corresponds to an argument role that has been abstracted over:

(117) a. $\lambda x\langle$ **LIKE, liker:jill, likee:x**; + $\rangle$ (abstract corresponding, roughly, to 'who does Jill like')

b. $\lambda x, y\langle$ **HOT, location:x, time:y**; + $\rangle$ (abstract corresponding, roughly, to 'when is it hot where')

I assume these abstracts are construed situation theoretically: see Aczel and Lunnon 1991 for a mathematical account of a requisite notion of abstraction, Barwise and Cooper 1991 for a reworking of this notion into situation theory. In addition to SOA's and situations, the universe also contains a class of SOA-abstracts, SOA-ABST$_0$.[45]

Within this view of abstraction, abstracts can be *applied* to assignments, assignments to the parameters abstracted over, with output a SOA. I call such a SOA a *specification* of the abstract:

(118) a. $\lambda x\langle$ **LIKE, liker:jill, likee:x**; + $\rangle[x \mapsto$ **mike**$] = \langle$ **LIKE, liker:jill, likee:mike**; + $\rangle$

b. $\lambda x, y\langle$ **HOT, location:x, time:y**; + $\rangle[x \mapsto$ **HCRC**$, y \mapsto$ **3am**$] = \langle$ **HOT, location:HCRC, time:3am**; + $\rangle$

Hence, the notion of a specification-set defined and exemplified in figure 11.

With this sketch of the properties of abstracts, we can describe how questions fit into the universe.**In general: I assume that any situation $s_0 \in$ Sit$_0$ and n-ary ($n \geq 0$) abstract $\lambda X_1, \ldots, X_n\sigma(X_1, \ldots, X_n) \in$ SOA-ABST$_0$ give rise to a question $(s_0?\lambda X_1, \ldots, X_n\sigma(X_1, \ldots, X_n))$.**

In figure 12 a general definition of decidedness is offered, which for a question $(s_0?\mu)$ amounts to the exhaustive answer defined by μ and Sit_0 being a fact of s_0. Specifically, given (120), Fact-$\bigwedge$ amounts to the following:

[44] What side the balance of ontological conservatism/parsimony/plausability tilts to in this case is, of course, far from clear: the idea for countenancing partial SOA's for this kind of purpose derives from Crimmins 1991, whose intention was to provide an entity that could perform many of the functions required of states-of-affairs containing *parameters* while avoiding the ontological commitment to parameters as semantic entities. Thus, in terms of the underlying metaphor developed here, the reductive analysis of partial SOA's to relation-like entities, SOA-abstracts, might be argued to be unfortunate. Nonetheless, since abstracts appear to perform the semantic tasks required of them here quite adequately, I do not attempt to fully satisfy my own ontological "intuitions". Whether this proves to be a substantive issue must await more direct attempts at cognitive modelling. I am indebted to Robin Cooper for discussion and proposals concerning this issue.

[45] Barwise and Cooper 1991 assume also the existence of a class of proposition abstracts; these are irrelevant to the current discussion.

(119) SPECIFICATION-SET$(\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n)) =_{def}$
$\{\tau \in SOA_0 | \exists f(\tau = \lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n)[f])\}$

For instance:

(120) a. $\{\langle$ R,a;+ $\rangle\}$ = SPECIFICATION-SET($\langle$ R,a;+ $\rangle$) (For a SOA, the specification set is a singleton.)

b. Any $\langle\langle$ R,a;+ $\rangle\rangle$ that is in SOA_0 will be $\in$ SPECIFICATION-SET($\lambda X\langle$ R,X;+ $\rangle$)

Figure 11: The SPECIFICATION-SET defined by a SOA-abstract

(121) $(s_0?\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n))$ is **decided** iff
$s_0 \models$ Fact-$\bigwedge_{Sit_0}(\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n))$

Fact-$\bigwedge_{Sit_0}$ represents the most exhaustive specification determined by the n-ary abstract component of a question *relative to the given set of situations* Sit_0:

(122) Fact-$\bigwedge_{Sit_0}(\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n)) =_{def}$
Either
$\bigwedge(\{\tau \in SOA_0 | \exists f(\tau = \lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n)[f]) \wedge \exists s_0(s_0 \in Sit_0 \wedge s_0 \models \tau]\})$ **if this set** $\neq \emptyset$
Or
$\bigwedge(\{\tau \in SOA_0 | \exists f(\tau = \overline{\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n)[f]}) \wedge \exists s_0(s_0 \in Sit_0 \wedge s_0 \models \tau]\})$ *Otherwise*

Figure 12: Decidedness conditions for a question

- For a yes/no-question $(s_0?\sigma)$: Fact-$\bigwedge_{SIT_0}(\sigma)$ is whichever of σ or $\overline{\sigma}$ is factual relative to Sit_0, if either is.
- For a wh-question $(s_0?\lambda X_1\ldots X_n\sigma(X_1\ldots X_n))$, Fact-$\bigwedge_{SIT_0}(\lambda X_1\ldots X_n\sigma(X_1\ldots X_n))$ is the maximal factual specification if any factual specifications exist; otherwise, it is the negative universal quantificational answer (if that is made factual by Sit_0)

The two important tasks that remain are describing the aboutness relation and the conditions for a question to be resolved.

5.5 Aboutness

I am assuming that *aboutness* discussed previously is a relation entirely determined on the level of SOA's and abstracts, so that a proposition $(s_1!\tau_0)$ is *about* a question $(s_0?\lambda X_1,\ldots,X_n\sigma(X_1,\ldots,X_n))$ iff About$(\tau_0,\lambda X_1\ldots X_n\sigma(X_1\ldots X_n))$ regardless of the identity of s_1 and s_0. *About* is what I will now characterize: attempting to capture the observations of section 3.[46]

The basic tool utilised is the informational partial-ordering $\rightarrow$ among the SOA's: the range of SOA's about a given abstract μ will involve subsuming a certain SOA (or SOA's) determined by μ. This means that the particular notion of aboutness we obtain is a consequence of the particular $\rightarrow$ we pick as our notion of informational subsumption. My assumption about this partial order is that is at least as rich as needed for generalised-quantifier subsumption between SOA's (so that

[46] I am indebted to Stanley Peters for important suggestions which lead to this method of defining aboutness.

e.g.
$\langle$ MANY, $\lambda Z\langle$ Q,Z;+ $\rangle$, $\lambda X\langle$ R,X;+ $\rangle$;+ $\rangle$
$\rightarrow \langle$ EXISTS, $\lambda Z\langle$ Q,Z;+ $\rangle$, $\lambda X\langle$ R,X;+ $\rangle$;+ $\rangle$.)

If we allow a more defeasible notion we should in principle be able to accommodate "indirect aboutness" of a type broached in section 2 (e.g. example (26)).

5.5.1 Potential resolvedness

Recall that in section 3 I motivated a distinction between the (class of) SOA's that *potentially resolve* a question and those that are merely *about* a given question. I start by defining the former relation:

(123) Given a SOA τ and a SOA-abstract μ, Pot-Resolve(τ,μ) holds iff either

a. $\tau \rightarrow \bigvee$SPECIFICATION-SET(μ)

Or

$\tau \rightarrow \overline{\bigvee\text{SPECIFICATION-SET}(\mu)}$

Figure 13: Potential Resolvedness conditions

Given (120a), for a 0-ary abstract, a SOA, $\bigvee$SPECIFICATION-SET(μ) is simply μ, hence $\overline{\bigvee\text{SPECIFICATION-SET}(\mu)}$) is $\overline{\mu}$. So for yes/no-questions, the relation reduces to:

(124) Pot-Resolve(τ,μ) iff $(\tau \rightarrow \mu) \vee (\tau \rightarrow \overline{\mu})$

On the other hand, for $n \geq 1$: $\bigvee$SPECIFICATION-SET(μ) is $\exists X_1,\ldots,X_n\sigma(X_1,\ldots,X_n))$, hence $\overline{\bigvee\text{SPECIFICATION-SET}(\mu)}$ is $\forall X_1,\ldots,X_n\overline{\sigma(X_1,\ldots,X_n)}$. Thus, for wh-questions, the relation reduces to:

(125) Pot-Resolve$(\tau,\lambda X_1,\ldots,X_n(\sigma(X_1,\ldots,X_n)))$ iff $(\tau \rightarrow \exists X_1,\ldots,X_n\sigma(X_1,\ldots,X_n))$ $\vee\ (\tau \rightarrow \forall X_1,\ldots,X_n\overline{\sigma(X_1,\ldots,X_n)})$

Hence the relation classifies as *potentially resolving* specifications and quantifications of the abstract for which the quantificational force is monotone increasing or stronger than the pure negative universal:

(126) a. $\langle$ R,a;+ $\rangle \wedge \langle$ R,b;+ $\rangle$ **is Pot-Resolve** $\lambda X\langle$ R,X;+ $\rangle$

b. $\langle$ R,a;+ $\rangle$ **is Pot-Resolve** $\lambda X\langle$ R,X;+ $\rangle$

c. $\langle$ SEVERAL, $\lambda Z\langle$ Q,Z;+ $\rangle$, $\lambda X\langle$ R,X;+ $\rangle$;+ $\rangle$ **is Pot-Resolve** $\lambda X\langle$ R,X;+ $\rangle$

d. $\langle$ NO, THING, $\lambda X\langle$ R,X;+ $\rangle$;+ $\rangle$ **is Pot-Resolve** $\lambda X\langle$ R,X;+ $\rangle$

However, both monotone decreasing quantificational forces (e.g. 'few', 'at most one') and disjunctions of specifications with negative specifications (e.g. $\langle$ R,a;+ $\rangle \vee \langle$ R,b;+ $\rangle$) are not classified as potentially resolving since neither disjunct in the defining condition above is informationally subsumed. This appears to be as desired.

5.5.2 Aboutness

Aboutness as we saw is a more inclusive relation than *Pot-resolves* and the definition displayed in figure 14 captures this aspect.

Note that here we make strong use of partiality: whereas on a traditional model-theoretic conception this defining condition is vacuous, given that in the SOA algebra $\sigma \vee \overline{\sigma} \neq 1$, the

(127)	Given a SOA τ and a SOA-abstract μ, About(τ, μ) holds iff $\tau \rightarrow$ $\bigvee$SPECIFICATION-SET(μ) $\vee$ $\overline{\bigvee}$SPECIFICATION-SET(μ)

Figure 14: Aboutness conditions

condition is restrictive. On the one hand, then, $\langle$ LEAVE, leaver:j;+ $\rangle$ will *not* be about $\lambda X\langle$LIKES ,X;+ $\rangle$.

However, some classes of SOA's that were classified as not being *potentially resolving* are accommodated:

(128) a. $\mu = \langle\langle$ AT-MOST-3, $\lambda Z\langle$ Q,Z;+ $\rangle$, $\lambda X\langle$ R,X;+ $\rangle$;+ $\rangle$ **is about** $\lambda X\langle$ R,X;+ $\rangle$ (Intuitively: 'at most one person left.' subsumes the disjunction 'There exists some person that left or no one left.')

b. $\mu = \langle$ R,a;+ $\rangle \vee \langle$ R,b;- $\rangle$ **is about** $\lambda X\langle$ R,X;+ $\rangle$ (Intuitively: 'John left or Mary didn't leave.' subsumes 'John left or someone other than Mary left or no one left.')

One strand must remain open for now: the precise nature of *aboutness* when the second argument is a SOA. From a purely descriptive point of view I have suggested that for a yes/no question 'whether p' the class of informational items *about* this question should include at least all modal informational items of the form 'mod p' ('possibly p', 'unlikely p' etc.) The schema we have here yields

(129) About(τ, σ) holds iff $\tau \rightarrow \sigma \vee \overline{\sigma}$

In a SOA algebra the join of a SOA σ and its dual $\overline{\sigma}$ represents the strongest information compatible with both σ and $\overline{\sigma}$. A number of semantic treatments of modals (see e.g. Veltman 1990) view 'might p' as representing information that is *incompatible* with an information state that already contains $\neg p$ (though the converse case, wherein $\neg p$ enters in an update subsequent to information classified by 'might p', is consistent.) Thus, it seems plausible to conjecture that the class of information which is *stronger* than $\sigma \vee \overline{\sigma}$ will include the requisite modal information. Demonstrating that this is indeed the case requires a (modal) extension to the notion of SOA algebra that is, as yet, unavailable.

5.6 Resolvedness

We have already seen how to define a notion of *exhaustiveness* defined by a question, when the decidedness conditions were defined in (121) above. I now move to provide a characterisation of the relativised notions of *resolvedness* and *partial resolvedness.*

The conclusions reached in section 3 concerning resolvedness were the following:

(130) I_0 is information resolving q_0 relative to a goal condition g_0 and mental state ms_0 if and only if I_0 is factual, is informationally stronger than g_0 relative to the informational resources of ms_0, and potentially resolves q_0.

Given this and what we have seen above, the definition in figure 15 is straightforward:

A proposition $(s!\tau)$ where τ satisfies the above clauses will be referred to as a *(g,ms) resolving answer.*

One clause of this definition, the third, requires additional comment: $\Rightarrow_{ms}$ is taken to be a notion of consequence available to the mental state *ms*. I offer nothing concrete on the nature of this notion: minimally, it could be identified as the transitive closure of the conditionals represented in *ms*. The clause is subdivided into two cases, depending on whether the goal is a question or proposition, in accord with the assumption on the SOA level determined by a goal (see (36)).

It is simple to see that if g_0 is fixed to be q_0, and $\Rightarrow_{ms}$ to be $\rightarrow$, then *resolvedness* reduces to *decidedness.*

(131) $q_0 = (s?\sigma)$ is **resolved** relative to g and ms iff $\exists\tau$ such that:

a. $s \models \tau$

b. Pot-Resolves(τ, σ)
And either:

c. $\tau \Rightarrow_{ms}$ Fact-$\bigwedge(g_0)$, if g is a question $(s_1?g_0)$.
Or:
$\tau \Rightarrow_{ms} g_0$, if g is a proposition $(s_1!g_0)$.

Figure 15: Resolvedness conditions

5.7 Partial Resolvedness

The conclusions reached in section 3 concerning partial resolvedness were the following:

(132) I_0 to Q-extent resolves q_0 relative to g_0 and ms_0 iff I_0 is factual, about q_0 and there exists I_1 that resolves q_0 relative to g_0 and ms_0 such that:

for Q-many informational items μ that are about q_0 and such that I_1 informationally subsumes μ, it is also the case that I_0 subsumes μ

The following definition attempts to capture this idea:

(133) $(s?\sigma)$ is to Q-extent resolved relative to g and ms iff $\exists\tau, \chi$ such that:

a. $s \models \tau$

b. For Q-many μ such that ABOUT(μ, σ) and $\chi \Rightarrow_{ms} \mu$, it is also the case that $\tau \Rightarrow_{ms} \mu$

c. $(s!\chi)$ is a (g,ms) resolving answer.

Figure 16: Partial Resolvedness conditions

5.8 Compound questions

What of compound questions and propositions? Barwise and Etchemendy show how, given any SOA algebra S_0, a Boolean algebra of propositions, $PROP(S_0)$, can be defined above S_0. Thus, although the algebraic structure on the SOA's in S_0 is not classical, the propositions can be provided with a classical logic in which identities such as the following hold:

(134) a. $(s!\sigma \vee / \wedge \tau) = (s!\sigma) \vee / \wedge (s!\tau)$

b. $(s!\sigma) \vee (s!\overline{\sigma}) = 0$

The reader is referred to Barwise and Etchemendy's paper for details. Two questions remain in this regard which I will briefly discuss. First, should there be common algebraic structure for questions and propositions? The second, what kind of algebraic structure should be defined for questions?

The first question arises because of constructions such as:

(135) Jill know who left and/or that Mary had been disappointed.

Examples such as (135) are among the motivations for Groenendijk and Stokhof's approach in which the extension of an interrogative is assumed to be of the same semantic type as the *intension* of a declarative, namely propositional.

(136a,b) illustrate that predicates that respectively license questions and propositions do not license hybrid question-propositions:

(136) a. # Bill asked who left and/or that Mary had been disappointed.

b. # Jill believed who left and/or that Mary had been disappointed.

This would appear to be problematic for the assumption that hybrid question-propositions are semantic entities in their own right. The alternative would be to assume some distributive mechanism that feeds in the declarative and interrogative argument separately. This would provide an account of the infelicity of (136), as well as accommodating (135). In fact, Groenendijk and Stokhof have argued that predicates that allow such constructions distribute over conjunction and disjunction of interrogatives.[47]

I offer a sketch of how to extend compounding to questions. Note first that the meet/join operations of the SOA algebra can be naturally extended to SOA-abstracts as follows:

(137) $\lambda X_1, \ldots, X_n \sigma(X_1, \ldots, X_n) \vee / \wedge \lambda Y_1, \ldots, Y_m \tau(Y_1, \ldots, Y_m)$
$=_{def} \lambda X_1, \ldots, X_n, Y_1, \ldots, Y_m \sigma(X_1, \ldots, X_n) \vee / \wedge \tau(Y_1, \ldots, Y_m)$ (Cooper 1993)

The idea would then be to extend compounding to the class of questions such that the following get identified:

(138) a. $(s?a) \wedge (s?b) = (s?(a \wedge b))$

b. $(s?a) \vee (s?b) = (s?(a \vee b))$

Given (137), we obtain fairly natural results such as

(139) SPECIFICATION-SET$(a \wedge b) = \{\tau \in SOA_0 | \exists \sigma, \mu \in SOA_0((\tau = \sigma \wedge \mu) and (\sigma \in SPECIFICATION-SET(a), \mu \in SPECIFICATION-SET(b)))\}$

Similarly, since $\models$ distributes over both $\wedge$ and $\vee$, (i.e. $s_0 \models \tau \wedge (\vee) \sigma$ entails $s_0 \models \tau$ and (or) $s_0 \models \sigma$).), it is straightforward to show that $(s?(a \wedge (\vee) b))$ is decided iff $(s?a)$ and (or) $(s?b)$ are decided. Similarly for resolvedness.

Whether we actually want compound questions so tightly reduced to an operation such in (138) might be called into question in light of examples (based on examples due to Lahiri 1991) as:

(140) What I find really odd is who came at 4 and who left at 6. (Does not follow: What I find really odd is who came at 4 and also what I find really odd is who left at 6.)

This suggests that rather than identifying compound questions in the manner of (138), what is required is a weaker sort of equivalence.

6 Concluding Remarks

In this paper a theory of questions was proposed that provides a unified characterisation of various uses interrogative clauses as well as other question denoting expressions can be put to, including uses as query objects and as descriptions of information, factual ('know who/why/where/whether...') or otherwise ('have intuitions about who/why/where/whether...').

The formal part of the account is based on a situation theoretic characterisation of two relations, *About* and *Resolved*:

[47] Conditionals are a somewhat different case since they clearly do form hybrids, of genus question:
(i) Bill asked who would come if Jill left.
(ii) # Bill believed who would come if Jill left.
These hybrids, nonetheless, can be handled not as question/proposition compounding but simply as SOA/SOA-abstract compounding of the kind discussed below.

- *About* is a relation between states-of-affairs (SOA's), viewed as items of information, and abstracts, viewed as underspecific items of information. Attunement to this relation is assumed to underlie the intuitions speakers exhibit in judging whether or not a response coheres with the query that elicited it.

- *Resolved*: a question $(s_0?\sigma_0)$ is conceived of as a relational entity individuated in terms of a situation s_0 and an abstract σ_0. Informally, $(s_0?\sigma_0)$ is resolved if and only if s_0 contains all relevant information about σ_0 known to be factual. The question is partially/for the most-part resolved iff s_0 contains some/most of this information.

Thus, on the present account, question objects are *not* viewed as representing *choices* of possible answers. Rather, the metaphor here is that a question provides an underspecified informational item, the abstract that specifies its aboutness domain. The crucial difference lies in the fact that on the current account a question can be fixed by provision of the abstract and a situation, *without* having any information about what the actual range of possible specifications is. Hence, the metaphor can accommodate *ignorant* queriers, ones who are not aware of the range of possible answers available to them.

The separation between aboutness and resolution enforced by the strategy of not *building into* the content assigned to question-denoting expressions *which* items of information about the question jointly constitute the resolution of that question affords a number of important advantages:

1. **Querying**: the account provides a description, more faithful than previous accounts, of the range of information, ranging from informationally very "weak" to completely resolving, which can serve as contents of felicitous responses to a query use of a question.

2. **Describing Information**: At the same time, it was shown that a richer domain of answers, a subclass of the information about the question, is needed to adequately characterise the class of informational items that can *potentially* resolve a given question: any of the items from this expanded range can, in particular contexts, become actually resolving, depending on such factors as what causal role the information is associated with or what knowledge or beliefs those manipulating that information have.

3. **Lexical properties of predicates**: I have demonstrated that the condition 'the content of the complement is resolved' is a presupposition carried to varying extents by predicates that take questions as arguments. Given the *semantic* nature of this characterisation, syntactically diverse complements can be uniformly characterised. A resolved question, just as a true proposition, can be used to describe factual information—that information which resolves the question. Nonetheless the distinction between a true proposition and a resolved question is revealed to be an important one: on the one hand, the account capture the 'veridicality' inherent in the dependency specified by predicates such as *depend-on* and *be-a-function*, predicates that are inapplicable to propositions. Conversely, the distinction makes possible the provision of a principled account of a fact problematic for any account that assigns propositional denotations to (certain classes of embedded) interrogatives, namely that predicates such as *believe* and *claim* that are applicable to (true) propositions are inapplicable to questions.

7 Appendix: Alternative approaches to interrogative complementation

In this appendix I compare some aspects common between my account of interrogative complementation and a number of recently proposed accounts, Groenendijk and Stokhof 1984, 1993, Berman 1991 and Lahiri 1991.

7.1 The QVE: an interrogatively based ambiguity?

The account I have proposed above for interrogative and declarative complementation did not build in any *ambiguities per se*, although the data provided might suggest some grounds for so doing. Instead, I have pinned most of the work on intrinsic lexical properties of the predicates such as factivity and resolutivity. Apart from considerations of parsimony, such a strategy is more promising in the light of the wide range of "idiosyncrasy" displayed (non/semi/full factivity/resolutivity) and in light of the semantic and cross-linguistic uniformity across distinct syntactic expressions.

I start by considering a phenomenon that has been a focus of much recent discussion, the 'quantificational variability effect' (QVE), first noted by Berman 1990, 1991, subsequently analysed in Lahiri 1991 and Groenendijk and Stokhof 1993. The main reason for considering this issue here is that it bears upon the decision of whether interrogatives should be assumed ambiguous: the claim in all three accounts offered hitherto is that only a certain class of interrogative clauses, those embedded by a certain class of predicates, whose nature is disputed among the three accounts, exhibit a particular ambiguity.

I have already argued, in section 3.6 that the reading provided by all three accounts is inadequate and suggested an alternative reading for the predicates they consider using the notion of a complement being required to be partially resolved. I will show that once one moves away from a reading involving *quantificational variability* all interrogative embedding predicates within the appropriate context can trigger the ambiguity. This will lead to a demonstration that the additional reading is independent of the nature of the embedded complement.

7.1.1 The nature of the QVE

Berman 1990 argues that sentences such as those in (141) exemplify a fundamental bifurcation among interrogative clauses. His claim is that whereas in (141b) the adverb can only be interpreted as quantifying over cases/events/situations—a reading I shall dub the cases reading— (141a) displays an additional reading, one I shall dub the *qv* reading, paraphrasable as (141c):

(141) a. Jill to some extent/mostly/often/seldom knows which students cheat on the exam.

b. Jill to some extent/ mostly/often/seldom wonders which students cheat on the exam.

c. For some/most/many/few students x that cheated on the exam, Jill knows that x cheated on the exam.

Berman assumes that the relevant distinction among embedding predicates is factivity: factive predicates do and non-factive predicates do not display the qv reading. The proper characterisation of the class of predicates that (putatively) do not display qv readings is a matter of some controversy among the three accounts, though there is broad agreement that it should include 'predicates of questions' such as *wonder, ask, investigate,* and *discuss.*. I will henceforth dub the complement of this class, those predicates that do exhibit qv readings, the class of "answer predicates".

The first issue of data raised here concerns which adverbs actually exhibit a *qv* as distinct from *cases* reading. Here I follow Lahiri, who argues carefully and in detail, that adverbs of frequency show no QVE effect: there is no question/answer bifurcation for these adverbs, no reading distinct from the cases reading. It is only adverbs of quantity that bring out an additional reading:[48] Thus, (142a) (Lahiri's (218)) should be paraphrased as (142b) (Lahiri's (224)) not (142c) (Lahiri's (219)):

(142) a. John usually knows who does well on the exam.

b. For most exams, John knows more or less who does well on the exam.

c. Most x, x does well on the exam, John knows that x does well on the exam.

[48] This was also noted, independently in Srivastav 1991 and Ginzburg 1992a.

7.1.2 A different perspective on the QVE?

Sofar, then, we have seen two important empirical revisions to the initial QVE data in (141): the first concerned the fact that for adverbs of frequency no qv reading or question/answer-predicate bifurcation exists. The second revision concerned the nature of the qv reading: we saw in section 3.6 that that reading did not in general involve quantificational *variability* as such. I now attempt to demonstrate that question predicates such as *wonder, investigate, discuss* and *ask* also exhibit a qv reading.

Some care is required here: it is clear that such predicates do not display a reading such as that paraphrased in (141a). This is hardly surprising given my claim that also answer predicates do not actually exhibit such a reading. In addition, all these predicates are, in the terms described above, non-resolutive predicates: hence the interrogative complement is not being used to describe a factual resolution of the denoted question; the predicates are not *applicable* to declaratives for such a reading to be available in principle.[49]

Nonetheless, my claim is that such predicates certainly do allow for readings distinct from the cases reading, readings which for both question and answer predicates can be paraphrased as follows:

(143) a. Jill adverb V Q = Jill had adverb-many Nom(V) of Q.

b. Jill for the most part/hardly/to some extent knows Q = Jill had almost complete/very partial/partial knowledge of Q.

c. Jill for the most part/hardly/to some extent discussed Q = Jill had almost complete/very partial/partial discussion of Q.

Consider first (144):

(144) a. This issue, who to hire for the position, is highly complex. We have managed sofar to discuss it only to a very limited extent/partially.

b. A limited/partial discussion of who to hire for the job ensued.

It seems clear that (144a) has a qv reading, paraphrasable as in (144b). Consider now (145):[50]

(145) a. There have been many issues for us to investigate, far far too many for us to do a thorough job. We have to some extent investigated who committed the crime, we have fully investigated who was at the scene of the crime, but only to a limited extent when the suspects were in town.

b. Partial investigation of the first issue, complete investigation of the second issue, limited investigation of the third issue.

(145a) has a reading paraphrasable as in (145b), one quite distinct from the cases-reading. A similar reading can be found for the predicate *depend*:

(146) Who comes here in the morning depends to some extent on how many terminals are free. (There is a partial dependency of the resolution of the question who comes here to the resolution of the question how many terminals are free.)

[49] Berman 1991 is aware of this point, as his discussion on p. 84 makes clear. However his discussion does not entirely address the problem: he suggests that even though question predicates do not have declarative complements, it is *prima facie* surprising that e.g. 'The principal mostly wonders which students cheat on the exam' has no reading wherein 'for most students x such that x cheated on the final exam, the principal stands in the wondering relation to the proposition that x is a student and x cheated on the final exam.' Given that *wonder* and other QI predicates are inapplicable to propositional denoting expressions in general, as we have seen above, this would make the proposed paraphrase ill-formed.

[50] This example was suggested to me by Elisabet Engdahl.

With *wonder*, it is somewhat less easy to get such readings: wondering involves, roughly, a desire to get an unresolved question resolved. Partial wonderment would thus appear to involve either a partial desire or a partially resolved question or both:

(147) a. I was really perplexed by his attack. Nonetheless, your explanation of his behaviour seems reasonable. I still wonder to some extent at least why anyone would adopt such an attitude (that is, to some extent I want to possess an explanation that could resolve that issue.)

b. To some extent I do wonder if there's any point in pursuing this project anymore. (That is, to a certain extent I realize why we should pursue the project, but I also have doubts.)

With *ask*, given its reportive function, some work is required to construct convincing examples of non-cases readings:

(148) a. I'm not sure if there is any point in my raising this question, how you deal with these ECP counterexamples, since the previous speaker was to a large extent asking this same question.

b. I hope you realize that what he's doing is to some extent asking you how much you'll pay up.

The conclusion these data point to is that adverbs of extent can trigger qv readings for QI predicates. The basic criterion for availability of such a reading seems to be: to what extent can the argument of the predicate be "partially consumed": partial knowledge or recollection are more easily conceivable than partial wonderment or asking. We will now see that non-cases readings also arise with non-interrogative complements of these same predicates: here again it appears that variability exists with respect to the availability of readings, variability that is not correlated with question/answer, factive/non-factive correlation.

Consider first (149):

(149) a. Bill is to some extent/partially/for the most part aware of this fact. (Bill has partial/almost complete awareness of the fact.)

b. ?Bill to some extent/partially/for the most part announced this fact.

Note that whereas (149a) is perfectly acceptable and shows what would appear to be a qv reading, (149a) is somewhat odd. Both *be aware of* and *announce* are answer predicates and exhibit qv readings with interrogatives.

Consider now (150):

(150) a. Jill has discovered to some extent that unpasteurised milk causes botulism in rats. Further tests are needed before we can be convinced that that is indeed the case. (Jill's discovery to that effect is still incomplete.)

b. The scientist regretted to a limited extent that unpasteurised milk causes botulism in rats. (The scientist has a partial regret concerning that fact.)

c. ?The committee announced to a limited extent/for the most part that unpasteurised milk causes botulism in rats.

d. Bill believes to a limited extent/for the most part that unpasteurised milk causes botulism in rats. (Bill has a partial/almost complete belief to that effect, he thinks there is some/much evidence showing it to be the case.)

(150a) illustrates that just as adverbs of extent can modify the resolutivity of a predicate embedding an interrogative complement, these adverbs can also modify the factivity of an embedded declarative. (150b) contrasts minimally with (150a): whereas with a semi-factive like *discover*, the factivity disappears (is projected away), with a full factive like *regret*, the factivity is maintained. In both cases a qv reading is exhibited. (150c) illustrates that *announce* can also be odd with declaratives when modified by adverbs of extent, leaving a cases reading as the more available reading. Finally (150d) illustrates a qv reading for a TF predicate such as *believe*.

7.1.3 The QVE: conclusions

The most important conclusion for current purposes is that, whatever the exact nature of qv readings, they do not exemplify an intrinsic bifurcation among interrogative embedding predicates. Indeed, once we concentrate our attention on adverbs of extent, given that adverbs of frequency do not allow for qv readings, we see that qv readings simply do not involve quantificational variability, as predicted by all three previous accounts of the QVE. Following this, the existence of qv readings among question predicates such as *wonder, investigate, discuss* and *ask* becomes noticeable: a common paraphrase for this reading was suggested in terms of modification of a nominalisation of the embedding predicate. The availability of a qv reading with the predicate seems to correlate well with the plausability of adjectival modification of the nominalised predicate. Indeed, similarly paraphrasable readings are available for all these predicates with non-interrogative complements such as declaratives and NP's, though here, as with interrogative complements, there is variability in the availability of the qv reading.

One possible account of this reading is to treat it as resulting from V modification: this could account for resolutivity/factivity projection properties, which are uniform for a given predicate. Thus, *be-amazed* or *regret* are holes both for factivity and resolutivity when extent-modified, whereas *discover* or *be aware* filter them away. *to-some-extent discover* is both partially resolutive and partially factive:

(151) a. Bill has to some extent discovered which person committed the crime. (Bill has discovered facts that go some way towards resolving the question of which person committed the crime.)

b. Bill has to some extent discovered that unpasteurised milk causes botulism in rats. (Bill has discovered facts that go some way towards establishing the truth of the claim that unpasteurised milk causes botulism in rats.)

I will not attempt to spell out this possible account in the current work.

7.2 Enriching answerhood and quantification over answers

The data we have seen seems problematic for approaches that try to pin the qv reading on quantification over the argument role associated with the wh-phrase in the embedded interrogative complement, as Berman's DRT account and Groenendijk and Stokhof's DMG account do.[51] The intuition underlying Lahiri's account is quite different, even though for these cases he obtains a Berman style reading.

The intuition underlying Lahiri's account is that a partial ordering can be defined on the set of answers to a given question in such a way that adverbs quantify over certain minimal elements of this algebra. This is to be seen simply as one instance of the familiar phenomenon

[51] Very roughly, Berman assumes that the embedded wh-interrogative denotes an open sentence and a DRT/FCS approach to adverbs (Lewis 1975, Kamp 1981, Heim 1982). He correlates the existence of a qv reading with the factivity of the embedding predicate. Hence, on his account, the embedded clause gets copied by 'presupposition accommodation' into the restrictive clause, which results in the requisite logical form. Groenendijk and Stokhof manage to achieve a similar effect within Dynamic Montague Grammar using dynamic 'donkey equivalence' so that an adverb of quantification modifying an implicational structure can 'capture' any existentially quantified variable that appears in the antecedent.

of adverbial modification of mass terms, plurals etc, all of which can be modelled naturally as Boolean structures of some kind.

Given the Hamblin/Karttunen denotation for interrogative which Lahiri assumes, the set of answer to a wh-interrogative is the set of its instantiations. Hence, the minimal parts of the answer are the individual instantiations. Thus, (152a) gets paraphrased as (152b):

(152) a. John mostly/partly knows who did well on yesterdays's exam.

b. Most/Some atomic factual answers to 'who did well on the exam' are atomic factual answers such that John knows them.

Thus, given the relation of answerhood assumed by Lahiri, this is equivalent, as Lahiri notes, to the reading proposed by Berman, which I have argued above to be incorrect.

It is worth pointing out what appears to be a source for this problem, namely the restricted notion of answerhood assumed. Once the range of answerhood is expanded, by allowing in e.g. quantified answers, and the notion of completeness is refined to allow goals distinct from the exhaustive answer, then the individual instantiations are no longer the atoms of the answerhood algebra that measure the 'extent' to which an answer is partial. This, for instance, directly blocks the quantificational variability reading from arising. Such an account achieves an effect similar to that achieved by assuming resolutivity can be modified, as is implicit in the definition of partial resolvedness in section 5.7. The two accounts differ in how they see the modification arising: given that I do not assume an interrogative ambiguity, there are no answers around to quantify over: for reasons I come to now I believe the asymmetries in interpretation between different interrogative clauses that Lahiri builds in are problematic.

Lahiri assumes the existence of a semantic type distinction among interrogative complement predicates. Predicates such as *know* are assumed to take arguments of type $< s, t >$, whereas predicates such as *wonder* take arguments of type $<< s, t >, t >$. Thus, when *know*- type predicates have arguments of type $<< s, t >, t >$ these arguments must raise at LF and be interpreted by a special rule. This rule, which Lahiri dubs *interrogative raising* (IR), causes the interrogative to raise and adjoin to some sentential constituent, which for concreteness Lahiri assumes is IP. The trace left by this rule is of the type of propositions, $< s, t >$. The structure formed by IR forms the nuclear scope of an adverbial of quantity (or a default if no overt operator is present.) and is interpreted by a special rule of *Int-IP-adjunction*. This, in conjunction with presupposition accommodation, yields the requisite quantificational structure.

The data we saw in the last section is problematic for an account such as this: on the one hand I claimed that question predicates *do* exhibit a qv reading. Such readings could not arise via IR since, according to Lahiri's assumptions, interrogatives are exactly of the right semantic type for these predicates. Conversely, I suggested that qv readings also exist for the declarative complements of factive predicates. Here again, according to Lahiri's assumptions, there is no type mismatch involving interrogatives and no 'amount of answers' to quantify over.

7.3 Intensional/extensional predicates?

I have already noted a number of points of strategy where the account of complementation offered here differs from those offered by Groenendijk and Stokhof. These concerned primarily the nature of exhaustiveness. Here I focus the on complementation-specific issue of whether assuming a bifurcation among interrogative embedders in terms of predicates that are *intensional* interrogative embedders (i.e. they embed the intension of the interrogative) or *extensional* interrogative embedders is motivated. The intensional/extensional bifurcation is assumed to account for various inferential asymmetries among interrogative embedding complements, roughly along the lines of the QI/RI bifurcation proposed in the current paper.

There are a number of important differences, however. First, intensional/extensional is a property pertaining to expressions, in this case interrogative clauses. Resolutive/non-resolutive is a semantic property of questions. Hence, my own account predicts, correctly it would seem, that identical inferences should arise with other question-denoting expressions whatever their syntactic manifestation, a case in point being concealed question uses of NP's or question/issue denoting NP's. Whether and how Groenendijk and Stokhof's account extends to these cases depends on the particular analysis of these non-interrogative expressions but there is no obvious argument leading to a uniform account.

Second, I have shown that resolutivity, just like factivity, is not an all or nothing affair: some predicates are full-resolutives (or equally, full factives), others are semi-resolutives (or equally semi-factives). These latter do not preserve resolutivity when "projected" under operators such as conditionals, negatives and yes/no-questioning. Whatever accounts are proposed for presupposition projection asymmetries among predicates (e.g. Stalnaker 1974) can apply equally for both notions. There is no obvious way for syntactic notions such as intensional/extensional to accommodate such fine grained distinctions.[52]

Third, we have seen that truth is inapplicable to interrogatives (and more generally to question denoting expressions.) This poses the following problem for Groenendijk and Stokhof: on their account the extension of an interrogative *is* a true proposition. In fact, Groenendijk and Stokhof assume that this is the source of the veridicality of interrogatives embedded e.g. by non factives such as *tell* and *report*. Hence one would expect that the predicate *true* be an extensional interrogative predicate. This expectation is not met. While this could be attributed to some idiosyncratic property of *true*, we have seen on further examination that this is part of a pervasive generalisation: a whole class of of predicates I have dubbed *TF predicates*, whose arguments must be truth predicable, are inapplicable to interrogatives. This leaves Groenendijk and Stokhof with subcategorisation as the sole way to explain away this cross-linguistically pervasive pattern of inapplicability.

Fourth, given Groenendijk and Stokhof's syntactic characterisation of interrogative extensionality, they classify dependency predicates such as *depend on* or *be a function of* which do not have declarative complements as intensional. But we have seen that such predicates are "conditionally resolutive": the second argument being resolved entails the first argument being resolved. Thus, the current account predicts that various semantic reflexes of resolutivity apply to these predicates, e.g. the contextual vagueness characteristic of resolutivity. This prediction seems to be correct.

Ginzburg 1992a contained a *fallacious* and (b)rashly stated demonstration of an individuation asymmetry predicted by positing an intensional/extensional split, namely that the complements embedded by the intensional predicates are, in principle, individuated with finer grain than the extensional complements. The fallacy, as pointed out in Groenendijk and Stokhof 1993, lay in the particular set up in which it was claimed the individuation asymmetry would arise. On a purely formal level it is possible to instantiate the basic set up in a way that does produce the individuation asymmetry, though given the difficulty in assessing what the relevant *linguistic* intuitions are, I certainly cannot dispute Groenendijk and Stokhof's claim that this problem is not an intrinsic one for their account and need not arise once their framework is formulated in a framework distinct from that of classical intensional logic.

7.4 A syntactic notion of factivity?

In the previous section where I discussed the QVE, I focussed on a number of the QVE specific assumptions made by Berman. I disputed both the characterisation of the qv reading he offers and the claim that a bifurcation exists among interrogative complement predicates with regards to the availability of this reading. This claim is what motivates his postulation of a bifurcation among interrogative embedding predicates relative to a notion of *factivity*: factive predicates embed a propositional denotation, non-factive predicates embed a Hamblin-like question denotation. Although my own account does not postulate an ambiguity, the two accounts share an assumption of the importance of presuppositional factors in explicating interrogative meaning. What I want to focus on here, then, is the relation between the notion of factivity Berman assumes and the notion of resolutivity posited in my account.

[52] Berman, who argues for the importance of presuppositional factors, though from a perspective quite distinct from the current one, voices analogous criticism (see Berman 1991 p.114).

Berman's proposal is that the predicates, dubbed by me here as being *resolutive* are *factive*, where factivity is understood in a sense which extends the characterisation I have offered above for declarative complements. Note, however, that since truth is not applicable to interrogative sentences, obtaining a uniform notion of factivity requires a quite distinct notion.

Berman assumes that the interpretation of (answer) interrogatives involves a quantified structure: the quantificational force is supplied either by an overt operator such as an adverb or (when such does not exist on the surface) an implicit universal; the wh-phrase(s) supply the restrictive term(s); the interrogative denotes an open proposition and this supplies the nuclear scope. Factivity as it applies to interrogatives is: 'adjoin the denoted open proposition to the restrictive term':

(153) a. Jill mostly knows who showed up.

b. MOST(person(x), know(showed-up(x)))

c. MOST((person(x) $\wedge$ showed-up(x)), know(showed-up(x)))

In order to attain generality for this notion of presupposition, Berman defines it syntactically rather than semantically, so that factivity is construed as relating a verb to its complement. Thus, the logical form of a presupposed declarative complement is represented as in (154c):

(154) a. Bill regretted that Jill is sick.

b. regret(b, sick(j))

c. regret(b, sick(j)) $\wedge$ sick(j)

The issue I raise here is the semantic motivation for this notion. For instance, it is not clear what connection exists between the *non* interrogative-factivity of predicates such as *ask, wonder* and the semantic properties they exhibit as predicates of unresolved questions discussed above. Why should they not license the copying of their complement into the restrictive term of the logical form of a quantified sentence?

And in fact, Berman notes such a problem for his syntactic notion of interrogative-factivity: within his account, in certain contexts, QI predicates such as 'wonder' and 'ask' do seem to require their complement to be copied into the restrictive term. For instance:

(155) If a student cheats on the exam, the principal usually wonders about it.

Although Berman suggests that this property is an instance of presupposition accommodation a la Lewis 1979, he does not provide an argument which might link the lexical semantics of the given predicates to such an effect. I have above offered evidence that the source for the factivity/resolutivity of various predicates is that such predicates require/allow their arguments to be states-of-affairs that are factual. If one assumes that a common means for finding out that a state-of-affairs is factual is by encountering an assertion to that effect,[53] the link with Stalnaker's notion of pragmatic presupposition is established: the existence of such an assertion in the common ground licenses the semantic selectional restriction; whereas the lack of such an assertion in the common ground will, following Lewis, encourage the hearer to accommodate it into the common ground. Such an account of factivity/resolutivity might be false or problematic, but the link from lexical semantics to pragmatic presupposition and accommodation is motivated. Such a link in the case of Berman's account would appear to be missing.

[53] The analogous case for interrogatives involves encountering an assertion assumed to convey a resolution of the denoted question.

8 References

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