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## A Semantic Ontology

### 3.1 Introduction: Semantic Theory and Ontology

This chapter has two main aims. The first is to develop an ontology of semantic types for the main clausal constructions in English, with particular focus on interrogative clauses and the predicates that embed them. Our second aim is to construct a semantic universe in which the fundamental properties of the semantic entities we posit can be explicated. Once again, our most important topic will be *questions*. Fulfilling these two aims will enable us to specify a semantic theory for a comprehensive fragment of English. We start by setting these goals and the way we hope to achieve them within a wider setting. Initially, we compare them with the basic tasks of semantic theory, as conceived within a framework such as Montague Semantics (Montague 1974b, Dowty et al. 1981). We conclude with some comments on cognitive aspects of a semantic theory.

The semantic theory developed by Montague consists of two main components: a syntax/semantics interface and a model theory. The model theory explicates which class of set-theoretic structures can function as possible models. The syntax/semantics interface consists of a set of rules that associate with an NL expression  $\phi$  an entity  $\llbracket\phi\rrbracket$  (the denotation of  $\phi$ ) in any of the class of possible models. In practice, the syntax/semantics interface is formulated by means of a translation procedure that associates with each NL expression an intensional logic formula. This simplifies the statement of the rules associating model theoretic entities with NL expressions, because the intensional logic formulas have a transparent model theoretic interpretation.

The models are the basis for explicating what have been taken to be core semantic notions such as synonymy, truth, and entailment. Though synonymy is a complicated notion whose application in practice is tricky, it is one that applies generally and indiscriminately to relate all types of expressions. Truth and entailment, on the other hand, are notions that apply only to declarative sentences; indeed, they apply only to uses of declarative sentences in context.<sup>1,2</sup> In a given context, uttering any of the examples in (1) seems to involve making the same claim about the world:<sup>3</sup>

- (1) a. A: Jill is the president.  
b. A: [Pointing at Jill] She is the president.  
c. A: That tall woman over there is the president.

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<sup>1</sup>In section 3.2 we will see examples of non-sentential expressions to which truth and entailment are applicable.

<sup>2</sup>How relativization to context is handled within our account is discussed in section 3.6.

<sup>3</sup>Of course, these sentences do have different *meanings* in a sense made precise by Montague, Kaplan and others. See section 3.6 for additional discussion of the meaning/content distinction.

The claim common to a given class of declarative utterances is often called a *proposition*. The idea of positing such entities goes back at least to Frege 1892, where they are termed *thoughts*.<sup>4</sup> Consequently, it turns out to be useful to think of truth and entailment not as metalinguistic notions applying to expressions, but rather as semantic notions that characterize the class of propositional entities. Developing a theory of truth and entailment on the class of propositions is one of the basic means of explicating what such entities are. In turn, determining what propositions are is a core ingredient of a theory of the understanding of declarative sentences in any natural language. Montague explicated propositions in terms of possible worlds: a proposition is a set of possible worlds:  $p$  is true in world  $w$  iff  $w \in p$ ;  $p$  entails  $q$  iff  $p \subset q$ . This explication can be extended straightforwardly to provide a theory of properties as well.

Thus, one way to view the model theory developed by Montague for the PTQ fragment is as a theory of natural language ontology. Following Turner (1997), a Montagovian structure can be presented as a relational structure of the form (2):<sup>5</sup>

$$(2) [D, Prop, True, \rightarrow, \Pi_T]$$

where:

1.  $D$  is a set representing the universe.
2.  $Prop$  is the power-set of the set of possible worlds ( $\mathcal{P}(W)$  for some set  $W$ ).<sup>6</sup>
3.  $True$  is  $\{W\}$ .
4. For each type  $T$ ,  $\Pi_T$  is a function from  $P[[T]]$  to  $Prop$  which, given as input a function  $f$  from  $[[T]]$  to  $\mathcal{P}(W)$ , returns  $W$  just in case for all  $d$  in  $[[T]]$ ,  $f(d) = W$ . Otherwise  $f$  returns the empty set.
5.  $\rightarrow$  is a function from  $Prop$  to  $Prop^{Prop}$  representing entailment:  
 $\rightarrow(A, B) = (W \setminus A) \cup B$ .<sup>7</sup>

Such structures explicate the nature of propositions and properties using standard set theoretic tools. The account is based on an ontology where worlds are taken as basic, i.e. they constitute a distinguished subset of the domain of individuals. Since Montague's pioneering efforts in the early 1970s, it has been recognized that there is a need for a wider range of entities in the ontology than those Montague originally allowed for. At the same time, as Bach (1981) and others have observed, the ontological theory needed to explain talk in natural language is not obviously the same ontological theory as that needed by physical science. Following Bach's terminology, we call the former theory *natural language metaphysics*. The first part of this chapter, section 3.2, is devoted to an empirical investigation of the natural language metaphysics needed for a semantic theory of finite clauses in English, with particular emphasis on interrogatives and declaratives.

With this task accomplished, we have a specification of the various entities required by natural language metaphysics. In addition to properties and propositions, these will include questions, facts, outcomes, and situations/events. Explicating the nature of such entities involves introducing abstract properties akin to truth, such as answerhood, facthood, and fulfilledness. Our task will then be to offer a formal analysis of these entities and abstract properties.

By analogy with Montague, our formal analysis will involve positing a structure that contains certain classes of elements as basic and certain set-theoretic operations through which the

<sup>4</sup>Somewhat misleadingly, since Frege clearly views such entities as non-psychological.

<sup>5</sup>See Turner 1997, definition 3.1.3.1.

<sup>6</sup>Given a set  $X$ ,  $\mathcal{P}(X)$  denotes the power-set of  $X$ , the set of all subsets of  $X$ .

<sup>7</sup>' $\setminus$ ' here denotes set difference.

‘non-basic’ entities get constructed. The main divergences from Montague will be that: (1) different entities are taken as basic and (2) the theory will make use of certain distinct set-theoretic operations, which are based on recent advances in non-well founded set theory (Aczel 1988, Barwise and Moss 1996). As we explain below, the ontology that emerges (which is particularly inspired by situation theoretic work) provides solutions to a number of fundamental semantic problems that beset the possible worlds framework, particularly those involving attitude contexts.

Our main innovation will be in the characterization of questions we put forward: we propose to identify questions with *propositional abstracts*. We will show that this approach, which, as we pointed out in Chapter 1, has a long history but which has been hampered by a host of technical and conceptual problems, actually provides an account of questions that is simpler and more empirically successful than other existing analyses.

The final task we undertake in this chapter is to show how the entities of our semantic universe can be represented within the framework of typed feature structures. This will render our account compatible with recent work in HPSG, specifically as sketched in the previous chapter. The role played by the typed feature structure semantic representations is akin to the function of intensional logic expressions in Montague’s theory: to facilitate the statement of rules associating syntactic and semantic/contextual information. We specify a mapping that assigns an interpretation to each of the various typed feature structures which serve as values for the CONTENT attribute in HPSG.

Our emphasis in this introductory section has been on a traditional perspective of semantics, one particularly inspired by work in philosophical logic. Although it was once assumed that the ‘realist’ perspective prominent in logically inspired views of semantics is antagonistic to the cognitive perspective championed by psychologists and AI workers (two recent proponents of this view are Tomasello (1998) and Gärdenfors (2000)), in fact many of the problems that inspire the approach to semantics developed here have their origin in a cognitive approach to semantics. Our ontology and the notions of content that we use avoid certain problems that challenge the construal of Montague semantics as a cognitive theory. As discussed in section 3.4.3, a semantic theory of the kind described here has been used for developing accounts of mental state representation, as part of a theory of attitude reports. Moreover, the theory of questions we develop here is motivated to a large extent by the need to allow for the pragmatic relativization that plays a key role in interrogative attitude reports, as well as by the need to develop notions of answerhood that can sustain a theory of querying in dialogue interaction. Some applications of our semantic framework to the description of linguistic phenomena characteristic of conversational interaction—for instance reprise utterances and fragments—can be found in Chapters 7 and 8, as well as in Ginzburg 2001. The framework can also be easily adapted for computational applications and may well have more general implications for research into the evolution of communicative interaction (Ginzburg 2000).

### **3.2 An Ontology for Finite Clauses in English**

Starting with the work of Hamblin and Karttunen in the mid 1970s, it has been common to recognize a distinction in semantic type between questions and propositions—the latter being the familiar denotata of declarative clauses. We will briefly reiterate the arguments that led to adopting this distinction and then examine the issue more closely. Although the evidence for maintaining

the question/proposition distinction is compelling, we will suggest, *contra* Karttunen, that there is equally compelling evidence to suggest that on some uses interrogatives and declaratives have the same semantic type. In previous work, most influentially that of Hintikka and Groenendijk and Stokhof, this semantic type has been taken to be a proposition.

We will argue against this position. Building on insights originally due to Vendler, we recognize a third ontological category, distinct from both questions and propositions, that of facts. We provide a variety of arguments for distinguishing such entities. For example, we will show: (1) that certain speech acts take facts as their descriptive content, (2) that certain predicates select for facts, but for neither propositions nor questions, and (3) that certain clause types, including exclamatives and certain declaratives, denote facts. With interrogatives, the situation is more subtle. We argue that certain predicates coerce the denotation of an interrogative clause they combine with into a fact, though the ‘stand alone’ denotation of an interrogative clause will be a question, not a fact. We will also briefly consider the semantic status of infinitives, subjunctives, and imperatives, proposing that there exists a single semantic type common to these clause types. We call this type of entity an *outcome*—intuitively, a specification of a situation which is futurate relative to some other given situation. The analysis of subjunctives as outcomes, taken together with the view developed below, that questions are constructed from propositions, will provide a simple account of the striking fact that there are no subjunctival interrogatives.

### 3.2.1 Distinguishing Questions from Propositions

Our initial aim in this chapter is to develop and apply an ontology that enables us to capture the fundamental properties of interrogative and declarative clauses and the predicates that embed them. As we will see, this is a complicated enterprise because there are grounds for maintaining a distinction between the denotation type of interrogatives and that of declaratives, but there are also grounds for maintaining a uniform denotation. We argue: (1) that all uses of an interrogative denote a question, a semantic object ontologically distinct from a proposition, and (2) that only some uses of any given declarative denote a proposition, which we take to be the kind of object that can be true or false.

Interrogatives and declaratives also have a class of uses in which a fact gets ‘semantically contributed’. For declaratives, this actually involves the possibility of a distinct fact-denoting denotation, whereas for interrogatives, facts get contributed in embedded contexts only, via coercion. The distinct mechanisms we propose for interrogative- and proposition-related facts will serve to explain why some predicates subcategorize for both interrogative and declarative clauses, as illustrated in (3):<sup>8</sup>

- (3) a. Jamie forgot that/whether the Pope likes stuffed cabbage.  
 b. Merle knows who insulted the Mayor/whether the Mayor was insulted/that the Mayor’s honor was at stake.  
 c. Brendan discovered when the tube shuts down/that the tube shuts down before midnight.

Early work on interrogative semantics in the 1960s actually took data such as (3) as motivation for assuming that interrogatives, like declaratives, denote propositions. An influential proposal by Hintikka proposed the following paraphrase:

<sup>8</sup>We use the term ‘subcategorization’ as a cover term for the syntactic requirements placed on its complements by a predicate and the term ‘selection’ for the corresponding semantic requirements.

- (4) a. Ashley Vs who came  $\leftrightarrow$  Any person is such that if (s)he came, then Ashley Vs that (s)he came.  
 b. Ashley Vs whether it is raining  $\leftrightarrow$  If it is raining, then Ashley Vs that it is raining, and if it is not raining, then Ashley Vs that it is not raining. (Hintikka 1976)

That there are grounds for actually positing an ontological distinction between questions and propositions was first argued in detail by Hamblin (1973) and by Karttunen (1977). Karttunen's main argument is based on the existence of a class of predicates which embed interrogative but not declarative complements:

- (5) a. Brooke asked/wondered/investigated who left.  
 b. #Brooke asked/wondered/investigated that Drew left.

Moreover, although one might attempt to provide a semantics for some of these predicates by means of lexical decomposition, Karttunen claims that there is no obvious way to lexically decompose predicates such as those in (6) in a similar way:<sup>9</sup>

- (6) a. Who wins the race depends upon who enters it.  
 b. When Mary will arrive will be influenced by who drives the bus.

We believe, with the vast literature that builds on Karttunen's work, that this argument as a whole is compelling. This type of argument—establishing the ontological distinctness of two clause types by exhibiting a class of predicates that are consistently compatible with one but not the other—is one we will appeal to repeatedly in arguing for our own ontology of semantic types. Nonetheless, what Karttunen's argument does not prove is that *all* embedded interrogative uses involve selection for questions. Such a position, which we will refer to as the Interrogative Uniformity Hypothesis, might seem attractive *prima facie* on grounds of parsimony. Parsimony, however, is to some extent in the eye of the beholder and various researchers, starting with Boër (1978), were disturbed by the fact that any approach like Karttunen's, adhering to the Interrogative Uniformity Hypothesis, needs to posit dozens of doublet relations: one doublet for each member of the class of predicates (*know*, *discover*, *tell*, etc.) that subcategorize for both interrogative and declarative clauses. That is, Karttunen posits a relation  $\text{know}^{\text{question}}$  to analyze interrogative-subcategorizing uses of *know* and a relation  $\text{know}^{\text{proposition}}$  for the corresponding declarative-subcategorizing uses. Karttunen proposed that such uses be related via meaning postulate.

However, questions of parsimony aside, we believe that Karttunen's hypothesis about uniform selection for questions can actually be refuted empirically. Our argument involves considering nominal complements in addition to the clausal complements of interrogative-subcategorizing predicates. This wider perspective reveals a fundamental bifurcation among interrogative-subcategorizing predicates. One class consists of factive and resolute predicates<sup>10</sup> such as *know*, *discover*, *forget*, *tell*, *guess*, *predict*. Distinguished from these is a second class of verbs which we call Question Embedding (QE) predicates, e.g. *ask*, *wonder*, *investigate*, and *discuss*. Our basic

<sup>9</sup>However, see Boër 1978 and Hand 1988 for a semantics for predicates like *depend*. These proposals share important assumptions with Hintikka's interrogative semantics.

<sup>10</sup>The class of predicates that behave 'factively' with interrogatives is somewhat wider than the class of factive, declarative-subcategorizing predicates. We dub those predicates, including *tell*, *guess*, *announce*, *predict* and *report*, which exhibit such behavior with interrogatives but not with declaratives 'resolutive' since they carry a presupposition that the embedded question is resolved, as we discuss in more detail in section 3.2.3.

claim is that a member of the QE class simply takes a question as its argument, whereas the resolutive and factives take as their argument a fact that constitutes an answer to the question denoted by the interrogative. The content of the complement clause does not serve as a ‘genuine argument’ of the predicate. Rather, the complement’s content—a question—is coerced into a fact resolving that question.

In order to ground this intuition in concrete data we appeal to a basic semantic notion originally put forward by Quine (1963), who equates a complement’s being a ‘genuine argument’ of a predicate—in his terms, the complement’s occurring purely referentially—with the complement passing the tests of substitutivity and existential generalization.<sup>11</sup> Using this criterion, questions can be shown to be genuine arguments of QE predicates. More precisely, QE predicates treat question-denoting nominals as arguments that are purely referential:<sup>12</sup>

(7) a. **Substitutivity:**

Jean asked/investigated/was discussing an interesting question.  
 The question was who left yesterday.  
 Hence: Jean asked/investigated/was discussing who left yesterday.

b. **Existential Generalization:**

Jean asked/investigated/was discussing who left yesterday.  
 Hence, there is a question/issue that Jean asked/investigated/was discussing yesterday.  
 Which question?  
 The question was who left yesterday.

Resolutive and factive predicates treat question-denoting nominals quite differently. For a start, many such predicates cannot felicitously take question-denoting nominals as complements.<sup>13</sup>

- (8) a. #Jan told me/forgot/guessed an interesting question.  
 b. #Brooke predicted/stated a strange issue.

More crucially, even those factive/resolutive predicates which can take question-denoting nominals as complements treat them in a markedly distinct way from QE predicates—both substitutivity and existential generalization fail.<sup>14</sup>

<sup>11</sup>See, for example, Quine 1963: 139–145 for discussion.

<sup>12</sup>The verb *wonder* does not subcategorize for NP arguments, but does subcategorize for PP arguments. With the requisite modifications, it also passes these tests.

<sup>13</sup>In case the question-denoting NP is definite, the felicity of the predication improves:

- (i) Jan guessed the question.  
 (ii) Brooke stated the issue with some precision.

This, we believe, is due to the fact that in such a case the question nominal can be coerced to be a ‘concealed question’ (See Baker 1970, Grimshaw 1979, Heim 1979, and Pustejovsky 1995)—a coercion which allows such predicates to take definite NP complements whose *N'* (the property denoted by it) is virtually arbitrary:

- (iii) Jan guessed the color of Jo’s eyes.  
 (iv) Brooke stated Mo’s weight with some precision.

Concealed questions are discussed more fully in Chapter 8.

<sup>14</sup>In fact, ‘*V about*’ passes pure referentiality tests in cases where *V* is a resolutive predicate. However, as noted already by Boër (1978), in such cases ‘*V about*’ manifests significantly distinct behavior from ‘*V*’. For instance, *Alexis managed to make a guess about who showed up to the party* does not imply that Alexis’ guess was correct, in contrast to *Alexis managed to guess who showed up to the party*. See section 8.3 for further discussion of how *about* fits into the picture in connection with *concealed questions*.

- (9) a. **Substitutivity:** Jean discovered/revealed an interesting question.

The question was who left yesterday.

*It does not follow that:* Jean discovered/revealed who left yesterday.

- b. **Existential Generalization:**

Jean discovered/knows who left yesterday.

*It does not follow that:* there is a question/issue that Jean discovered/knows.

These data pose an intrinsic problem for Karttunen's strategy of treating all interrogative-embedding predicates as involving predications of questions. Presumably the simplest way to explain the behavior of QE predicates is to assume that interrogatives have a use in which they denote the same class of objects (questions) that question-denoting nominals do. What a QE predicate selects for is then simply a question, though the precise range of complements such a predicate can co-occur with is apparently subject to syntactic factors as well.<sup>15</sup> If Karttunen's proposal were correct, then we would expect the class of entities that factive/resolutive predicates select for to include, *inter alia*, the class of questions. The fact that question-denoting complements do not sanction substitutivity and existential generalization argues strongly against the hypothesis that resolutive select for questions and, by extension, against the Interrogative Uniformity Hypothesis.<sup>16</sup>

### 3.2.2 Do Interrogatives Ever Denote Propositions?

Rejecting the Interrogative Uniformity Hypothesis, as we have argued one should, leads to the recognition that on some uses, the content supplied by an interrogative is not a question. What is it in such cases? It has commonly been proposed (see, for example, Hintikka 1976, 1983, Boër 1978, and Groenendijk and Stokhof 1984, 1997) that interrogatives embedded by factives and resolutive actually denote propositions.<sup>17</sup> We believe that there is an important intuition behind this view, namely that a unified semantic type exists for which factive predicates select. This explains why this class of predicates predominantly subcategorizes both for declaratives and for interrogatives. However, as we will demonstrate, basing this explanation on the assumption that

<sup>15</sup>The verb *wonder*, for instance, is incompatible with nominal complements, whereas *investigate* is incompatible with PP complements, while *answer* can only cooccur with non-clausal question-denoting complements:

- (i) Bo wondered #(about) the question.
- (ii) Bo investigated (#about) the question.
- (iii) Bo answered #(the question concerning) who inhaled.

<sup>16</sup>This argument might not, in and of itself, refute the Interrogative Uniformity Hypothesis. Our argument also requires some appeal to explanatory simplicity. Thus, an adherent of the Interrogative Uniformity Hypothesis could in principle assume that for each QE predicate there are actually two manifestations: one predicate that selects for a question, and another selecting for a distinct class of entity, assumed to be the denotation of question nominals. The two predicates would be related by means of a meaning postulate, though of course it remains unclear what class of entities would constitute the denotation of question nominals, if the latter is distinct from the denotation of interrogatives. Factive/resolutive predicates, on this story, would then have to involve at least THREE manifestations, one as a predicate of questions, one as a predicate of (the denotation of) certain nominals, and one as a predicate of whatever one takes declaratives to denote, say propositions. Given the failure of pure referentiality, there would be no systematic connection between the predicate of questions and the predicate of nominals, whereas there would be a meaning postulate relating the predicate of questions and the predicate of propositions. The redundancy and arbitrariness inherent in such a system speaks strongly against adopting it.

<sup>17</sup>Groenendijk and Stokhof differ from Hintikka and Boër in accepting the force of Karttunen's argument that on some uses interrogatives do in fact denote an entity that is distinct from a proposition.

interrogatives possess a propositional denotation leads to a highly unsatisfactory theoretical picture. There are two main reasons for this. One reason is that precisely the predicates that can be argued on independent grounds to select for propositions are incompatible with interrogative complements. This class of predicates, which we call TRUE/FALSE (TF) predicates, includes *believe*, *assert*, *deny*, and *prove*. Secondly, there are data parallel to examples (7)–(9) that demonstrate that factive predicates do not treat proposition-denoting complements purely referentially. These two sets of data, to which we now turn, argue strongly against the assumption that interrogatives ever denote propositions.

An initial consideration to support the assumption that TF predicates select for propositions was originally pointed out by Vendler (1972). These predicates impose an appropriateness condition on their nominal arguments, namely the condition that truth or falsity can be predicated of them. This is, of course, the hallmark of a proposition. The examples in (10) show that, in contrast to factive predicates, TF predicates can only co-occur with nominal complements of which truth can be predicated:

- (10) a. #Jackie believed/doubted/assumed/proved Bo's weight/my phone number.  
 b. Jackie knows/discovered Bo's weight./my phone number.  
 c. #Billie's weight/my phone number is true/false  
 d. Jo believed/doubted/assumed Billie's story/the claim/the hypothesis/the charges/the forecast.  
 e. Billie's story/the claim/the hypothesis/the charges/the forecast is true/false.

Relatedly, free relatives headed by such verbs can have truth/falsity predicated of them:

- (11) What Jo believed/doubted/assumed/proved was true/false.

Indeed such predicates satisfy the following inference pattern relating their nominal complements to an embedded clause:

- (12) a. Jean believed a certain hypothesis.  
 Hence, Jean believed that that hypothesis is true.  
 b. Merle denied a certain claim.  
 Hence, Merle denied that that claim is true.  
 c. Bo proved Merle's conjecture.  
 Hence, Bo proved that Merle's conjecture is true.

Let us dub this inference schema for future reference **T-Pred**:

- (13) **T-Pred** Inference Schema:

NP V the  $\tilde{N}$ .  
 Hence, NP V that the  $\tilde{N}$  is true

Interestingly, factive predicates do not obey **T-Pred**:

- (14) a. Jean discovered a certain hypothesis.  
*It does not follow* that Jean discovered that that hypothesis is true.  
 b. Bo forgot Merle's conjecture.  
*It does not follow* that Bo forgot that Merle's conjecture is true.  
 c. Merle revealed a certain claim.  
*It does not follow* that Merle revealed that that claim is true.

A second consideration which supports the assumption that TF predicates select for propositions is that they treat proposition-denoting complements purely referentially:

(15) a. **Substitutivity:**

The Fed's forecast was that gold reserves will be depleted by the year 2000.  
Brendan believes/denies the Fed's forecast.  
Hence, Brendan believes/denies that gold reserves will be depleted by the year 2000.

b. **Existential Generalization:**

Brendan believes/denies that gold reserves will be depleted by the year 2000.  
Hence, there is a claim/hypothesis/prediction that Brendan believes.

If interrogatives have a propositional denotation, it is surprising that TF predicates, which without exception select for propositional arguments, cannot co-occur with interrogative complements:<sup>18</sup>

- (16) a. #Bo supposes/assumes the question/issue of which pitcher will play tomorrow.  
b. #Bo supposes/assumes which pitcher will do what tomorrow.  
c. #Carrie claimed/argued who came yesterday.  
d. #Carrie denies/doubts who stole Mo's key.  
e. #Tony believes/suggests whether Bo stole Mo's key.

These facts are stable across a wide range of languages, including English, Hebrew, Japanese, Greek, and Turkish. In fact, we will hypothesize below that this generalization, the inability of TF predicates to license interrogative complements, constitutes a linguistic universal. Assuming this to be the case, we believe that the generalization should be captured in terms of a sortal incompatibility between the embedding predicate and the denotation of the interrogative complement. It does not seem amenable to an explanation in terms of syntactic subcategorization or pragmatics. Thus, any attempt to explain the inability of TF predicates to license interrogative complements simply as a consequence of putative syntactic incompatibility between TF predicates and interrogatives will founder due to the fact that the incompatibility is maintained under pronominalization. Example (17a) shows that the proposition expressed by a declarative can be picked up by a pronoun, which is the complement of a TF predicate.

- (17) a. A: Jo left yesterday.  
B: Bo believes that.  
b. A: Who left yesterday?  
B: #Bo believes that.  
c. A: Who left yesterday?  
B: Bo knows that.

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<sup>18</sup>We should note here that the verb *prove* is subject to speaker variation. There are speakers, usually ones with significant exposure to mathematical discourse, who accept locutions such as (i) and (ii):

- (i) Jo proved that fact.  
(ii) Bo proved that fact to be true.

Such speakers also accept sentences such as (iii) and (iv), where *prove* takes an interrogative complement:

- (iii) Jo proved whether Bo committed the crime.  
(iv) Jo proved who did what.

The account we will propose below correlates the ability of a predicate to take interrogative complements with its compatibility either with questions or with facts. Thus, our account will lead to the expectation that speakers who reject (i) and (ii) should equally reject (iii) and (iv).

In contrast, (17b) demonstrates that the denotation of an interrogative cannot serve as an antecedent for a pronoun embedded by a TF predicate, though it is perfectly acceptable when embedded by a factive.<sup>19</sup>

The pragmatic explanation which most readily suggests itself for the incompatibility of interrogatives with TF predicates is that it arises out of the conflict between a principle like the following, with some sort of factivity inherent in interrogatives:<sup>20</sup>

“Do not fill the cognitive argument of a TF predicate with material already present in the common ground.”

The main problem for such an explanation is that, although the complements of TF predicates tend to constitute non-presupposed material, this is no more than an easily overridden tendency. This matter is treated in greater detail in Ginzburg 1993, where the following examples are discussed:

- (18) a. For a long time there had been allegations that Dana was seeing a certain journalist. It’s turned out that the allegations are well founded. Thus, even though we all know they’re true, Brett, staunchly loyal, doesn’t accept the allegations.  
 b. Bo’s claim was that Merle was ill. I discovered that, in fact, Merle was ill. After that, everyone accepted the claim.  
 c. Bo is usually so wrong-headed, but for once he actually believes something we all accept without batting an eyelash, namely that the sun will rise tomorrow.  
 d. Now that she’s been shown the evidence, and let me assure you it conclusively establishes his guilt, Jo won’t deny that Bo could have committed the crime.

However, even in a context that establishes the veridicality of a certain item of information, the incompatibility of interrogatives with TF predicates remains, in contrast to the declarative case:

- (19) a. Fergie knows who left: Birch, Alexis and Gerry.  
 So, it is also true to say that #Fergie believes/assumes who left.  
 b. Fergie knows that Jo left.  
 So, in particular, it is also true to say that Fergie believes/assumes that Jo left.  
 c. #Fergie correctly believes/assumes who left.

We note some additional considerations against the assumption that interrogatives possess a propositional denotation. First, that assumption leaves unexplained the fact that interrogatives cannot be used equatively with proposition-denoting nominals:<sup>21</sup>

<sup>19</sup>Of course we cannot absolutely rule out the possibility of a syntactic explanation of the inability of TF predicates to license interrogative complements. That is, one can certainly assume that there is some abstract morphosyntactic property common to TF predicates that renders them incompatible with interrogatives. One such account is perhaps the proposal of Huang’s (1982) that attitude predicates be distinguished according to whether they subcategorize for a [WH –] or [WH +] complementizer. An ontologically-based account of the kind we suggest is needed does not necessarily conflict with such a morphosyntactically based one, although it arguably renders it superfluous. Indeed, to some extent, which type of account is to be preferred is a question of methodological predilection, correlating with whether one has more confidence in the independent justification for the ontology or for the morphosyntactic theory employed. One *prima facie* advantage for ontologically-based accounts of such facts is that they have greater applicability across languages with diverse morphosyntactic systems and lexicons.

<sup>20</sup>Such an explanation is offered by Boër (1978).

<sup>21</sup>For that matter, interrogatives cannot be used equatively with fact nominals, either. In Chapter 8, we will take this as motivation for a coercion analysis, which is triggered by the embedding predicate:

(i) #The fact is who left.

- (20) a. The question is who left.  
 b. The claim is that Bill left.  
 c. #The claim is who left.

And of course, interrogatives cannot be used assertorically, as would be expected if they in fact allowed a propositional reading:

- (21) I'm going to make the following claim: #who left this building dirty/#Did someone leave this building dirty.

We now turn to a related issue (which in fact motivated the interrogatives-as-proposition idea in the first place): the independent and deep-seated assumption that factive predicates select for propositional arguments. The only motivation we are aware of for this assumption is simple *declarative uniformity*; the assumption that since some uses of declaratives denote propositions, all uses of declaratives denote propositions. We already saw above that factives do not directly predicate truth of their arguments, as indicated by the data in (14). However, as we shall now show, there is evidence to suggest that factives do not even treat propositions as genuine arguments as they clearly fail at least one test for the pure referentiality of their proposition-denoting complements, namely substitutivity. This is regardless of whether the context indicates that the proposition at issue is true:<sup>22</sup>

- (22) **Substitutivity:**

The Fed's forecast was that gold reserves will be depleted by the year 2000.

(The Fed's forecast is true).

Brendan discovered/was aware of the Fed's forecast.

*It does not follow* that: Brendan discovered/was aware that gold reserves will be depleted by the year 2000.

To conclude this section: we considered the standard alternative to the Karttunen-inspired Interrogative Uniformity Hypothesis, namely the position that when embedded by resolutive predicates interrogatives denote propositions. We suggested that this view is highly problematic for three main reasons. First, those predicates that uncontroversially select for propositions, the class of predicates we have dubbed TF predicates, are incompatible with interrogatives. This cross-linguistically highly stable incompatibility does not seem to lend itself to either a syntactic or a pragmatic explanation, and hence calls for an explanation based on sortal incompatibility. Second, interrogatives lack properties that are characteristic of truth-bearing expressions. They cannot be used equatively with proposition-denoting nominals, although they can be so used with question-denoting nominals. Nor can interrogatives be used assertorically. Third, those predicates that motivated positing a propositional denotation for interrogatives, namely factives, actually appear not to select for propositional arguments.

<sup>22</sup>The situation with existential generalization is somewhat trickier. Is the inference pattern in (i) a reasonable one? Intuitions are difficult because of the (minimally) awkward nature of predications such as (ii)

- (i) Kylie forgot that the party would take place before the Millenium. Hence, there is a true claim/hypothesis/statement/report that Kylie forgot.  
 (ii) ?Kylie forgot a hypothesis/statement/report.

### 3.2.3 The Missing Semantic Type: Facts

So far, our discussion of the ontological status of interrogatives and declaratives has yielded both positive and negative conclusions. On the positive side, we have seen reason to endorse the existence of a semantic type distinction between some uses of interrogatives and declaratives. We have provided grounds for assuming that there is a class of predicates that select for questions and a class disjoint from this whose members select for propositions. On the other hand, we have provided arguments for rejecting two commonly assumed positions, the Karttunen-inspired Interrogative Uniformity Hypothesis and the position, stemming from the work of Hintikka and Groenendijk and Stokhof, that interrogatives possess a propositional denotation. Rejecting the latter position while endorsing an insight that underlies it, namely that factives select for the same type of semantic object when they embed either interrogatives or declaratives, immediately raises two related questions:

1. What do interrogatives denote when embedded by factives?, and
2. More generally, what semantic type do such predicates select for?<sup>23</sup>

Our task in this section is to offer an answer to these questions that will lead us to a general discussion of the ontological space that we need to posit.

The approach we take is generally in line with what is by now a significant body of work, pioneered by Vendler (1968, 1972), both in the formal semantics and philosophical literature (e.g. Asher 1993, 1996 and Peterson 1997) and in computational lexical semantics (e.g. Pustejovsky 1995). This work, the ‘Vendlerian Turn’, has demonstrated the need for an ontology of ‘abstract entities’ intrinsically richer than that extant in Montague’s intensional logic, which as we mentioned in Chapter 1 is an intensionalized version of the austere ontology of Wittgenstein’s *Tractatus*.

Work in the Vendlerian Turn articulates a distinction between a class of entities called *events* (sometimes called *eventualities*), a more general term meant to accommodate states as well, and the classes of *facts/possibilities* and *propositions*. These distinctions cut across syntactic categories. For example, there are NPs that can have denotations in all three classes and *POSS-ing* gerunds can also fluctuate between an eventive and a factive denotation.

We now examine some of the key properties of the various classes. First, the eventualities are taken to be ‘semi-concrete’ objects which are spatio-temporally located and can be modified by concrete adjectives:

- (23) a. The wedding lasted a long time/was lavish/took place in Sheikh Jarah.  
 b. Tony’s savaging of the party has lasted for years/is bloody/is not limited to London.

In contrast, facts/possibilities and propositions are not spatio-temporally located and resist modification by concrete adjectives:

- (24) a. #The fact that Tony savaged the party has lasted for years/is bloody/is not limited to London.  
 b. #Tony’s savaging the party has lasted for years/is bloody/is not limited to London.  
 c. #That Tony savaged the party lasted a long time/was lavish/took place in Sheikh Jarah.  
 d. The hypothesis was that Glyn is dangerous. #That hypothesis has lasted for years/is bloody/is not limited to London.

<sup>23</sup>The same issues of course arise for non-factive, resolute predicates such as *tell*, *guess*, and *predict*, though there the answers that arise are subtly different. We suggest in section 3.6.3 that resolutives select for various kinds of entity, including propositions, facts, and (in some cases) events.

Among the abstract entities, a crucial distinction is drawn between facts/possibilities and propositions. The former have causal powers which the latter lack entirely:

- (25) a. The fact that Tony was ruthless made the fight against her difficult.  
 b. Tony's being ruthless frightened Glyn.  
 c. The possibility that Glyn might get elected made Tony's hair turn white.  
 d. #The claim/hypothesis/proposition that Tony was ruthless made the fight against her difficult.

Truth is predicable only of propositional entities, not of facts/possibilities:

- (26) a. #The fact that Tony was ruthless is true.  
 b. #Tony's being ruthless is true.  
 c. #The possibility that Glyn might get elected is true.  
 d. The claim/hypothesis/proposition that Tony was ruthless is true/false.

In what follows, a three-way distinction is drawn between events, facts/possibilities, and propositions. In particular, we distinguish between a class of entities that contains all possibilities (factual/realized and otherwise) and the class of propositional entities. Although they will play an important role in our ontology, as *situations*, we will not discuss eventive denotations in detail. In a more comprehensive treatment, one might plausibly treat this class of entities as the denotation type of certain types of phrase, such as POSS-ing gerund and naked infinitive phrases.

Using the proposition/fact distinction, let us return to consider the semantic nature of the complements of factive predicates. We have seen that such predicates embed neither question-denoting complements nor proposition-denoting complements purely referentially. This does not mean that such predicates are 'hyperintensional', but only that we have so far failed to provide them the type of complement that they actually select for. When one supplies the appropriate kind of complement, i.e. one that denotes a fact, we can once again see the effects of pure referentiality, as illustrated in (27):

- (27) a. Jean is aware of/reported/revealed an alarming fact.  
       That fact is that Brendan has been working hard to destroy the company.  
       Hence, Jean is aware/reported/revealed that Brendan has been working hard to destroy the company.
- b. Jean knows two facts about Marin Marais.  
       One is that he was a student of Saint Colombe, the other is that he composed music for the viola da gamba.  
       Hence, Jean knows that Marin Marais was a student of Saint Colombe and Jean knows that he composed music for the Viola da gamba.
- c. Jean regrets/remembers well a troubling fact about the McCarthian era.  
       That fact is that everyone was required to sign the pledge.  
       Hence, Jean regrets/remembers well that everyone was required to sign the pledge.

- (28) a. Philippe knows/discovered that Marin Marais composed music for the Viola da gamba.  
Hence, there is a fact that Philippe knows/discovered.  
Which fact?  
The fact that (indicating/proving that) Marin Marais composed music for the Viola da gamba.
- b. Philippe knows/discovered whether Emanuelle was in town.  
Hence, Philippe knows/discovered a fact that indicates/proves whether Emanuelle was in town.
- c. Philippe knows/discovered who attended the WTO meeting.  
Hence, Philippe knows/discovered a fact, one that resolves the issue of who attended the WTO meeting.
- d. Dominique revealed to me when the train is leaving.  
Hence, Dominique revealed a fact to me, one that resolves the issue of when the train is leaving.

The data in (28) reflect a common intuition. When factive predicates embed an interrogative, they are predicating something of a fact that constitutes an answer to the question expressed by the interrogative (i.e. an answer that *resolves* that question). Declaratives work similarly. When such predicates embed a declarative, there seems to be a predication of a fact that proves the associated proposition true. We might schematize these inference patterns as follows:

- (29) a. Brendan **Vs/has Ved** (knows/discovered/told me/reported/managed to guess) that p.  
So, Brendan **Vs/has Ved** a fact that proves the proposition p.
- b. Brendan **Vs/has Ved** q.  
So, Brendan **Vs/has Ved** a fact that resolves the question q.

The most direct way to account for these inference patterns is to assume that factives select for fact-denoting arguments. How are we to reconcile this with our previous assumption that interrogatives denote questions and declaratives denote propositions? In principle, two strategies are open to us: one is to assume that a given clause-type can denote more than one semantic type; the other is to assume that no such ambiguity exists and that a factive predicate can coerce clauses so that their denotation becomes fact-denoting.<sup>24</sup> We believe that the two strategies each have a role to play: the coercion strategy for interrogatives, the ambiguity strategy for declaratives. This conclusion goes against the proposals of Groenendijk and Stokhof, who advocate the ambiguity strategy for interrogatives. Within their system the intensions of interrogatives denote questions and the extensions denote propositions.

There are three noticeable differences between declaratives and interrogatives which lead to this conclusion. First, declaratives but not interrogatives can be used equatively with fact-denoting nominals:

- (30) a. The fact is that Tony vanquished the anti-Leninist faction.  
b. #The fact is whether Tony vanquished the anti-Leninist faction.  
c. #The fact is who vanquished the anti-Leninist faction.

Second, whereas interrogatives can be used as complements of nouns such as *question* and *issue*, they cannot be complements of the noun *fact*, which can of course take a declarative complement:

<sup>24</sup>See Pustejovsky 1995 for a relevant notion of 'coercion'.

- (31) a. The question of who hacked into turing.stanford.edu.  
 b. #The question that Bo hacked into turing.stanford.edu.  
 c. The fact that Bo hacked into turing.stanford.edu.

And third, declaratives, but not interrogatives, can participate in anaphora with fact-denoting nominals:

- (32) a. A: I'd like to point out a crucial fact to you.  
 B: Go on.  
 A: The Pope is waiting for you in my office.  
 b. A: I'd like to point out a crucial fact to you.  
 B: Go on.  
 A: #Who is waiting for you in my office.

These data pinpoint that there is a need for a 'stand alone' fact-denotation for declaratives, but not for interrogatives, which in contrast seem to require a fact-denotation only in embedded contexts. We have already seen in Chapter 2 that the denotation type of simple a declarative clause is the semantic supertype *austinian*, which subsumes both *proposition*, and *outcome*.<sup>25,26</sup> There are additional considerations that argue against attempting to explicate the fact-contributing potential of interrogatives in terms of a constructional ambiguity. For example, any such analysis would produce fact-denoting interrogative clauses that would be selectable by any fact-selecting predicate.

The first consideration arguing against a fact-denoting analysis of interrogatives is that there exists a class of predicates, including *intrigue*, *mystify*, and *puzzle*, that are compatible with both questions and facts. These predicates satisfy pure referentiality arguments with interrogatives, though not with declaratives:

- (33) a. The question is who entered the building last night.  
 That question intrigues me.  
 Hence, it intrigues me who entered the building last night.  
 b. The claim is that Jerry entered the building last night.  
 That claim intrigues me.  
 #Hence, it intrigues me that Jerry entered the building last night.  
 c. That Jerry entered the building last night intrigues me.  
 Hence, there is a fact that intrigues me, namely the fact that Jerry entered the building last night.

Second, the class of emotive predicates selects for facts. But for many speakers, emotive predicates are incompatible with interrogatives (Lahiri 1991, Peterson 1997):<sup>27</sup>

<sup>25</sup>Recall, however, that a finite declarative clause will invariably be either proposition-denoting or outcome-denoting, depending on whether the verb is indicative or subjunctive. We posited a phrasal type *factive-cl*, which builds a fact-denoting clause from a proposition-denoting phrase.

<sup>26</sup>The system developed by Asher (1993) also builds in an ambiguity for declaratives. In Asher's system, a declarative potentially denotes any of the various abstract entities he motivates, including propositions and facts.

<sup>27</sup>There is little controversy that emotives resist polar interrogatives. There are, however, speakers who accept examples such as the following:

- (i) Jo really regretted which student was picked for the job.  
 (ii) Bo resented/was surprised who ate what at the cheese fair.

- (34) a. #Jo resents/regrets when Billie left the party.  
 b. #Mo regrets/resents whether Dominique joined the reformist wing.

By limiting the coercion mechanism to a selected class of predicates, we can accommodate such data. The coercion mechanism allowing interrogative clauses to provide fact-denoting arguments is discussed in Chapter 8.

We conclude this section by providing additional motivation for incorporating facts into our ontology for messages. The most commonly studied speech act is assertion, an act which is typically analyzed as having a proposition as its descriptive content. An informal, partial characterization of assertion might run as follows:

- (35) **Assertion**  
 a. Point: Convince the audience that  $p$  is true.  
 b. Sincerity condition: The speaker believes that  $p$ .  
 c. Preparatory condition: It has not been accepted in the context that either (a)  $\neg p$  is true or (b)  $p$  is true.

By the same token, there exist types of speech act that seem best analyzed as having a fact as their descriptive content. We mention two here: *reminding* and *exclaiming*. Consider first reminding:

- (36) **Reminding**  
 a. Point: Speaker brings a fact  $f$  presumed to be in the conversational common ground to the addressee's attention.  
 b. Preparatory condition:  $f$  is in the common ground.  
 c. Sincerity condition: Speaker believes  $f$  is in the common ground.

The evidence for treating the descriptive content of a reminding as a fact is primarily based on the assumption that such acts involve the factive predicate *remind*:

- (37) a. Fergie: Why don't the vendors here speak Straits Salish?  
 Bo: We're in New York City, for Pete's sake.  
 b. Bo reminded Fergie (of the fact) that they were in New York City.

Exclaiming differs from reminding in that the speaker expresses astonishment (or at the very least surprise) about a certain fact  $f_0$ . At the same time, there is the potential for disagreement between speaker and addressee about the factuality of  $f_0$ . Since  $f_0$  is striking, at least for the speaker, it is apt to be non-mundane, relatively improbable, and frequently will concern matters whose objective verification is difficult:

- (38) a. That's such an amazing play!  
 b. Look at that. Bo really gets the most out of the musicians!  
 c. Oh boy, that's such an inefficient way to run a university!

There can be disagreement about what the background facts are and this is why reminders and exclamations can be challenged:

- (39) a. A: That's such an amazing play!  
 B: [yawns] Rather mundane for my taste.  
 b. A: Why do they look at us with hostility?  
 B: Remember: we're American nationals.  
 A: Oh, but I gave up my citizenship a while back.

This points to the need to ensure that ‘facthood’ is somehow defeasible. Indeed, this will be captured in our semantic ontology in virtue of the assumption that facts belong to a wider class of entities, the possibilities. The question of which such entities manifest the property of being realized/factual is typically contingent. This sort of assumption is needed independently, in order to explain presupposition projection and anaphora. In (40a) what is predicated of Kimmo is potential regret of a possibility, which at utterance time is unknown to be factual, whereas we take the anaphora in (40b) to refer to a possibility whose factuality is controversial:

- (40) a. If Sandip leaves, Kimmo will regret that fact bitterly.  
 b. A: I regret the fact that Kim left.  
 B: It’s not a fact. She’s hiding in my cupboard.

Given our assumption that an indicative declarative clause can denote a fact (as an option to denoting a proposition), it is straightforward to explain reminding and exclamative uses of declaratives. However, declaratives are not the only means for expressing exclamative speech acts. There exists a clause-type often called an ‘exclamative’ clause, analyzed in Chapter 6, whose matrix uses involve exclamations:

- (41) a. What an amazing play Frayn has written!  
 b. How inefficiently they run this place!

Not surprisingly, in light of our discussion above concerning exclamations and their descriptive content, we assume that exclamatives denote facts. This assumption receives independent support from a variety of phenomena. First, exclamatives can be used equatively with fact-denoting nominals, but not with question or proposition-denoting nominals:

- (42) a. The amazing fact I noticed during my visit was how modest all Ruritians are.  
 b. A striking fact I became aware of is what a reputation Bo has carved out for herself among computational ethologists.  
 c. #An interesting claim Mo has put forward is what a reputation Bo has carved for herself among computational ethologists.  
 d. #An intriguing question I’ve been investigating is what a reputation Bo has carved for herself among computational ethologists.

Second, the inferential behavior of exclamatives seems to resemble that of interrogatives and declaratives embedded by factives/resolutives:<sup>28</sup>

- (43) a. Merle is struck by how incredibly well Bo did in the elections.  
 b. Hence, Merle is struck by a fact, a fact that demonstrates that Bo did very well in the elections.
- (44) a. Bo told us a fact. This fact shows that Micky did very badly on the exam.  
 b. Hence, Bo told us just how badly Micky did on the exam.

Third, exclamatives cannot be used assertorically, to provide new information:

<sup>28</sup>As discussed in Chapter 6, *wh*-clauses such as (43a) and (44b) have two analyses, one as an exclamative and one as an interrogative.

- (45) a. A: #I'd like to make the following claim: what a big building that is.  
 b. A: I've got some news for you about Lee's injury.  
 B: uh huh.  
 A: Lee is badly injured./Lee is injured to a fairly significant extent./  
 #How badly Lee is injured!

Fourth, neither QE predicates nor TF predicates are compatible with such clauses;

- (46) a. #Jo wondered/asked what a runner Dana is.  
 b. #Jo wondered/asked how very well Merle did in the elections.  
 c. #Jo believes/claims what an artist Dana is.  
 d. #Jo believes/claims how very well Merle did in the elections.

Fifth, both resolute, factive and indeed emotive predicates are compatible with exclamatives:

- (47) a. Jo finally discovered what a runner Dana is.  
 b. Merle knows how incredibly well Merle did in the elections.  
 c. Brendan forgot what an artist Dana is.  
 d. Lou told us how very badly Micky did on the exam.  
 e. Kim actually managed to predict what a mess the Prime Minister would cause.  
 f. Taylor regrets what a horrible mess he created in the Senate.  
 g. Gerry resents just how much better Dana gets paid than she does.

The fact that exclamative utterances can be challenged, as in (48), is closely related to the data discussed above concerning the defeasibility of facts:

- (48) Watson: What a queer, scrambling way of expressing his meaning!  
 Holmes: On the contrary, he has done remarkably well.  
 (*The Valley of Fear*, A. Conan Doyle.)

This section has suggested the need to introduce facts into the semantic ontology. Following a significant body of work inspired by Vendler, such entities are taken to be distinct both from events and from propositions. We have suggested that facts are among the entities selected by factive predicates and that certain speech act types have facts as their descriptive content. We argued that two distinct types of clause—declaratives and exclamatives—may take a fact as their denotation. Interrogatives, by contrast, do not actually denote facts but can be associated with appropriately resolving facts when they are embedded as complements of factive and resolute predicates.

### 3.2.4 Outcomes

We move now to discuss briefly two more clause types relevant to the syntax and semantics of interrogatives: infinitivals, which allow interrogatives, and subjunctives, which do not:

- (49) a. I wonder who to invite to the party.  
 b. I wasn't sure whether to leave the anarchist faction.  
 c. \*Billie wonders whether Mo leave the anarchist faction.  
 d. \*Billie wonders who be invited to the party.

We posit a class of abstract entities called *outcomes* as the denotata of subjunctives and certain uses of infinitives.<sup>29,30</sup> Intuitively, an outcome is a specification of a situation which is futurate relative to some other given situation:

- (50) a. Bo demanded that Mo be released.  
 b. Kjell demanded to leave the party.  
 c. The regulations require that Luca resign next week.  
 d. The citizens of Worms prayed that Solomon's book be found.  
 e. Glen ordered that we be brought to see her.  
 f. Glen ordered Billie to be brought to see her.

The argumentation for the existence of outcomes as distinct entities in the ontology is entirely parallel to the one we used above to motivate the existence of questions. There exists a semantically coherent class of predicates (mandatives), including *demand*, *require*, *prefer*, and *instruct*, which are incompatible with indicative declaratives but which allow subjunctive declaratives:

- (51) a. #Bo demanded that Mo is released.  
 b. #Kjell demanded that Billie left the party.  
 c. #The citizens of Worms prayed that Solomon's book was found.  
 d. #The regulations require that Luca resigns next week.  
 e. #Glen ordered that Billie was brought to see her.

These predicates exhibit purely referential behavior with outcome-denoting nominals:<sup>31</sup>

- (52) a. One possible outcome is for Jo to get the position.  
 I prefer/want that outcome.  
 Hence, I want Jo to get the position.  
 b. One conceivable outcome was that Bo be given the position.  
 Lynn actually demanded that outcome.  
 Hence, Lynn demanded that Bo be given the position.  
 c. There are two possible outcomes, that Mo be expelled from the party or that he be put on trial by the central committee.  
 I prefer the former outcome.  
 Hence, I prefer that Mo be expelled from the party.

<sup>29</sup>For an account of subjunctives and infinitives which has partly inspired our own see Portner 1997.

<sup>30</sup>Recall that we argued in Chapter 2 that infinitivals also manifest a reading as a SOA, which can subsequently be used to build the propositional argument of a raising verb.

<sup>31</sup>The verb *want* subcategorizes for infinitives but not for subjunctives. We assume that this is a syntactic idiosyncrasy, describable by restricting *want*'s subcategorization to nonfinite clauses. Verbs close in meaning to *want* (such as *wish*, *desire*, and *prefer*) are compatible with subjunctives, as well as infinitives:

(i) I desire/wish/prefer that Taylor leave immediately.

Moreover, in many other languages, verbs similar in meaning to *want* do select for finite clauses corresponding to English subjunctives, for example the Modern Hebrew verb *racá*, which selects for (morphologically) future tense finite clauses:

(ii) raciti      še    tistaleq      mipo      od      etmol  
 wanted-1-sg that leave-fut-2-sg from-here already yesterday  
 I wanted you to leave yesterday.

- (53) a. Lynn demanded that Bo be given the position.  
Hence, there is an outcome that Lynn demanded, the one in which Bo gets the position.
- b. Jo wants to be promoted.  
Hence, there is an outcome Jo wants, one in which she gets promoted.

How do imperatives fit into the picture? We believe that the descriptive content of a directive speech act is also an outcome. This provides a description of an eventuality typically involving the addressee, which is futurate to the utterance situation, and which the speaker would like to see realized.<sup>32</sup> We offer two arguments for this view of imperatives. The first is that imperative uses can often be paraphrased using the mandative predicate *order*, which can be shown to select for an outcome:

- (54) a. Chris: Go home Leslie!  
Chris ordered Leslie to go home.
- b. Chris ordered that Leslie go home.
- c. Bo: Don't touch the ball with your hands, Dana; you'll be sent off.
- d. Bo implored Dana not to touch the ball with his hands.
- e. Bo suggested to Dana that he not touch the ball with his hands.

Moreover, from a semantic perspective, this view of imperatives provides a straightforward analysis of negative and stative imperatives such as (55) below, which a view of imperatives in terms of actions (common in speech act based treatments; see e.g. Allen and Perrault 1980) are unable to give:

- (55) Don't worry; be happy!

We return to explain how facts such as those in (49) can be accounted for once we offer a semantic explication of what questions and outcomes amount to in the following sections.

### 3.2.5 Interim Summary and Implications

Let us summarize the main conclusions of this section:

1. Interrogatives and declaratives need to be distinguished denotationally: interrogatives unambiguously denote questions, whereas indicative declaratives denote either propositions or facts.

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<sup>32</sup>Indeed in some languages, e.g. Modern Hebrew, there is no imperative/subjunctive distinction, their function is subsumed by indicative future tense:

- (i) tistaleq mipo  
Get out-2nd-fut from-here  
Go away!
- (ii) ani tove'a še tistaleq mipo  
I demand-1st-sg that Get-out-2nd-fut from-here  
I demand that you leave.

Note though that this 'future tense' form, as with *roce* ('want') in footnote 31 above, can be used for past tense mandative predicates:

- (iii) jīhad tava še nistaleq mipo  
Jihad demanded-3rd-pst that get-out-1st-pl-fut from-here  
Jihad demanded that we leave.

Modern Hebrew possesses an additional, morphologically distinct set of imperative forms. But, with some exceptions, these are perceived as archaic and are falling out of use.

2. Factive predicates select for facts: this type of entity can be provided directly by fact-denoting expressions such as NPs, indicative declarative clauses and exclamative clauses, or else via coercion of an interrogative clause.
3. Non-finite declaratives, as well as imperatives and certain uses of infinitives, denote outcomes.

### 3.3 Building an Ontology of Semantic Types: Basic Tools

In section 3.2 we provided linguistic motivation for an ontology that distinguishes questions, propositions, facts, situations/events and outcomes. Our task in this section is to show how to construct a semantic universe in which distinctions between abstract entities such as these can be captured.

#### 3.3.1 Basic Strategy

The strategy we adopt, in common with past work in Situation Theory (ST)<sup>33</sup> and in Property Theory,<sup>34</sup> is to characterize semantic objects such as properties and propositions, and in our case, also questions, facts, and outcomes in a way that treats their identity conditions very much on a par with ‘ordinary’ individuals. Such entities are taken as basic, but they are *structured objects*. That is, they arrive on the scene with certain constraints that ‘define them’ in terms of other entities of the ontology. In this way, various foundational problems that beset classical theories of properties, propositions and (in particular given current concerns) questions can be circumvented. For propositions, these problems typically center around doxastic puzzles such as logical omniscience and its variants such as Soames’ puzzle (Soames 1985).<sup>35</sup>

A key innovation of ST, the distinction between SOAs and propositions, provides a solution to the ‘Paradox of the Liar’.<sup>36</sup> This distinction, combined with an innovative theory of abstraction, also enables us to develop a theory of questions which reconstructs an old intuition: that questions are akin to open propositions. Our view of questions will be compared to the most influential formal semantic characterization, one based on entities that encode Exhaustive Answerhood Conditions (EAC). We will show that our approach affords a solution to a number of fundamental problems besetting EAC approaches, including problematic characterizations of answerhood and the misplaced identification of positive and negative polar questions.

We adopt the approach to modeling situation theoretic universes developed in Seligman and

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<sup>33</sup>See, for example, Barwise and Etchemendy 1987, Barwise and Cooper 1991, Cooper and Poesio 1994, and Seligman and Moss 1997.

<sup>34</sup>See, e.g. Bealer 1982, Chierchia and Turner 1988, and Chierchia 1994.

<sup>35</sup>See footnote 76 for discussion of this puzzle.

<sup>36</sup>In this book, soas are discussed in two distinct settings, at the level of typed feature structures and at the level of the semantic universe we build up. Of course the former is used to model aspects of the latter, so we try to maintain terminological consistency across the two levels. In order to prevent confusion, however, we introduce the following notational convention:

- (i) SOA names a feature.
- (ii) *soa* names a type, which the feature SOA takes as value.
- (iii) **Soa** names a (3-place) structural relation of SITSTRs.
- (iv) SOA names those (real world) entities structurally built up by means of the structural relation **Soa**.

A final terminological remark. The term SOA originated as an acronym for *state-of-affairs*. However, despite the etymology, SOAs are intended to be neutral with respect to the stative/eventive distinction.

Moss 1997 (S&M–97), which we recommend to our formally inclined readers.<sup>37</sup> We proceed somewhat informally here, employing simplified definitions when appropriate. A semantic universe is identified with a relational structure  $\mathcal{S}$  of the form  $[\mathcal{A}, S_1, \dots, S_m; R_1, \dots, R_m]$ . Here  $\mathcal{A}$ —sometimes notated also as  $|\mathcal{S}|$ —is the universe of the structure. From the class of relations we single out the  $S_1, \dots, S_m$  which are called the *structural relations*, intended as they are to capture the structure of certain elements in the domain. Specifically, for our purposes, we use structural relations first to ‘build’ SOAs up from relations and assignments of entities to the argument roles of the relations. Subsequently, SOAs and situations serve as the ‘basic building blocks’ from which the requisite abstract entities of our ontology are constructed. Each  $S_i$  can be thought of as providing a condition that defines a single structured object in terms of a list of  $n$  objects  $x_1, \dots, x_n$ . For instance, a SOA  $\sigma$  is built up from a relation  $R$  and an assignment  $f$  (of entities to the argument roles of the relation). The structural relation **Soa**, consequently, ensures that  $\sigma$  is a structured object whose components are  $R$  and  $f$ .

We proceed incrementally, first explaining what a Situation Structure (SITSTR) is. We then introduce notions of abstraction and application; a structure closed under such operations will be called a  $\lambda$ (lambda)-structure. We then define our semantic universe, building from a  $\lambda$ -SITSTR a Situational Universe with Abstract Entities (SU+AE), which contains facts, propositions, and outcomes. Since the SU+AE is a  $\lambda$ -structure, it will automatically also contain questions, given our identification of these with proposition abstracts.

A word about the consistency of our semantic theory. S&M–97 show how to build a SITSTR. This same technique can be used to expand a SITSTR to an SU+AE. They also prove that any extensional structure can be expanded to a  $\lambda$ -structure.<sup>38</sup> Thus, at all steps the consistency of our theory is as safe as the consistency of set theory.<sup>39</sup> In particular, the step we make in expanding the universe to include questions involves no danger, as far as consistency goes. Some additional discussion of these issues is provided in Appendix B.

### 3.3.2 Situation Structures

The most basic relational structure which underpins our modeling, following Seligman and Moss, is a SITSTR. Intuitively, a SITSTR is simply a universe which contains among its entities a class of temporally located entities called situations and a class of entities called SOAs. The SOAs, as we have noted, are structured objects, constructed from a relation  $R$  and an assignment  $\alpha$ , that assign a set of entities from the universe to a set of argument roles that they are appropriate for. Indeed, the assignment itself is taken to be a structured object characterized in terms of the ordered

<sup>37</sup>For an earlier approach, which attempts to linguistically motivate an ST universe, see Cooper and Poesio 1994.

<sup>38</sup>The universe is said to be EXTENSIONAL if structured objects are defined uniquely: for any structural relation  $S_i$  and list of  $n$  objects  $x_1, \dots, x_n$  there is at most one object  $y$  such that  $S_i(x_1, \dots, x_n, y)$ . As S&M–97 note ‘The extensionality condition is a form of Leibniz’s Law: objects that are indistinguishable on the basis of their structural relationships are identical’. (S&M–97, p. 260)

<sup>39</sup>The set theory in question is  $ZFC^- + AFA$ :  $ZFC^-$  is Zermelo Fraenkel set theory with the axiom of choice but without the axiom of foundation. AFA is the anti-foundation axiom proposed by Aczel (1988). AFA is an alternative to the axiom of foundation. The axiom of foundation stipulates that set theoretic membership cannot involve cycles—for instance, cases like  $a \in a$  or  $a \in b \in a$  are excluded. AFA, by contrast, allows such cycles to occur and consequently enables circularity to be modeled. This makes it a highly useful tool for modeling circular phenomena, such as those that occur in NL semantics, in computational processes, in legal reasoning and so forth. Aczel has shown that  $ZFC^- + AFA$  is consistent iff  $ZFC^-$  is. For a highly readable introduction to non-well-founded set theory and its applications see Barwise and Moss 1996.

pairs that make its graph: for a role  $i$  and entity  $a$ , **Sele(ctionally)Ad(equate)Val(ue)**( $i, a, \alpha$ ) will mean that  $a$  satisfies the selectional restrictions of role  $i$  and that they are elements of the assignment  $\alpha$ 's graph;  $\alpha$  will of course be required to be functional. One crucial departure from the familiar Montagovian set-up is that relations, in contrast to assignments, are here taken as unstructured atomic individuals, rather than as intensionalized sets of tuples of individuals.<sup>40</sup>

Situations are partial, temporally located, actual entities, whose role is to explicate such objects as states or events.<sup>41</sup> SOAs perform the function of designating *properties* that situations might possess, as illustrated by the two SOAs depicted in (56):<sup>42</sup>

- (56) a.  $\langle\langle \text{See}; \text{see-er:jo, seen:bo} \rangle\rangle$   
 b.  $\langle\langle \text{Hot}; \text{location:holborn station, time:3:45 gmt} \rangle\rangle$

It is worth emphasizing that these are solely depictions of SOAs. Far from being sentences in a formal language, they are non-linguistic abstractions individuated in terms of real-world objects. To take a rather familiar example, the Roman philosopher Cicero is occasionally referred to by the anglicized form of his middle name, Tully. Example (57a,b) shows two depictions of a single SOA that could be used to predicate of a situation that it includes Cicero sleeping.

- (57) a.  $\langle\langle \text{Sleep}; \text{sleep-er:cicero} \rangle\rangle$   
 b.  $\langle\langle \text{Sleep}; \text{sleeper:tully} \rangle\rangle$

This is because the constituent of the SOA is the individual Marcus Tullius Cicero, regardless of how we manage to refer to him.<sup>43,44</sup> One final condition on  $\alpha$  as the assignment of a SOA is that the assignment itself be appropriate: we place no constraints on what components make up an assignment. Examples of possible assignments are given in (58):

- (58) a. runner:tully,time:3:45 gmt  
 b. seer:tully,seen:seneca  
 c. runner:tully,seen:seneca  
 d. seer:tully,eaten:salome

Of these only (58a,b) are appropriate in the sense that they involves a coherent set of roles.

We should mention an additional important function which SOAs fulfill, already alluded to in Chapter 2, footnote 14, namely that they serve as ‘semantic common denominators’ among distinct semantic abstract entities. A long standing and often repeated assumption of Speech Act

<sup>40</sup>An additional mechanism for building up relations, namely abstraction, is discussed below. Unlike abstracts in Montague Semantics, which are construed as sets, our abstracts are structured objects.

<sup>41</sup>Their most important innovative semantic use has been to serve as denotations of naked infinitive clauses (see, for example, Barwise and Perry 1983 and Cooper 1998), and to explicate domain restriction in quantification (Cooper 1996). We return to the matter of domain restriction in Chapter 4.

<sup>42</sup>A somewhat more precise, albeit more pedantic, notation for the SOAs in (56) would be:

- (i)  $\langle\langle \text{See}; \{ \text{see-er:jo, seen:bo} \} \rangle\rangle$   
 (ii)  $\langle\langle \text{Hot}; \{ \text{location:holborn station, time:3:45 gmt} \} \rangle\rangle$

This is more precise because it emphasizes that a SOA consists of two components (the relation and the assignment) and that the latter is itself a structured object.

<sup>43</sup>We emphasize this familiar point here because it plays a considerable role in the way we model propositions and facts. Note that the approach developed here differs from many others that might appear similar in certain respects, notably Discourse Representation Theory (Kamp and Reyle 1993). See section 3.4.3 below.

<sup>44</sup>However, see section 3.6 for a discussion of how naming information associated with uses of proper names gets packaged in HPSG.

Theory (see e.g. Searle 1969, Searle and Vanderveken 1985), which in fact originates with Frege (1918), is the assumption that assertions, polar queries, and commands differ on the level of illocutionary force, but share the same descriptive/propositional content. Applied, for instance to (59), the claim amounts to saying that (uttered in the same context), the declarative, the interrogative, and the imperative have the same content, namely some proposition *p*. The difference between these potential utterances, on this view, is that (59a) will be used to assert *p*, whereas (59b) will be used to ask *p*, and (59c) to command *p*:

- (59) a. Bo will go away.  
 b. Will Bo go away?  
 c. Go away Bo!

This view, the Frege-Searle Propositional Content Hypothesis, is untenable, as it stands; we already provided evidence in section 3.2.4 that showed that the denotata of indicative and subjunctive declaratives/imperatives should be distinguished. We now show the weaknesses of identifying the denotation of a polar interrogative with that of the corresponding declarative.<sup>45</sup> An obvious problem with such an identification is this: if the difference between a declarative and a polar interrogative is merely one of illocutionary force, then an utterance of the latter should be paraphrasable using a proposition-denoting *that*-clause. As (60) shows, this is not the case; such a paraphrase requires a *whether*-clause:

- (60) a. A: Did Bo leave?  
 b. A asked whether/#that Bo left.

That this difference between *that* and *whether* is semantically significant is illustrated by the fact that (61a) differs from (61b) in allowing for the possibility that Jo didn't leave:

- (61) a. Bo knows whether Jo left.  
 b. Bo knows that Jo left.

Another problem with the Frege-Searle Propositional Content Hypothesis is this: if a polar question denotes a proposition it should be assertible and bear a truth value, neither of which is the case:

- (62) a. I wish to make the following claim: #Did Bo leave?  
 b. #It is true/false whether Bo left.

The thesis about denotational identity across declaratives, interrogatives, and imperatives is, then, fallacious. This does not mean, however, that the intuition which underlies it, the existence of a 'common semantic denominator' cannot be salvaged. Indeed, on our account, one will be able to characterize this common denominator in terms of a SOA, which is a component of the respective proposition, polar question, and outcome posited to capture the distinct denotations. As already mentioned in Chapter 2, footnote 14, the existence of such a common denominator is of considerable importance, in that it provides a uniform account of the role of quantification and of adverbial modification in declarative, interrogative, and imperative clauses.

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<sup>45</sup>Indeed in Chapter 7, we even argue against identifying the denotations of declaratives and of 'intonation' questions such as (i):

(i) Bo is leaving?

Moving on to relate SOAs and situations: the notation in (63) indicates that a situation  $s$  is correctly classified by a SOA  $\sigma$ :

$$(63) \quad s \models \sigma$$

This is sometimes referred to as the situation *supporting* the SOA or making the SOA *factual*. If a situation fails to be correctly classified by a SOA  $\sigma$ , we notate this as follows:

$$(64) \quad s \not\models \sigma$$

Negation plays an important role in explicating what questions are. Thus it is important to understand how the effects of negation fit within our framework. We assume that SOAs come in pairs—positive and negated—as regulated by the *NegOf* relation introduced below. In developing our grammatical framework we will depart from most of the existing work in Situation Semantics which marks polarity overtly (via 1/+ and 0/– or else a feature POLARITY taking such elements as its value). Rather, we will take positive SOAs as literally unmarked and build negative SOAs by means of an adverbial-like operator that takes the positive SOA as its argument. We notate the SOA dual to  $\sigma$  as  $\bar{\sigma}$ . Our assumptions (see below) about symmetry, functionality, and duals' sharing of defining relation and assignment will yield the familiar cancellation of double dualization:

$$(65) \quad \bar{\bar{\sigma}} = \sigma$$

We will assume that all situations are consistent in the following sense:

$$(66) \quad \text{If } s \models \sigma, \text{ then } s \not\models \bar{\sigma}$$

Because situations are partial, there is a difference between a situation failing to be correctly classified by  $\sigma$  and being correctly classified by  $\bar{\sigma}$ . For any situation  $s$  and SOA  $\sigma$ , (67a) holds, but (67b) does not generally hold:

- (67) a. Either  $s \models \sigma$  or  $s \not\models \sigma$   
 b. Either  $s \models \sigma$  or  $s \models \bar{\sigma}$

The intuition is that classifying  $s$  with  $\bar{\sigma}$  means that that  $s$  actually possesses information which rules out  $\sigma$ , rather than simply lacking concrete evidence for  $\sigma$ . To take a simple example, a situation in which some individual *kiko* is running will typically support both the SOA (68a) and also (68b); however, it will support neither (68c) nor (68d):

- (68) a.  $\langle\langle \text{Run; runner:kiko} \rangle\rangle$   
 b.  $\langle\langle \text{Alive; agent:kiko} \rangle\rangle$   
 c.  $\langle\langle \text{Sleep; sleeper:cicero} \rangle\rangle$   
 d.  $\overline{\langle\langle \text{Sleep; sleeper:cicero} \rangle\rangle}$

Cooper (1998), motivated in part by data from naked infinitive clauses, has proposed a pair of axioms that attempt to capture this intuition. (69a) states that if a situation  $s$  supports the dual of  $\sigma$ , then  $s$  also supports positive information that precludes  $\sigma$  being the case:

- (69) a.  $\forall s, \sigma [s \models \bar{\sigma} \text{ implies } \exists (Pos)\psi [s \models \psi \text{ and } \psi \Rightarrow \neg \sigma]]$   
 b.  $\forall s, \sigma [s \models \bar{\sigma} \text{ implies } \exists (Pos)\psi [s \models \psi \text{ and } \psi > \sigma]]$

(69b) tells us that if a situation  $s$  supports the dual of  $\sigma$ , then  $s$  also supports information that

defeasibly entails that  $\sigma$  is the case.<sup>46</sup>

To these two dualization axioms, one might add a third, which is a converse of (69a): if a situation  $s$  supports a SOA which is incompatible with  $\sigma$ , then  $s$  supports  $\bar{\sigma}$ .<sup>47</sup>

$$(70) \quad \forall s, \sigma \exists \psi [s \models \psi \text{ and } \psi \Rightarrow \neg \sigma], \text{ then } s \models \bar{\sigma}.$$

Given that SOAs encode different ways situations could be (in other words, they are potential properties of external reality), they play a role similar to possible worlds in possible worlds semantics. In particular, they will be a key component in the explication of what propositions are. Nonetheless, there are two obvious differences between SOAs and possible worlds.<sup>48</sup> First, SOAs are structured objects; second, their ‘informational range’ is microscopic compared to a possible world, which determines the resolution of each conceivable issue (and then some). The SOAs defined in definition 3 are all *basic* SOAs—their direct components are simply a relation and an assignment of entities to the argument roles of that relation. In many ST accounts, it is assumed that in addition to basic SOAs, there also exist compound SOAs, built structurally; but we do not make this assumption here. Although compound SOAs play no role in any of our analyses, we take no stand on the issue of whether such entities should be avoided on general theoretical grounds, as suggested by Devlin (1991).<sup>49</sup>

Before summarizing our assumptions about SITSTRs,<sup>50</sup> we review a few preliminaries about structural relations:<sup>51</sup>

### Definition 1 Structural Sorts

*Given a structural relation  $S$ , the class  $S^*$  consists of those objects  $a$  such that  $S(\vec{x}, a)$  holds for some sequence  $\vec{x}$  of elements of  $\mathcal{A}$ . The elements  $\vec{x}$  will be called the components of  $a$ . The classes  $S_i^*$  constitute the structural sorts of the relational structure  $\mathcal{S}$ .*<sup>52</sup>

### Definition 2 Extensionality

*In general, we will assume that the relational structures we define are extensional: structured objects are determined uniquely. That is, given a structural relation  $S_i$  and a sequence of objects  $\vec{x}$ , there exists at most one  $y$  such that  $S_i(\vec{x}, y)$ .*

<sup>46</sup>Suppose, for example, that we say (i):

- (i) Jo saw Bo not stop at the traffic lights.

Here we are typically talking about a situation where Bo approaches a red traffic light, a situation that usually involves stopping. We leave the notion of defeasible entailment unanalyzed here. Various notions could be used, however, for instance the notion of defeasible entailment developed within Barwise and Seligman’s Channel Theory (Barwise and Seligman 1996).

<sup>47</sup>This property of dualization would follow directly if one assumed the class of SOAs to be a Heyting algebra, with dualization constituting a pseudo-complement operation. For one such set-up, see Barwise and Etchemendy 1990.

<sup>48</sup>We mentioned above that situations are usually taken to be ACTUAL. However, there is nothing in the theory that rules out postulating non-actual situations. Nonetheless, as Cooper (1993) shows, one can recast Montague’s theory of modality in situation theory without making this additional assumption, in which case the ‘possibilities’ would all be explicated by means of SOAs. For recent discussions of modality in ST, see Barwise 1997 and Vogel and Ginzburg 1999, where the use of non-actual situations is entertained.

<sup>49</sup>For discussion, see Barwise 1989b.

<sup>50</sup>The definition here involves the minimum conditions for a structure to be a SITSTR. Some additional assumptions that would typically be assumed have been discussed above.

<sup>51</sup>See definition 3.2 of Seligman and Moss.

<sup>52</sup>It should be emphasized that structural sorts are merely a metatheoretical device, useful for talk about structural relations. When talking about a class of relational structures, we will sometimes find it convenient to discuss it in terms of its associated structural relations; on other occasions it will be more convenient to formulate discussion in terms of structural sorts.

The assumptions about a SITSTR have been partitioned into four categories. The first two groups concern the nature of SOAs and negation, respectively. The third group imposes certain obvious sortal requirements, while the fourth specifies certain basic assumptions about temporal structure.<sup>53</sup>

### Definition 3 A Situation Structure (SITSTR)

A Situation Structure (SITSTR) is a relational structure of the following type:<sup>54</sup>

[  $\mathcal{A}$ , **SelAdVal**<sup>3</sup>, **Soa**<sup>3</sup>, **Pos**<sup>1</sup>, **Neg**<sup>1</sup>;  $Sit$ <sup>1</sup>,  $\models$ <sup>2</sup>,  $Rel$ <sup>1</sup>,  $ArgRole$ <sup>1</sup>,  $Approp$ <sup>1</sup>,  $NegOf$ <sup>2</sup>,  $Time$ <sup>1</sup>,  $Timespan$ <sup>2</sup>,  $Anterior$ <sup>2</sup> ] such that:

#### 1. Basics concerning SOAs:

- (a) If **Soa**( $R, \alpha, \sigma$ ), then  $Rel(R)$  and  $Approp(\alpha)$ .
- (b) If **SelAdVal**( $i, a, \alpha$ ), then  $ArgRole(i)$ .
- (c) If **Soa**( $R, \alpha, \sigma$ ), then for any  $i, a, b$  such that **SelAdVal**( $i, a, \alpha$ ) and **SelAdVal**( $i, b, \alpha$ ) it follows that  $a = b$ .
- (d) If  $s \models \sigma$ , then  $Sit(s)$  and there exist  $R, \alpha$  such that **Soa**( $R, \alpha, \sigma$ ).<sup>55</sup>
- (e) Notation: If **Soa**( $R, \alpha, \sigma$ ), then we write:  $\sigma = \langle\langle R; \alpha \rangle\rangle$

#### 2. Negation and SOAs:

- (a) If for some  $R, \alpha$  **Soa**( $R, \alpha, \sigma$ ), then exactly one of the following: **Pos**( $\sigma$ ) or **Neg**( $\sigma$ )
- (b) The  $NegOf$  relation is symmetric and functional (If  $NegOf(\sigma, \tau)$ , then  $NegOf(\tau, \sigma)$ ;  
If  $NegOf(\sigma, \tau)$  and  $NegOf(\sigma, \tau')$ , then  $\tau = \tau'$ )
- (c) Dual SOAs are constituted from the same SOA and role assignment: If **Soa**( $R, \alpha, \sigma$ ), then there is a SOA  $\bar{\sigma} \neq \sigma$  such that  $NegOf(\sigma, \bar{\sigma})$  and **Soa**( $R, \alpha, \bar{\sigma}$ )

#### 3. **Soa**\* and **SelAdVal**\* are disjoint.

#### 4. Temporal Structure:

- (a) If  $Timespan(s, t)$ , then  $Sit(s)$  and  $Time(t)$ .  $Timespan$  relates a situation to the times occurring within it.
- (b) If  $Anterior(s_1, s_2)$ , then  $Sit(s_1)$  and  $Sit(s_2)$ .  $Anterior$  is a partial ordering on the class of situations in terms of temporal constitution such that  $Anterior(s_1, s_2)$  intuitively means that the temporal instants of  $s_1$  precede the temporal instants of  $s_2$ .

### 3.3.3 Simultaneous Abstraction

The final component we need before we can fully define our semantic universe is the notion of *simultaneous abstraction*. Simultaneous abstraction will play a pivotal role in providing a viable notion of *propositional abstract*, one which can be used to overcome the formal and conceptual problems involved in previous ‘open proposition’ accounts of questions. Simultaneous abstraction, first introduced by Aczel and Lunnon (1991), is a generalization of unary abstraction (familiar from the  $\lambda$ -calculus) with two crucial differences. First, instead of abstracting over a single

<sup>53</sup>These latter assumptions are novel to our account and not in S&M–97.

<sup>54</sup>We adopt the notational convention that structural relations are depicted in boldface and have numerical superscripts corresponding to their r-ity. We will typically omit the latter.

<sup>55</sup>An alternative approach we could adopt, discussed in S&M–97, is to view  $Sit$  and  $\models$  as structural relations. The idea behind this is that situations are then taken to be structurally determined by the SOAs they support. This has the advantage of pinning down in very concrete terms the identity conditions of situations.

variable, one abstracts over a set.<sup>56</sup> Second, an abstract is not construed functionally, but rather by means of structural relations that relate it to its body and the (abstracted) roles. Thus, if the universe contains objects of sort  $\phi$  (e.g. SOAs or facts or propositions), then abstraction constitutes an operation that potentially expands the universe to contain also objects of sort  $\phi$ -abstract. Such objects can be applied to an assignment  $f$  to yield objects of sort  $\phi$  in which substitution as specified by  $f$  has taken place. We proceed to clarify the nature of the closely related notions of substitution and abstraction.

### Substitutions and Simulations

Given an extensional structure  $[\mathcal{A}, S_1, \dots, S_m; \dots]$ , a substitution is simply a mapping  $f$  between elements of the universe  $\mathcal{A}$ . A relation  $g$  that extends  $f$  is called an  $f$ -simulation if it relates two elements  $a$  and  $b$  just in case  $a$  and  $b$  are identical modulo ‘substitutions induced by  $f$ ’.<sup>57</sup>

What this amounts to is the following:<sup>58</sup>

#### Definition 4 f-Simulation

Given a mapping  $f$ , a binary relation  $G$  is an  $f$ -simulation just in case: if  $G(a,b)$  holds, then

1. if  $a \in \text{Dom}(f)$ , then  $b = f(a)$   
Otherwise:
2.  $a = b$ , for an unstructured object  $a$
3. If  $a$  is a structured object, then whenever  $S(x_1, \dots, x_n, a)$  for some structural relation  $S$ , then there exist  $y_1, \dots, y_n$  such that  $S(y_1, \dots, y_n, b)$  and for each  $i$ :  $G(x_i, y_i)$
4. Conversely, whenever  $S(y_1, \dots, y_n, b)$ , there exist  $x_1, \dots, x_n$  such that  $S(x_1, \dots, x_n, a)$  and for each  $i$ :  $G(x_i, y_i)$
5. Given a substitution  $f$ , if there exists an  $f$ -simulation that relates  $a$  to  $b$ , we write this as  $b = a\{f\}$ .

To make this concrete, let us take a simple example with a SITSTR. If  $f$  is the mapping in (71), then, by clause 2 of definition 4, a relation  $G_0$  can be an  $f$ -simulation only if it relates any ordinary, unstructured individual  $a$  other than kim and lou to itself:

$$(71) \quad f : [\text{kim} \mapsto \text{sam}, \text{lou} \mapsto \text{billie}]$$

Now consider SOAs, the prime example so far of a structured object. For simplicity, we restrict our attention to simple SOAs, where the elements in the range of the role assignment mapping are unstructured. Any such SOA whose role assignment mapping does not contain either kim or lou in its range can only be related to itself. This is because a SOA  $\sigma$ 's components are the relation  $R$  and the role assignment mapping  $\alpha$ .  $R$  is unstructured, and (by our previous discussion) can only be related to itself by  $G_0$ ; the components of  $\alpha$  are the roles and the elements in the range of  $\alpha$ . These are all, by our assumption, unstructured and distinct from kim and lou. And so again, by our previous discussion, these can only be related to themselves by  $G_0$ . A SOA such as (72a), which does contain kim as a constituent of its role assignment mapping, would need to be related by  $G_0$  to (72b), whereas a SOA like (72c) would need to be related to (72d):

<sup>56</sup>A related notion does exist in certain versions of the lambda calculus, which allows for the product operation. See, for example, Barendregt 1984.

<sup>57</sup>The notion of an  $f$ -simulation is closely related to the notion of *bisimulation* discussed in Appendix B.

<sup>58</sup>See S&M-97 definition 3.11.

- (72) a.  $\langle\langle \text{Sleep}; \text{sleeper:kim} \rangle\rangle$   
 b.  $\langle\langle \text{Sleep}; \text{sleeper:sam} \rangle\rangle$   
 c.  $\langle\langle \text{See}; \text{see-er:kim, seen:lou} \rangle\rangle$   
 d.  $\langle\langle \text{See}; \text{see-er:sam, seen:billie} \rangle\rangle$

These examples illustrate that two objects related by means of an  $f$ -simulation are indeed identical, modulo ‘substitutions induced by  $f$ ’.

### Abstraction and Application: Initial Notions

With this in hand, we can now turn to abstraction.<sup>59</sup> We start with unary abstraction. Recall that in a framework such as Montague Semantics, abstracts have no ontological status as such.  $\lambda$ -terms function as useful *notation* for functions. For instance, (73a) is construed as (73b):<sup>60</sup>

- (73) a.  $\lambda x. \text{See}(x, j)$   
 b. the function  $h : D_e \rightarrow \{0, 1\}$  such that  $h(a) = \llbracket \text{See}(x, j) \rrbracket^{M, g_x^a}$

Although one could develop a variant of this ‘functional’ approach for our framework, we will adopt a strategy where abstraction is a semantic operation akin to substitution; the main difference is that the element which gets ‘substituted in’ functions as a place holder, not a regular role filler. There are a number of reasons for adopting such an approach. For a start, it can be argued to be conceptually simpler, directly expressing the intuition that abstraction over an entity of type  $\phi$  creates an ‘open  $\phi$ ’. The functional view further requires that the domain of the function be explicitly computed. This conceptual advantage of the substitutional approach has concrete ramifications: a functional construal of an abstract involves an unmotivated loss of semantic grain. This is because intuitively distinct descriptions of the domain of the function can end up being instantiated by the same set. For instance, if we interpret the interrogatives in (74) as abstracts and in turn construe these abstracts functionally, then the two denotations will be identified.<sup>61</sup> Such a conflation will not arise on the approach we develop here.<sup>62</sup>

- (74) a. Which primes smaller than five are divisors of 9?  
 b. Which numbers smaller than 4 are divisors of 9?

How are we to formalize our notion of abstraction? Given the modeling strategy so far, it is clear that abstracts will be specified using structural relations. At first, one might think that in view of the notation  $\lambda b.p$ , one could simply posit a three place structural relation **Abst** such that **Abst**( $p, b, a$ ) would mean that  $a$  arises by abstracting  $b$  from  $p$ . But such an approach will not quite work. The reason for this is quite simple: structured objects are required to have a unique set of components. For instance, the SOA which we depict as  $\langle\langle R, f \rangle\rangle$  is built from the relation  $R$  and the assignment  $f$ . But by its very nature, an ‘abstract’ is not uniquely determined by the single entity it has been ‘abstracted from’. After all, abstraction, as its name implies, ‘generalizes’ over

<sup>59</sup>Our presentation here, on the formal side, is highly dependent on S&M–97. However, the formulation we provide differs slightly from theirs: the way we set things up makes the introduction of restrictions on abstracts somewhat simpler. Moreover, it will help us ensure—for reasons explained below—that an abstract is necessarily distinct from the entity it is abstracted from. This means that S&M–97’s theorem that every extensional structure can be extended to a  $\lambda$ -structure needs to be modified subtly, though not in a way that hampers our application of it, as we show in Appendix B.

<sup>60</sup>One could make the comparison to the current framework even more direct by substituting for  $\{0, 1\}$  a sort such as **SOA**\*

<sup>61</sup>The denotation will be the function  $x : \{2, 3\} \mapsto \text{Divide}(x, 9)$ .

<sup>62</sup>Actually, the approach we discuss in this chapter does not provide a fully satisfactory account of abstraction with restrictions. A minor adjustment, presented in Chapter 4, will provide the requisite notion.

a whole class of entities.  $\lambda x \langle \langle \text{See}; \text{see-er}:x, \text{seen:bo} \rangle \rangle$  can no more be structurally determined by  $\langle \langle \text{See}; \text{see-er}:jo, \text{seen:bo} \rangle \rangle$  than by  $\langle \langle \text{See}; \text{see-er}:mo, \text{seen:bo} \rangle \rangle$ .

A more successful method is to specify abstraction using two structural relations, one of which involves an essential self reference. Think of an abstract as a structured object containing a place-holder.<sup>63</sup> In turn, think of the place-holder as specified in terms of an entity which contains the place-holder as a component. This latter entity, the body of the abstract, is the substitution instance of the various entities which the abstract generalizes over.<sup>64</sup>

In order to characterize a structure with an abstraction operation, one which we will call an *abstraction structure*, we posit two structural relations: **PlaceHolder**<sup>2</sup>( $b, \pi$ ), which relates the body  $b$  and the place-holder  $\pi$ , and **Abst**<sup>2</sup>( $b, a$ ), which relates the body  $b$  and the abstract  $a$ . Objects of sort **PlaceHolder**\* are called place-holders and objects of sort **Abst**\* are called abstracts.

In order that these specifications serve to define an abstraction operation we need to impose certain conditions on these relations. First, we want to ensure that a place-holder is on one hand a component of the body of the abstract; conversely, it does not have any other structural description:

- (75) a. If **Abst**( $b, a$ ), then  $b \neq a$  and there exists  $\pi$  such that **PlaceHolder**( $b, \pi$ ).  
 b. If **PlaceHolder**( $b, \pi$ ), then the only sort of  $\pi$  is **PlaceHolder**\*.

Second, we want to ensure that the result of applying the abstract will be well defined. This we achieve by requiring that a place-holder can occur in only one body:

- (76) If **PlaceHolder**( $b, \pi$ ) and **PlaceHolder**( $b', \pi$ ), then  $b = b'$ .

Finally, and most crucially, we want to ensure that the body of the abstract is indeed a substitution instance of the various entities which the abstract generalizes over. This is what will ensure that the result of applying an abstract is the intended one, namely that it involves substituting a non place-holder in place of the abstract's place-holder.<sup>65</sup> We state this as follows:

- (77) a. Given an abstraction structure  $\mathcal{S}$  and two objects  $a$  and  $c$ , an abstract  $\tau$  is THE ABSTRACTION OF  $b$  FROM  $\sigma$  if there exist  $\pi$  and  $c$  such that
1.  $b = a\{c \rightarrow \pi\}$
  2. **PlaceHolder**( $b, \pi$ )
  3. **Abst**( $b, \tau$ )
  4. The only sort of  $\pi$  is **PlaceHolder**\*.
- b. Given an abstract  $a$  in an abstraction structure  $\mathcal{A}$ , a substitution  $\pi \rightarrow d$  is an appropriate assignment to  $a$  if there exists  $b$  such that
1. **PlaceHolder**( $b, \pi$ )
  2. **Abst**( $b, a$ )
  3.  $b\{\pi \mapsto d\}$  exists.
- c. If  $b\{\pi \mapsto d\}$  exists, we call it the application of  $a$  to the substitution  $\pi \mapsto d$ .

<sup>63</sup>Also known as a ROLE INDEX in Aczel and Lunnon 1991 and Cooper 1993 and as a POINTER in S&M-97.

<sup>64</sup>Recall that the set theory which formally underpins our account accommodates non-well-founded phenomena.

<sup>65</sup>Indeed the distinction between the body and the abstract will become more pronounced once we introduce abstraction with restrictions in Chapter 4. The restrictions will be components of the abstract which delimit the possible substitutions which the abstract can be applied to. However, they will not in general be components of the body or of substitution instances of the abstract.

Let us consider a simple example. Abstraction over the SOA in (78a) yields a SOA abstract that we notate as (78b). The place-holder involved in this abstraction ‘occupies’ the role previously filled by *jo*:

- (78) a.  $\langle\langle\text{See}; \text{seer:jo}, \text{seen:bo}\rangle\rangle$   
 b.  $\lambda\{jo \mapsto \pi\}\langle\langle\text{See}; \text{see-er:jo}, \text{seen:bo}\rangle\rangle$

Whereas, applying (78b) to (79a) would yield (79b):

- (79) a.  $f : [\pi \mapsto kim]$   
 b.  $\langle\langle\text{See}; \text{seer:kim}, \text{seen:bo}\rangle\rangle$   
 c.  $f_0 : [jo \mapsto kim]$

Note that this is identical with the result of starting out with a substitution  $f_0$  as in (79c) and—via a  $f_0$ -simulation—replacing *jo* in the original SOA (78a) with *kim*.

As we have noted, **PlaceHolder** and **Abst** are structural relations. This implies that *b* being abstracted out of  $\sigma$  yields a unique place-holder and a unique abstract. This, in turn, implies that in creating a structured object, abstraction ‘forgets’ the original fillers of the argument role. Thus, the abstract (80a) can be shown to be identical to (80b), a property analogous to  $\alpha$ -equivalence in  $\lambda$ -calculus:

- (80) a.  $\lambda\{billie \mapsto r_1\}\langle\langle\text{See}; \text{seer:billie}, \text{seen:bo}\rangle\rangle$   
 b.  $\lambda\{jo \mapsto r_2\}\langle\langle\text{See}; \text{seer:jo}, \text{seen:bo}\rangle\rangle$

Moreover, there is no need to reify as members of the universe ‘parameters’ or similar variable-like entities to fill the roles over which abstraction takes place (cf. Barwise and Cooper 1991). Rather, place-holders are modeled as structured objects, postulated to be entities which have no other sort.<sup>66</sup> A consequence of the unique definability of place-holders is a notational convention we will often adopt: unless reference to the place-holder is of import in a particular discussion, we will omit the place-holder from the notation for abstracts. (81b) will serve as the notation for (81a):

- (81) a.  $\lambda\{billie \mapsto r_1\}\langle\langle\text{See}; \text{seer:billie}, \text{seen:bo}\rangle\rangle$   
 b.  $\lambda\{billie\}\langle\langle\text{See}; \text{seer:billie}, \text{seen:bo}\rangle\rangle$

### Simultaneous Abstraction

We can now turn to simultaneous abstraction. This turns out to be a straightforward generalization. Abstracting a set of entities  $c_1, \dots, c_n$  from an object  $\sigma(c_1, \dots, c_n)$  of which they are components, is equivalent to the existence of a  $[c_1 \mapsto r_1, \dots, c_n \mapsto r_n]$ -simulation which relates  $\sigma(c_1, \dots, c_n)$  to the body of the abstract:

#### Definition 5 Simultaneous Abstraction

*In an abstraction structure  $\mathcal{S}$ , given  $a$  and a set  $C (= \{c_1, \dots, c_n\})$ , an abstract  $\tau$  is the abstraction of  $C$  from  $\sigma$  if there is an injective function  $\pi : C \rightarrow |\mathcal{S}|$  (the PlaceHolder function) and  $b$  such that:*

1.  $b = \sigma\{c_1 \mapsto \pi(c_1), \dots, c_n \mapsto \pi(c_n)\}$ .
2. For each  $c_i$ : **PlaceHolder**( $b, \pi(c_i)$ ).

<sup>66</sup>This elegant view of abstraction, which does not presuppose the existence of parameters ‘prior’ to the abstraction is due to Seligman and Moss. For a detailed and insightful development of a related view, see Crimmins 1993a.

3. **Abst**( $b, \tau$ ).
4. For each  $c_i$ : the only sort of  $\pi(c_i)$  is **Placeholder**\*

The abstraction of  $C (= \{c_1, \dots, c_n\})$  from  $\sigma$  is notated as either  $\lambda C.\sigma$  or as  $\lambda\{c_1, \dots, c_n\}\sigma$ .

An appropriate assignment  $f$  for a simultaneous abstract is a function whose domain includes the roles of the abstract. In addition,  $b\{f\}$  must exist, for  $b$ —the body of the abstract. The formal definition is identical *mutatis mutandis* to (77b).<sup>67</sup> For instance, abstraction over the SOA in (82a) yields the SOA abstract in (82b). Applying this abstract to the assignment in (82c) is identical to the result of substituting the objects *kim* and *lou* for the objects *bo* and *jo* abstracted out of the SOA (82a), as shown in (82d):

- (82) a.  $\langle\langle\text{See}; \text{seer:jo}, \text{seen:bo}\rangle\rangle$
- b.  $\lambda\{\text{jo} \mapsto r_1, \text{bo} \mapsto r_2\}\langle\langle\text{See}; \text{seer:jo}, \text{seen:bo}\rangle\rangle$
- c.  $f : [r_1 \mapsto \text{kim}, r_2 \mapsto \text{lou}]$
- d.  $\langle\langle\text{See}; \text{se-er:kim}, \text{seen:lou}\rangle\rangle$

### Ontology and $\lambda$ -Structures

Definition 3 postulated that one of the components of a SOA is a relation, a postulate we repeat here as (83a). To this we add an additional natural assumption, given in (83b), that ensures that SOAs are closed under substitutions:

- (83) a. If **Soa**( $R, \alpha, \sigma$ ), then  $Rel(R)$ .
- b. If **Soa**( $R, \alpha, \sigma$ ) and if  $\alpha\{f\}$  exists, then **Soa**( $R, \alpha\{f\}, \sigma$ ).

Let us consider the ontological status of SOA abstracts. Given a SOA  $\sigma = \langle\langle R; \alpha \rangle\rangle$ , abstraction over a set  $B$  yields an object  $\rho = \lambda B\langle\langle R, \alpha \rangle\rangle$ . If there exists  $f$ , an appropriate assignment for  $\rho$ , it follows from (83b) that  $\rho\{f\}$  is a SOA; indeed it is  $\langle\langle R; \alpha\{f\} \rangle\rangle$ . Consequently, given our assumption in (83a), it follows that  $\rho$  is a relation. This emphasizes that the ontological status of abstracts is, at least in part, determined by assumptions concerning other structural relations.

One additional point to note, which will be of relevance in our treatment of polar questions, concerns 0-ary abstraction. Definition 5 does not require that the set of elements abstracted away be nonempty. We will assume that the 0-ary case is to be construed as follows: a 0-ary abstract  $Ab^0(\sigma) = \lambda\{\}\sigma$  involves a place-holder function that is a mapping from the empty set into the universe. This picks out a Placeholder  $\pi_0$ , an element of the universe which points at no component of  $\sigma$ , the body of  $Ab^0(\sigma)$ . The structural relations that hold by virtue of the definition (5) are these:

- (84) a. **Placeholder**( $\sigma, \pi_0$ )
- b. **Abst**( $\sigma, Ab^0(\sigma)$ )
- c. The only sort of  $\pi_0$  is **Placeholder**\*

Given the basic characteristic of the structural relation **Abst** that requires the body to be distinct from the abstract, it will also be the case for 0-ary abstracts that  $\sigma$  is distinct from  $Ab^0(\sigma)$ .

In Montague's IL, as in various other type theories, it is assumed that the domain is closed under functional type formation: 'if  $a$  is a type and  $b$  is a type, then so is  $\langle a, b \rangle$ '. The analogous

<sup>67</sup>In Chapter 4 a definition of application for simultaneous abstraction with restrictions will be provided.

assumption for abstraction, which we will assume our semantic universe to obey, is *closure under simultaneous abstraction*.<sup>68</sup>

### Definition 6 A $\lambda$ -Structure

An extensional structure  $\mathcal{S}$  is a lambda structure ( $\lambda$ -structure) if for every element  $a$  of  $|\mathcal{S}|$ , the universe of  $\mathcal{S}$ , and every set  $C$  of elements of  $|\mathcal{S}|$ , the simultaneous abstraction  $\lambda C.a$  exists.

## 3.4 A Situational Universe with Abstract Entities

Before we proceed to construct the semantic universe we use to ground our theory of questions, it may be useful to digress briefly into what might be called the Austinian strategy—the approach we adopt toward the abstract objects in our ontology.

### 3.4.1 The Austinian Strategy

This approach has two components. First, propositions, facts, and outcomes will be assumed to be situationally relativized—a particular situation will be one of their defining components. Second, a distinction is drawn between ‘pure’ informational units, as represented by the SOAs, and the entities which carry information, the situations. The first component of the strategy is not particularly idiosyncratic; there has been a fair amount of work over the last 10 years that has motivated the need for relativization to events/situations. This includes work on definite reference and anaphora inspired by situation semantics (for some recent examples see Poesio 1993, Cooper 1996, Milward 1995, Recanati 1996). But also there is a vast amount of work based on a Davidsonian strategy, wherein predications involve relativization to events (although these get existentially closed at some stage of a semantic derivation. (See, for example, Parsons 1994, Kamp and Reyle 1993.) Cooper (1998) observes that there are important parallels between the Davidsonian strategy and the Austinian one, though in certain key cases (Cooper focuses on the treatment of naked infinitives) the two approaches generate subtly distinct predictions. The debate on the issue of reference vs. existential closure to situations/events is still ongoing and difficult to resolve conclusively. Given this, we should point out that we could adopt a more complex modeling strategy, in which relativization to situations would not involve indexicality but would incorporate situational existential closure in some fashion. Such a move, possibly eschewing any situational relativization, might be needed independently to cope with general sentences, such as *Two and two are four* or *Fish swim*.<sup>69</sup>

As for the second component of the Austinian strategy, the distinction between information and its carriers, such a modeling strategy was pioneered by Barwise and Etchemendy (1987). They provided the first detailed formalization and used it to provide a constructive solution to the Liar’s Paradox, a foundational conundrum that has no general solution in more familiar forms of semantics, such as possible worlds semantics. As we discussed above in section 3.3.2, in relation to the Frege-Searle propositional content hypothesis, the distinction is of considerable utility: it provides a means for capturing semantic generalizations about and operations on the entire class of abstract entities.

<sup>68</sup>In fact, given the notion of simultaneous abstraction with restrictions introduced in Chapter 4, we will ultimately require closure under this latter notion.

<sup>69</sup>This was recognized already by Barwise and Perry (1985). See Glasbey 1998 and Kim 1998 for proposals that some propositions are Austinian, whereas others (e.g. mathematical and individual-level statements) are Russellian (in Barwise and Etchemendy’s (1987) sense; that is, they do not make reference to a particular situation).

### 3.4.2 Basic Definition

We now specify the semantic universe that grounds our grammatical framework. A Situational Universe with Abstract Entities (SU+AE) is a SITSTR closed under abstraction (a  $\lambda$ -SITSTR) with some additional structural sorts. Before presenting these in detail, we provide a brief overview. **Proposition\***, **Possibility\***, and **Outcome\*** are sorts whose elements represent, respectively, the propositions, possibilities, and outcomes of the universe. For the two sorts **Proposition\***, **Outcome\***, we also posit a corresponding sort **At...** (viz. **AtProposition\***, **AtOutcome\***), whose elements are ‘atomic’—‘basic’ in some terminologies—members of the corresponding sort. Atomic propositions are structurally determined by a situation and a SOA; atomic outcomes by a situation and a SOA abstract (one in which the temporal argument is abstracted away). This latter class of entities will be characterized by means of a structural sort **Irr(ealis)Soa\***.<sup>70</sup> The atomic/non-atomic distinction is needed because we will subsequently posit the existence of ‘compound’ members of these sorts. Possibilities are structurally determined by a proposition, atomic or otherwise.

Following our discussion in section 3.2.3, we will also posit a property *Fact*, applicable to the class of possibilities. Those possibilities that are factual will constitute the facts of the universe. Analogously, there will be properties *True* and *Fulfill*, which capture the notions of truth and fulfilledness for propositions and outcomes.<sup>71</sup> The notation ‘ $\rightarrow_{prop}$ ’ represents a concept of entailment on propositions.<sup>72</sup>

We bring questions into the picture in section 3.5, but, since we will take them to be proposition abstracts, and given that a SU+AE must be closed under abstraction, they will automatically exist in any SU+AE.

The foregoing paragraphs can be summarized by the following definition: A SU+AE is an extensional relational structure of the type given in Definition 7:

#### Definition 7 Situational Universe with Abstract Entities

A SU+AE is a relational structure of the following type:

$[\mathcal{A}, \text{Possibility}^2, \text{AtProposition}^3, \text{Proposition}^1, \text{AtOutcome}^3, \text{Outcome}^1, \text{IrrSoa}^3; \text{Fact}^1, \text{True}^1, \text{Fulfill}^1, \rightarrow_{prop}^2]$ , where  $\mathcal{A}$  is a  $\lambda$ -SITSTR and in addition:

1. **Possibility\***, **Proposition\***, **Outcome\***, **Soa\***, **SelAdVal\*** are pairwise disjoint.
2. **AtProposition\***  $\subset$  **Proposition\***; **AtOutcome\***  $\subset$  **Outcome\***;
3. If  $\rightarrow_{prop}^2(p, q)$ , then **Proposition**( $p$ ) and **Proposition**( $q$ );  $\rightarrow_{prop}^2(p, q)$  if *True*( $p$ ) implies *True*( $q$ )
4. ... (additional conditions stated below)

### 3.4.3 Possibilities, Facts, and Propositions

The first notion we characterize pertains to what we will call an *atomic proposition*. The semantic setup we have provides a fairly direct conceptualization; recall that the SOAs constitute the properties that can hold of situations. Consequently, we assume that a situation  $s$  and a SOA  $\sigma$  serve to define a proposition, which we will notate as  $\text{prop}(s, \sigma)$ , the proposition that  $s$  is a

<sup>70</sup>The *r-soa/i-soa* type distinction was discussed in Chapter 2.

<sup>71</sup>Neither *Fact*, nor *True* or *Fulfill* for that matter, are structural relations. This reflects the (not incontrovertible) intuition that identity conditions and truth conditions are orthogonal.

<sup>72</sup>As will become clear, we offer only the barest specification possible for such a notion. For discussion as to how to port a logic into the current setup see S&M–97.

situation of the type designated by  $\sigma$ . This assumption amounts to the following requirements on the structural relation **AtProposition**:<sup>73</sup>

- (85) a. If **AtProposition**( $s, \sigma, p$ ), then  $Sit(s)$  and there exist  $R, \alpha$  such that **Soa**( $R, \alpha, \sigma$ )  
 b. If  $Sit(s)$  and there exist  $R, \alpha$  such that **Soa**( $R, \alpha, \sigma$ ), then there exists  $p$  such that **AtProposition**( $s, \sigma, p$ )

Truth for atomic propositions is straightforwardly definable as follows:

- (86) If there exists  $s, \sigma$  such that **AtProposition**( $s, \sigma, p$ ), then  $s \models \sigma$  if and only if  $True(p)$ .

Note that because our semantic universe is extensional, structured objects are defined uniquely. Hence, in particular, we can talk about the sole proposition defined by a situation, SOA pair ( $s, \sigma$ ).

What are possibilities? The account we adopt here follows the correspondence theory of truth, namely that a proposition is true in virtue of the existence of a fact (see, for example, Russell 1949 and Mulligan et al. 1984). In our account, this is made concrete by assuming that possibilities are structurally determined by propositions.<sup>74</sup> The possibility defined by a proposition is a *fact* just in case the corresponding proposition is true:

- (87) a. If **Possibility**( $p, f$ ), then **Proposition**( $p$ )  
 b. If **Proposition**( $p$ ), then there exists  $f$  such that **Possibility**( $p, f$ )  
 c.  $Fact(f)$  iff there exists  $p$  such that **Possibility**( $p, f$ ) and  $True(p)$   
 d. Notation:  $poss(p)$  denotes the possibility individuated by the proposition  $p$ .

Note that by treating facts as a subclass of the possibilities, we have a straightforward account of the defeasability of facts in dissent and projection phenomena discussed above (see examples (40), repeated here as (88)):

- (88) a. A: I regret the fact that Kim left.  
 B: It's not a fact.  
 b. If Sandip leaves, Kimmo will regret that fact bitterly.

In cases like (88a), we assume that the reference is to a possibility and the discussion pertains to whether it is also a fact. Similarly, in (88b) what is predicated of Kimmo is potential regret of a possibility, which at utterance time is not known to be factual.

Let us consider some of the fundamental characteristics of the current theory of propositions and possibilities. In contrast to possible worlds semantics, propositions are individuated with finer grain than truth conditions. By extensionality there will be exactly one proposition defined in terms of its basic components: a situation and a SOA. The SOAs in (89a,b) hold in all possible worlds, but neither they nor the corresponding propositions (and by extension facts) are identified. Thus, logical omniscience, the most intrinsic problem besetting possible worlds semantics,

<sup>73</sup>Actually, we could get by without STIPULATING that (85b) is the case. As we discuss in Appendix B, we can always build models ('anti-founded structures'), where such requirements hold.

<sup>74</sup>Our ontologically scrupulous readers might wonder why we assume possibilities to be structurally determined by propositions and not, say, vice versa. In fact, one could construct an ontology of the latter kind and, as far as we are aware, it would be as viable as the one we define in the text. The main advantage gained by basing things on propositions is a certain simplicity when dealing with questions, whose status as *propositional* abstracts we will argue for.

does not arise for a situation theoretic universe:<sup>75</sup>

- (89) a.  $\langle\langle \text{SelfIdentical}; \text{marais} \rangle\rangle$   
 b.  $\langle\langle \text{SelfIdentical}; \text{poulenc} \rangle\rangle$

Indeed, avoiding logical omniscience can be achieved simply by taking propositions to be sets of situations. However, as Soames (1985) observes, such a move does not escape what has come to be known as Soames' puzzle. An Austinian view of propositions evades this difficulty.<sup>76</sup> But not all doxastic puzzles can be solved just by adopting an improved ontology, the prime example being Kripke's Pierre puzzle (Kripke 1979). This is actually a family of puzzles revolving around an agent's failure to identify a single object that has distinct 'presentations': two distinct names, or tokens of names, or even two distinct smells, for a canine agent. The most well known form of the puzzle involves the Frenchman Pierre who works near Trafalgar Square in London. After witnessing the foul state of Nelson's Column, he is moved to affirm (90a):<sup>77</sup>

- (90) a. I believe that Nelson's Column is fouled up.  
 b. Je ne crois pas que le Column de Nelson est sale.  
 c.  $\text{prop}(s_{\text{trafalgar-sq}}, \langle\langle \text{Ugly}; \text{nc} \rangle\rangle)$   
 d. Pierre believes that Nelson's Column is fouled up.

At the same time, Pierre, who was educated in a monolingual school in France, retains his school-boy belief about a pristine marble arch he knows as the *Column de Nelson*, which he does not connect with Nelson's Column. In conversation with his French ex-school mates, Pierre will affirm (90b). However, the Austinian propositions associated with the embedded clauses of (90a) and (90b) are identical—for example, (90c), and so a potential paradox looms when trying to assess if (90d) is true.

Actually, the paradox just described arises only if (ignoring tense) one takes attitude predicates to be dyadic: relations between an agent and an abstract entity (proposition/fact/question etc). Thus, one way around the paradox (following Crimmins and Perry 1989, Crimmins 1993b, and Cooper and Ginzburg 1996) is to jettison the assumption of dyadicity. Instead, the assumption can be made that an additional, implicit argument exists for such predicates, one that is filled by a particular information state of the reported agent. The attitudinal relation is then taken to involve an agent, an information state *IS* (belief, knowledge, wondering etc), and an abstract object  $\alpha$  (proposition, fact, question) such that *IS* has  $\alpha$  as its content.

On this view, a single agent can rationally possess distinct information states, even though these may possess contradictory contents. This approach also explains why substitutivity of co-

<sup>75</sup>LOGICAL OMNISCIENCE is the identification contentwise of logically equivalent sentences, as is the case in possible worlds semantics.

<sup>76</sup>Soames' puzzle arises by considering the chain of inferences in (i) to (iv):

- (i) The Babylonians believed that 'Hesperus' referred to Hesperus and that 'Phosphorus' referred to Phosphorus.  
 (ii) The Babylonians believed that 'Hesperus' referred to Hesperus and that 'Phosphorus' referred to Hesperus.  
 (iii) The Babylonians believed that 'Hesperus' referred to something<sub>i</sub> and that 'Phosphorus' referred to it<sub>i</sub>.  
 (iv) The Babylonians believed that 'Hesperus' and 'Phosphorus' were co-referential.

(i) is clearly true and (iv) clearly false, given that the Babylonians had distinct names for Venus. The puzzle is to find the fallacious inferential link. See Soames 1985 for discussion of the puzzle. In fact, in order to defuse the puzzle, it is sufficient to take (uses of) sentences to denote SOAs, as in 'Russellian' approaches to propositions.

<sup>77</sup>Strictly speaking, this is a variant on Kripke's own example, in which the belief at issue is whether London is pretty or not. That particular formulation of the puzzle, however, CAN straightforwardly be defused using Austinian propositions.

referring terms can be legitimate, but need not be. This follows because in attitude reports it is typical that the reporter chooses words so as to transparently reflect the representational structure of a particular information state of the cognizer. Using the name *Nelson's Column* in a belief report like (90d), implicates that this is a name by means of which Pierre would refer to the London monument. Nonetheless, this implicature is cancellable, for instance by adding *though he wouldn't phrase it this way*.

This discussion is relevant to an issue that our modeling of possibilities and propositions brings up. We have assumed explicitly that possibilities and propositions are distinct but bijectively related. In this we deviate from a number of past proposals. Asher (1993, 1996) suggests that beliefs are individuated with finer grain than facts and possibilities. Thus, with respect to the Tully/Cicero conundrum, Asher suggests that (91a) constitutes a distinct propositional entity from (91b), but that the fact represented by (91c) is identical to the one represented in (91d):

- (91) a. The belief that Tully was a famous orator  
 b. The belief that Cicero was a famous orator  
 c. The fact that Tully was a famous orator  
 d. The fact that Cicero was a famous orator

One problematic consequence of this suggestion, given Asher's assumption that attitude predicates are dyadic, is that it predicts differences in granularity between predicates selecting for propositions and predicates selecting for facts. Assuming (91a) to be distinct from (91b) immediately explains a discourse such as (92a):

- (92) a. Tom holds that belief.  
       Which belief?  
       The belief that Tully was a famous orator.  
       Hence, Tom believes Tully was a famous orator, though not (necessarily) that Cicero was a famous orator.  
 b. Tom is aware of that fact.  
       Which fact?  
       The fact that Tully was a famous orator.  
       Hence, Tom is aware that Tully was a famous orator.  
       Hence, Tom is aware that Cicero was a famous orator.

However, the assumption that (91c) and (91d) are identical leads to the acceptance of (92b). This predicted asymmetry between TF predicates and factives seems incorrect. On the other hand, if we follow the suggestion that attitude predicates are triadic, then we can accept that the propositional objects at issue in (91) are identical (as are the facts) without difficulty.

In ST, it has often been common to call factual SOAs *facts*, not as we have been doing here.<sup>78</sup> Identifying facts with factual SOAs is, however, problematic if one attempts to treat facts, as we do here, as abstract entities that are known, discovered, and so forth. If one assumes, in the spirit of the Austinian program, that atomic propositions are individuated in terms of a situation and a SOA, but facts are SOAs, one predicts an asymmetry between propositional and factive predicates as far as the 'situatedness' of the attitude. Propositional attitudes, on this view, involve

<sup>78</sup>The connection between facts in ST and the philosophers' facts (e.g. those of Austin and Vendler) is discussed by Barwise (1989a).

*situationally relativized* entities, whereas factives involve *situationally absolute* entities. Once again, there seems no evidence to support such an asymmetry for a pair such (93a,b); insofar as Kimmo’s belief concerns a particular arrival event, so does her knowledge:

- (93) a. Kimmo believes that Sandheep arrived on time.  
b. Kimmo knows that Sandheep arrived on time.

### 3.4.4 Outcomes

We move now to consider how outcomes should be modeled. In Chapter 2 we discussed the class of *irrealis* SOAs. In fact, *irrealis* SOAs will not be SOAs, but rather SOA abstracts—SOAs out of which the temporal argument has been abstracted away. For notational ease we employ a circumflexed  $\hat{t}$  to notate the unary abstraction operator in the case of such SOA abstracts. An irrealis SOA  $\hat{t}\sigma$  is characterized as an entity whose Placeholder  $r$  is one for which a time is selectionally adequate and such that substituting a time for  $r$  yields a SOA:

- (94) If **Irrsoa**( $c, r, \hat{t}\sigma$ ), then:  
1. **Abst**( $c, \hat{t}\sigma$ ),  
2. **Placeholder**( $c, r$ ), and  
3. there exists  $t_0, R, \mu$  such that: (a) *Time*( $t_0$ ) and (b) **Soa**( $R, \mu, \hat{t}\sigma\{r \rightarrow t_0\}$ ).

Our constraints will, for example, associate the irrealis SOA in (95) with the subjunctive verb *leave* ( $b$  denotes the individual supplied by the subject):

- (95)  $\hat{t}\langle\langle\text{Leave}; \text{leaver:b, time:t}\rangle\rangle$

We will treat outcomes as structured objects, constructed from an irrealis SOA  $\hat{t}\sigma$  and a situation  $s$ .  $\hat{t}\sigma$  provides a condition that is uninstantiated within the timespan of the situation:

- (96) a. If **AtOutcome**( $s, \hat{t}\sigma, o$ ), then there exist  $c, r$  such that:  
(a) *Sit*( $s$ ) and (b) **Irrsoa**( $c, r, \hat{t}\sigma$ ) and there is no  $t_0$  such that: (a) *Timespan*( $s, t_0$ ) and (b)  $s \models \hat{t}\sigma\{r \rightarrow t_0\}$   
b. Notation: If **AtOutcome**( $s, \hat{t}\sigma, o$ ), then we use the notation  $\text{out}(s, \hat{t}\sigma)$  to stand for  $o$ .

Thus, intuitively, an outcome allows us to represent a possible path of evolution for a situation. Outcomes are distinct from possibilities and propositions, hence neither factuality nor truth is applicable. There is, nonetheless, a somewhat analogous notion which is readily definable—the conditions according to which an atomic outcome is fulfilled. For an outcome  $\text{out}(s_0, \hat{t}\sigma)$ , this involves the existence of a situation  $s_1$  which is situated temporally after  $s_0$  such that  $s_1$  supports an instantiation of  $\hat{t}\sigma$ . This is the sense in which outcomes are ‘futate’.

- (97) *Fulfilled*( $o$ ) iff there exist  $s_0, s_1, \hat{t}\sigma, c, r, t_0$  such that:  
a. **AtOutcome**( $s_0, \hat{t}\sigma, o$ ) and  
b. **Irrsoa**( $c, r, \hat{t}\sigma$ ) and  
c. *Anterior*( $s_0, s_1$ ) and  $s_1 \models \hat{t}\sigma\{[r \rightarrow t_0]\}$

Our constraints associate the outcome in (98) with the subjunctive clause *that Billie leave* ( $s_0$  denotes a contextually supplied situation):

- (98)  $\text{out}(s_0, \hat{t}\langle\langle\text{Leave}; \text{leaver:b, time:t}\rangle\rangle)$

### 3.4.5 Compounding Operations on propositions

We further assume that propositions and outcomes can be compounded.<sup>79</sup> We consider here only propositions, since the minimal structure we impose on them will be of some importance when we come to discuss questions. It would be a routine exercise to define an analogous construction for outcomes.

The following definition allows for set-theoretic structure on propositions, imposes familiar truth conditions on the meet and join of a set of propositions, ensures that these exist, and imposes certain conditions on propositional negation:<sup>80</sup>

**Definition 8 A De Morgan  $\wedge / \vee$ -closed Situation Structure with Abstract Entities**

An  $SU+AE$   $\mathcal{S}$  of type  $[ \mathcal{A}, \mathbf{Set}^1, \epsilon^2, \mathbf{ConjOf}^2, \mathbf{DisjOf}^2; \mathbf{NegationOf}^2 ]$  is De Morgan  $\wedge / \vee$  closed iff:

1. (a)  $\mathbf{ConjOf}^* \subset \mathbf{Proposition}^*$ ; (b)  $\mathbf{DisjOf}^* \subset \mathbf{Proposition}^*$ ; (c)  $\epsilon^* \subset \mathbf{Set}^*$ .
2. The elements of  $\mathbf{Set}^*$  are regulated by the axioms of the set theory  $ZFC^-$ .
3. If  $\mathbf{Set}(X)$  and for each  $p \in X$ ,  $\mathbf{Proposition}(p)$ , then there exist  $\wedge X$  and  $\vee X$  such that for each  $p \in X$   $\mathbf{ConjOf}(p, \wedge X)$ ,  $\mathbf{DisjOf}(p, \vee X)$ .
4. If  $\mathbf{Set}(X)$  and  $\mathbf{Proposition}(p)$  for each  $p \in X$ , then:  $\mathbf{True}(\wedge X)$  iff for each  $p \in X$ ,  $\mathbf{True}(p)$ .
5. If  $\mathbf{Set}(X)$  and  $\mathbf{Proposition}(p)$  for each  $p \in X$ , then:  $\mathbf{True}(\vee X)$  iff  $\mathbf{True}(p)$  for some  $p \in X$ .
6. The  $\mathbf{NegationOf}$  relation is symmetric and functional (If  $\mathbf{NegationOf}(p, q)$ , then  $\mathbf{NegationOf}(q, p)$ ; If  $\mathbf{NegationOf}(p, q)$  and  $\mathbf{NegationOf}(p, q')$ , then  $q = q'$ )
7. Dual atomic propositions are constituted from the same situation and SOA:  
If  $\mathbf{AtProposition}(s, \sigma, p)$  then there is a proposition  $\neg p \neq p$  such that  $\mathbf{NegationOf}(p, \neg p)$  and  $\mathbf{AtProposition}(s, \bar{\sigma}, \neg p)$
8. If  $\mathbf{Set}(X)$  and  $\mathbf{Set}(Y)$  and for each  $p \in X \cup Y$ ,  $\mathbf{Proposition}(p)$ , and  
(a) for each  $p \in X$  there is a  $q \in Y$  such that  $\mathbf{NegationOf}(p, q)$ , and  
(b) for each  $q \in Y$  there is a  $p \in X$  such that  $\mathbf{NegationOf}(p, q)$   
then:  $\mathbf{NegationOf}(\wedge X, \vee Y)$

Note that we now have two negation-like notions around: the  $\mathbf{NegOf}$  operations on SOAs and the relation  $\mathbf{NegationOf}$  on propositions. The latter is dependent on the former, since for atomic propositions the relation  $\mathbf{NegationOf}$  is defined on the basis of  $\mathbf{NegOf}$ . This leads to a negation operation on propositions that is classical in the respect that, for atomic propositions at least,  $\neg\neg p$  is identical to  $p$ . However, in contrast to most work in ST, the space of propositions that emerges is not quite classical, since it will not in general be the case that:

$$(99) \quad p \text{ is true iff } \neg p \text{ is false}$$

Rather, we only have the weaker:

- (100) a. If  $p$  is true, then  $\neg p$  is false.
- b. If  $\neg p$  is true, then  $p$  is false.

<sup>79</sup>Given that possibilities are constructed from propositions, any expansion of the universe that results in additional propositions will ‘trigger’ a concomitant expansion of the sort **Possibility**\*

<sup>80</sup>This definition is closely modeled on definitions 3.16 and 3.17 in S&M-97.

We believe that this deviation from standard ST practice is required if, as we suggest later, questions are taken to be proposition abstracts. This is required empirically both for an adequate definition of answerhood and for an account of the properties of polar questions.

### 3.4.6 Summary

In this section, we have provided a sketch of the semantic universe that underlies the grammar we develop in the following chapters. The semantic universe, technically a Situational Universe with Abstract Entities, is a  $\lambda$ -SITSTR with additional structural sorts. These sorts are used to explicate propositions, possibilities, outcomes, and in the next section, questions. Atomic propositions have as their defining components a situation and a SOA. An outcome has as its defining components a situation and a SOA abstract whose temporal argument is abstracted away. Possibilities, a subclass of which constitute the domain of facts, are built out of propositions. We have also sketched rudimentary notions of compounding and negation on the class of propositions.

## 3.5 Questions

What is a question? There have been dozens of answers to this question, motivated, for the most part, as attempts to explicate one or more of the following sets of phenomena.

**Short Answers.** One of the most obvious ways in which an interrogative use changes the context is to enable elliptical follow-ups (*short answers*): phrasal utterances used to respond to queries. The nature of the question asked strongly influences the semantic type, and to some extent, the form of the short answer. A polar question gives rise to short answer responses that can be a sentential modifier; a unary *wh*-question gives rise to a short answer whose semantic type matches that of the *wh*-phrase in the interrogative (*who*: animate NPs, *when*: temporal phrases, etc.); a multiple *wh*-question gives rise to a pair of phrases, each of which matches one *wh*-phrase in the interrogative and so forth.

- (101) a. A: Did Bo attend the meeting?  
B: Yes./Maybe./Probably.
- b. A: Who attended the meeting?  
B: Mo/No students./A friend of Jo's.
- c. A: When did Bo leave?  
B: Yesterday./At two.
- d. A: Who was interacting with whom at the party?  
B: Bo with Mo./Some of my friends with each of her friends.
- e. A: Why did Carrie cross the road?  
B: Because she thought no cars were passing.

**Resolvedness/Exhaustivity.** In section 3.2, we discussed the fact that an interrogative complement embedded by a factive predicate supplies that predicate with an argument that is (pretheoretically) an answer resolving the question denoted by the complement. An inference pattern illustrating this is given in (102a).<sup>81</sup> Such an answer is commonly also referred to as *exhaustive*. In what follows, we will reserve the term 'exhaustive' as a technical term (to be defined below), using 'resolving' as the pretheoretical notion. An important task for any theory of questions is to characterize this answerhood relation. One needs to explain why the second utterances in (102b,c) are typically intuited to constitute facts that resolve the questions *whether Terry left*

<sup>81</sup>Note that the inference also goes in the other direction: (102a(iii)) entails (102a(i)) and (102a(ii)).

and *who will help the President* respectively, whereas the responses in (102d,e) are examples of facts that would not usually be taken to resolve these questions:

- (102) a. (i) I know/discovered a particular fact.  
 (ii) This fact resolves the question whether Terry left/of who will help the President.  
 Therefore, (iii) I know/discovered whether Terry left/who will help the President.
- b. Bo knows/discovered whether Terry left.  
 Terry did (didn't) leave.  
 Therefore, Bo knows/discovered that Terry did (didn't) leave.
- c. Sandy: Who will help the President?  
 Jackie: His close friends./Bo Derek and Bo Diddley./A number of high powered lawyers.  
 Jackie indicated to Sandy who would help the President.
- d. Lee: Did Terry leave?  
 Chris: It's not very likely.  
 Chris did not actually indicate whether Terry left.
- e. Whitney: Who will help the President?  
 Kim: Few people that the two of us know.  
 Kim couldn't quite tell Whitney who would help the President.

**Aboutness.** Many factors go into characterizing the full range of options available to someone responding to a query. Particularly complex is the matter of figuring out what an optimal response might be. Nonetheless, even someone who is not clued in to either the querier's goals or to her belief/knowledge state can distinguish a certain class of propositions that are, quite independently of their truth or specificity relative to current purposes, intimately related to the specific question posed, call it  $q_0$ . This class consists of those propositions characterizable as providing information ABOUT or CONCERNING  $q_0$ . The aboutness criterion is illustrated in (103) and (104)

- (103) a. Jo: When is the train leaving?  
 Carrie: At 2:58, 17.333398 seconds, according to our caesium clock./At 2:58./In about an hour./In a short while.  
 Carrie provided information (whose accuracy I will not vouch for) about when the train is leaving.
- b. Chris: Did Merle leave?  
 Kim: Yes./Probably./It's not likely./No.  
 Kim provided information (whose accuracy I will not vouch for) about whether Merle left.
- c. Sandy: Who will help the President?  
 Tracy: His close friends./Few people we know./Merle Africa or Merle Haggard.  
 Tracy provided information (whose accuracy I will not vouch for) about who will help the President.
- (104) a. Jo: When is the train leaving?  
 Lee: I don't have a clue./We should be informed of this quite soon./Why do you ask?/Go talk to that guard over there; she'll put you on it.  
 Lee responded to the question, but could/did not provide any information about when the train is leaving.

These examples also show that the ‘aboutness’ answerhood relation is a less restrictive condition than the ‘resolving’ answerhood relation. Thus, responses that provide information that are neither useful nor even factual can sometimes be described as being ‘about’ the question, as long as their subject matter is appropriate. Conversely, many felicitous responses, even helpful ones, cannot be described as providing information ‘about’ the question, even if they can be described as suggesting how to obtain information about the question.

### 3.5.1 Questions as Exhaustivity Encoders

In this section, we compare two ways of conceptualizing what questions are. The first derives from a common intuition, triggered in part by short answer phenomena, that a question is somehow akin to an open proposition.<sup>82</sup> Making sense of this basic intuition has proved remarkably difficult within standard semantic ontologies. In opposition to this first approach lies an approach (motivated primarily by exhaustivity phenomena) that seeks to explain questions as semantic entities that encode Exhaustive Answerhood Conditions (EAC). This approach was originally pioneered by Åqvist and Hintikka, whose accounts did not include an ontological distinction between questions and propositions. The approach has been most influential through the proposals of Hamblin (1958, 1973), Karttunen (1977) and Groenendijk and Stokhof (1984, 1997).

These latter proposals explicitly develop a distinction between questions and propositions. Questions are specified as properties of propositions; concretely, the property of being the *exhaustive answer* to the question. It is probably true to say that this latter explication is the most widely accepted in contemporary formal semantics. The popularity of the EAC view notwithstanding, we will show that the semantic setup described in the previous sections provides a formally explicit and conceptually viable version of the ‘questions as open propositions’ view, one that is, we will argue, conceptually simpler, and empirically superior to the EAC alternative. In this section we focus on some problematic aspects of the EAC view. In the following section, we provide our own explication of what questions are.

#### EAC Basics

In order to make the discussion concrete, we start with a brief survey of the EAC view as formulated by Groenendijk and Stokhof (Gr & St). Two key assumptions are the following:

- (105) a. **Semantic absoluteness of embedded answerhood:** Resolving answerhood conditions can be characterized in purely semantic terms, rather than as also involving complex ‘pragmatic’ factors that depend heavily on context.
- b. **Aboutness is reducible to resolvedness:** the notion of answerhood relevant to query uses is derivative, and can be deduced from or explained in terms of the notion of answerhood associated with clauses embedded by factive/resolutive predicates.

To this one should add a specific empirical claim:<sup>83</sup>

- (106) A fact  $f$  resolves a question  $q$  iff  $f$  is an *exhaustive answer* to  $q$ :
  - a. For a polar interrogative  $p?$ :  $f$  entails  $p$  if  $p$  is true; otherwise  $f$  entails  $\neg p$
  - b. For a *wh*-interrogative  $who \mathbf{V}s$ :  $f$  entails *whether*  $a_1 \mathbf{V}s$  for all  $a_1$  in the relevant domain.

<sup>82</sup>See Jespersen 1965 and Cohen 1929 for early statements of such a view.

<sup>83</sup>Karttunen argues for a somewhat different characterization of *wh*-interrogatives. But his approach is equally committed to there being a simple semantic formula for calculating exhaustiveness.

Given the assumptions in (105) and in (106), Gr & St's theory is simple and elegant: the extension of an interrogative is identified with the exhaustive answer. Hence, the intension of an interrogative is that function which maps a world to the proposition that constitutes the exhaustive answer in that world. Within a possible worlds semantics, the picture that emerges is this: the extension of an interrogative at  $w$  is a set of worlds, those that determine the extension of the queried property equivalently. The intension of the interrogative is the partition of the set of possible worlds induced by this equivalence relation.

(107) a. whether Morgan likes Bo.

Extension at  $i$ :  $\lambda j.[like(m, b)(j) = like(m, b)(i)]$

(All worlds  $j$  that agree with respect to the truth value of  $like((m, b)$  at  $i$ .)

Intension:  $\lambda i.\lambda j.[like(m, b)(j) = like(m, b)(i)]$

b. who likes Bo. Assumed paraphrasable as: for all  $x$  whether  $x$  likes  $b$ .

Extension at  $i$ :  $\lambda j.[\lambda x.like(x, b)(j) = \lambda x.like(x, b)(i)]$

(All worlds  $j$  that agree with respect to the extension of  $like(x, b)$  at  $i$ .)

Intension:  $\lambda i.\lambda j.[\lambda x.like(x, b)(j) = \lambda x.like(x, b)(i)]$

Gr & St assume that the notion of answerhood relevant for querying (*partial answerhood*) is derivative from exhaustive-answerhood: a 'partial answer' is a disjunction of some, but not all possible exhaustive answers defined by the question. In terms of partitions, it is a proposition that eliminates at least one partition from further consideration as an exhaustive answer.

### Exhaustivity

The simplicity of the EAC view is also the source of its theoretical vulnerability. This weakness derives from the fact that a question is identified with a semantic object primarily on the basis of one essential class of phenomena associated with interrogatives, namely the semantic properties of interrogatives embedded by factive and resolute predicates. The attractiveness of the strategy depends on two assumptions: (1) that resolute embedding is purely referential, and (2) that resolving answerhood can be characterized in purely semantic terms, as mentioned previously.

If factives/resolutives embedded interrogative complements purely referentially, this would provide some evidence identifying the semantic object which is posed in a query—a question—with an object that encodes exhaustive answerhood conditions. However, as we saw in section 3.2.1, this assumption is false. The issue of the semantic nature of resolvedness is complex. There have been a number of works arguing forcefully that the resolving answerhood conditions for many types of interrogatives cannot be reduced to the simple semantic formula assumed by Hintikka, Karttunen, and Groenendijk and Stokhof. This class of interrogatives includes:

- *who is I*: Boër and Lycan (1985) discuss examples like (108a,b):

(108) a. Who is that man?

b. Bertie knows who Quine is. (Boër and Lycan 1985: 96, example (11))

It is clear that the answer specified by (108b) cannot be characterized in terms akin to (106) above, i.e. as an answer that entails for each possible property  $P$ , whether or not Quine has  $P$ . Without knowledge of the background surrounding a statement like (108b) (Is Bertie a professional philosopher, an undergraduate, or a newspaper vendor?), it is virtually impossible to predict the nature of the answer Bertie knows.

- *why S*: Bromberger (1992) and Ginzburg (1995a) discuss examples like (109):
  - (109) a. Why is there something rather than nothing? (M. Heidegger)
  - b. Why has there never been a President of the United States named Clovis? (Bromberger 1992: 92)
  - c. We have been told why he is writing this paper. (Ginzburg 1995a)
- *where S*: Ginzburg (1995a) discusses examples like (110a) and shows that whether (110b) is judged to be exhaustive varies with context:
  - (110) a. Jo knows where she is.
  - b. Jo is in Helsinki. (resolving: Jo about to step off a plane in Helsinki; non-resolving: Jo steps out of a taxi in Helsinki.)
- *how S*: Hintikka (1976) and Asher and Lascarides (1998) discuss examples such as (111):
  - (111) Jo knows how to get from London to Oxford.

Here, as Hintikka points out, a proposition that provides a single route can be resolving. As Asher and Lascarides point out, however, this is not simply an ambiguity. In certain contexts (Jo is a travel guide, say), a resolving answer must be exhaustive, providing every single route, as well as indicating which routes to avoid.

In all these cases there are a multiplicity of possible resolving answers. Moreover, audience background and interests seem crucially involved in determining which ones are resolving answers appropriate for a given context.

In fact, Ginzburg and, more circumspectly, Asher and Lascarides suggest that this pragmatic indeterminacy extends to interrogatives in general. Ginzburg discusses examples such as (112) and suggests that any of (112b-d) can constitute resolving answers reportable as (112e):

- (112) a. Who attended the lecture?
- b. Bo: A number of important Swan and Ubikh specialists along with their students.
- c. Bo: A mix of the old and new generation from among the local researchers
- d. Bo: Gia, Leila, Zurab, Nino, . . .
- e. Bo revealed who attended the lecture.

Which of these would qualify as a resolving answer in a particular context requires reference to highly particularized details about the context and the conversationalists' background knowledge, interests and the like.

For the sake of the argument, let us momentarily assume that a purely semantic notion of exhaustiveness does provide an adequate characterization of the resolvedness conditions of regular *who*-interrogatives. It still remains the case that there is no straightforward general semantic characterization of the resolvedness conditions of a large class of interrogatives (including *who is P*-, *when*-, *where*-, *how*-, and *why*-interrogatives). For these, one needs an account that is relativized to unquestionably pragmatic or agent-specific parameters such as goals and background beliefs. Thus, the EAC strategy offers at best an insufficiently general account of resolvedness conditions. Consequently, it cannot provide a general account of what a question is.

To summarize, the EAC approach treats the content of an interrogative as an entity intended to fix the resolvedness conditions of a question. Given what we have seen about these, the EAC approach amounts to positing a *semantic* denotation whose value—for at least a significant number

of cases—is only fixed relative to unquestionably *pragmatic*, agent-specific parameters. Such a strategy raises some significant methodological questions, which at present remain unanswered. For instance, how does one talk about questions in a way that is independent of the existence of agents? How do agents share questions? Other things being equal, a semantic ontology which does not require answers to such questions would be preferable.

### Polar Interrogatives

So far we have suggested that the basic motivation for the EAC approach is flawed. We now point to two additional problems. The first concerns identity conditions of polar interrogatives; the second involves the aboutness conditions specified by interrogatives.

In approaches where questions are characterized in terms of exhaustive answerhood conditions, it follows that when two interrogatives carry the same exhaustive answerhood conditions, the questions they denote must be regarded as identical. This predicts that positive and negative polar interrogatives such as (113a,b) are deemed to have the same content:

- (113) a. whether Morgan likes Bo.  
 Extension at  $i$ :  $\lambda j.[like(m, b)(j) = like(m, b)(i)]$   
 (All worlds  $j$  that agree with respect to the truth value of  $like(m, b)$  at  $i$ .)  
 Intension:  $\lambda i.\lambda j.[like(m, b)(j) = like(m, b)(i)]$
- b. whether Morgan doesn't like Bo.  
 Extension at  $i$ :  $\lambda j.[\neg like(m, b)(j) = \neg like(m, b)(i)]$   
 (All worlds  $j$  that agree with respect to the truth value of  $\neg like(m, b)$  at  $i$ .)  
 Intension:  $\lambda i.\lambda j.[\neg like(m, b)(j) = \neg like(m, b)(i)]$

Let us call this hypothesis Negative-Positive Interrogative Synonymy (NPIS). NPIS initially appears unproblematic, perhaps even a favorable consequence as far as interrogatives embedded by resolutive go, since it predicts that (114a,b) have identical truth conditions:

- (114) a. Ronnie knows whether Morgan likes Bo.  
 b. Ronnie knows whether Morgan does not like Bo.

But there are phenomena which suggest that any such identification is problematic. Przepiórkowski (1999) points out that, contrary to the claims that are standardly made, negative interrogatives can trigger negated answers:

- (115) a. A: I wonder whether Sanca really didn't get married . . .  
 B: Yes, she didn't. (Przepiórkowski's (4.7))
- b. A: I wonder whether Sanca really got married . . .  
 B: # Yes, she didn't. (Przepiórkowski's (4.7))
- c. A: I suppose Mo DIDN'T go to the store.  
 B: Yes, she didn't. (Przepiórkowski's (4.8))
- d. A: I suppose Mo went to the store.  
 B: # Yes, she didn't. (Przepiórkowski's (4.8))

We can strengthen these observations with further data involving intonation questions. These provide further support for the claim that negation need not be neutralized in polar interrogatives. An example like (116a) is well paraphrased by (116c) and (116d), but far less successfully by (116e) and (116f), where the content of latter examples is a positive polar:

- (116) a. A: In the end Kim and Sandy didn't leave yesterday?  
 b. B: Right, (they're still here.)  
 c. A asked whether Kim and Sandy had actually not left.  
 d. A checked if Kim and Sandy had not in the end left.  
 e. ?A asked if Kim and Sandy left.  
 f. ??A checked if Kim and Sandy had in the end left. (? marks inaccurate paraphrase)

It is also worth noting that the common belief underlying NPIS—that the response patterns triggered by the two types of polars are identical—ignores a small but important fact. In a language like modern English, which lacks a word like *si/doch*, responding *tout court* with *yes* frequently results in ambiguity. This is illustrated by the following dialogue, whose initial query is a negative polar question, expressed either as an interrogative sentence or by means of an intonation question:

- (117) A: She's not annoyed?/Isn't she annoyed?  
 B: Yes.  
 A: She is or she isn't annoyed?

The essence of our account of this phenomenon, further articulated in Chapter 8, is simply this: the semantics we provide associates distinct contents for positive and negative polars. However, the answerhood relations we posit will turn out to yield identical exhaustive answers for  $p?$  and  $\neg p?$ . These basic facts will allow us to develop an account that can distinguish the contexts created by uses of  $p?$  and  $\neg p?$ , while at the same time capturing the identity of truth conditions associated with pairs like (114a,b).

### Aboutness

An additional problem we mention here concerns aboutness. Ginzburg (1995a) shows in detail that both Karttunen's and Gr & St's accounts underdetermine the notion of aboutness needed to explain coherence intuitions in querying. Consider first polar interrogatives. Propositions such as the one expressed by the responder in (118), although frequently not fully satisfying the goal which leads to asking the question, seem to be entirely coherent responses, i.e. they seem to constitute information about the question.

- (118) Pat: Is Dominique leaving tomorrow?  
 Stevie: Possibly/It's unlikely

Responses like these represent information that any competent speaker of the language associates with the question in virtue of their knowledge of meaning.<sup>84</sup>

However, Gr & St's system does not recognize such information as answers to the question, partial or otherwise. The reason for this is that a partial answer needs to eliminate at least one partition. However, since a polar question consists of only two partition blocks (propositions entailing  $p$  and propositions entailing  $\neg p$ ), the only answers which can eliminate partitions are exhaustive answers. That is, the prediction of Gr & St's system is that no partial answers exist, contrary to (118).

<sup>84</sup>Although Stevie's response in (118) is really rather UNUSEFUL, responses such as (i) and (ii) have similar modal force, but could be quite useful—despite the fact that they entail neither 'yes' nor 'no':

- (i) If she finds her rail ticket in time.  
 (ii) Only if she manages to write the two remaining sections of her paper.

For a *wh*-interrogative, partial answerhood is a richer notion than exhaustive answerhood. Thus, for an interrogative like *who left*, a Gr & St partial answer will have a form paraphrasable as:<sup>85</sup>

- (119)  $p =$  No one left or only Leslie left or only Leslie and Chris left or . . . or only Leslie and Chris and Tracy left or . . .

This means that only one type of answer can be accommodated, namely ‘exhaustified’ answers:

- (120) a. ‘Only several firemen left’  $\leftrightarrow$  The (set of) leavers consisted of several firemen (and no one else).  
 b. ‘Only few journalists left’  $\leftrightarrow$  The (set of) leavers consisted of few journalists (and no one else). (That is, either no one left or the ones who left were journalists and few.)  
 c. ‘Only every student left’  $\leftrightarrow$  The (set of) leavers consisted of every student (and no one else).

What this notion of partial answer fails to accommodate is non-exhaustified information about the question that need not be construed as in (120a,b). But non-exhaustified partial answers certainly exist, as shown in (121):

- (121) Q: Who left?  
 A: (All I know is that) several firemen left/few journalists left.

### A Computational Argument

Bos and Gabsdil (2000) point out a computational problem for an EAC approach such as Gr & St’s that seriously threatens its construal in cognitive terms. A natural way of computationally implementing the partition view of questions is to identify a partition with a set of sets of first order formulas, where each set of formulas represents a propositional condition characteristic of a single block of the partition. For a unary *wh*-question and a domain of size  $n$ , there will be  $2^n$  partition blocks. In the general case this means that partitions are intractably big, unless for some reason the domain happens to be very small.

### Summary

Let us briefly review our claims concerning the EAC approach to questions. We have argued that the motivation for identifying a question—the semantic object associated with the attitude of wondering and the speech act of asking—with an entity that encodes exhaustive answerhood conditions is flawed. We have shown that, in fact, most classes of interrogatives clearly resist an analysis of their resolving answerhood conditions in the purely semantic terms assumed by EAC approaches.

We have noted further empirical problems facing such approaches:

1. An EAC analysis presupposes a notion of answerhood that mischaracterizes intuitions about coherence of responses to queries.
2. Despite the existence of data to the contrary, an EAC analysis depends on the assumption that positive and negative polar interrogatives are synonymous.
3. At least on one construal, the EAC analysis is problematic from a computational point of view.

We now show that an older and more basic intuition about what questions are avoids such prob-

<sup>85</sup>In other words, such an answer is a disjunction of one or more exhaustive answers.

lems, without in any way forgoing an adequate characterization of notions related to answerhood—including the conditions under which an answer is resolving.

### 3.5.2 Questions as Propositional Abstracts

The view of questions as akin to open propositions has frequently been put forward. However, given certain technical and conceptual problems it faces, it has not been influential among semanticists. One obvious issue is how to construe the notion of ‘open proposition’. There seem to be two main options. The first option, let us call it the Uninstantiated Variable (UV) view, is to construe an open proposition in a fairly literal minded spirit as a structured object that contains variable-like objects which are uninstantiated.<sup>86</sup> One obvious problem for such an approach are embedded uses of interrogatives, such as (122):

(122) Bo knows who left.

The content associated with the entire sentence needs to be a proposition. However, the prediction of the UV view is that it is a question, since the variables associated with the embedded interrogative remain unbound.

A second issue which has typically remained unexplored within UV proposals is the fate of polar interrogatives. The most obvious proposal would be to say that polar interrogatives constitute the limiting case where the number of uninstantiated variables is 0. But this involves identifying polar questions with the queried proposition, which is untenable, as we mentioned above in our discussion of the Frege-Searle propositional content hypothesis.

A second strategy for implementing the open proposition approach, which has been widely explored, is to abstract over the variables rather than keep them uninstantiated. (See, for example, Keenan and Hull 1973, Hull 1975, Hausser 1983, and Hausser and Zaefferer 1979.) This strategy seemed crucially flawed when viewed from an early 1980s Montagovian perspective as emphasized by Groenendijk and Stokhof (1984, 1989). Within a type theory such as Montague’s intensional logic, the type of any two interrogatives differing in *r*-ity (e.g. unary/binary/ternary *wh*-interrogative-sentences) or in the type of argument (e.g. adverbial vs. argumental *wh*-phrase) is distinct. This contradicts a popular methodological constraint stating that a given syntactic category should map onto a single semantic type. In addition, there is a related empirical problem concerning coordination: how does one interpret a coordinate structure consisting of conjuncts of distinct semantic type? To these problems, which are actually surmountable, one can add a third—one of ontology. Questions seem quite incontrovertibly distinct entities from relations:

- (123) a. The question is who is happy—This question is unresolved.  
 # The property of being happy is unresolved.  
 # To be happy is unresolved.
- b. Can you tell me something about who is happy?  $\nrightarrow$  Can you tell me something about being happy.
- c. Some man is happy.  
 So we know that happiness and manfulness are not incompatible.  
 # So we know that the question of who is happy and who is a man are not incompatible.

<sup>86</sup>For a recent proposal that adopts such a strategy, see Kempson et al. 2000. The UV theorist is not forced to take a structured object perspective. One could construe such an object as the set of all its instantiations, like open formulas are treated in first order logic.

- d. A: What was Bill yesterday?  
 B: Happy.  
 B: #The question of who is happy.
- e. Bill and Phil are almost identical: the only property Bill has that Phil doesn't is happiness.  
 #The only question Bill has that Phil doesn't is who is happy.

A final problem concerns answerhood. If one views a question as an abstract of some kind, then it does not encode in any direct way a notion of exhaustiveness. Neither does the set of substitution-instances of an abstract come close to providing an adequate characterization of the notion of aboutness—the range of propositions coherently connected to a question.

Within the universe that we have built up, however, there are solutions to all four problems: characterizing the semantic distinctness of polar interrogatives and propositions, maintaining the uniform type hypothesis, allowing for the ontological distinctness of questions and relations, and explicating answerhood. Let us start with the ontological problem. Within ST, as mentioned above, SOA abstracts are treated as relations. Paired with an appropriate assignment, a SOA abstract yields a SOA. Crucially, our ontology provides a sharp distinction between propositions and SOAs. Consequently, within our system, propositional abstracts are ontologically distinct from SOA abstracts, and more generally from relations. Consequently, no ontological objection stands in the way of our identifying questions with proposition abstracts.<sup>87</sup> We will see in Chapter 7 that the assumption that questions are abstracts over propositions, as opposed to facts or outcomes, makes some interesting predictions about the construal of in-situ *wh*-phrases in English.

It is worth emphasizing that within the basic approach to semantic modeling adopted here, even if there are strong links tying questions to propositional abstracts, one could forgo identifying the two, and merely view the former as structurally determined by the latter. However, in the absence of strong reasons to the contrary, given the considerable simplification that results, we will proceed to identify questions with the class of proposition abstracts. Although this could not be done uniformly in Montague's intensional logic, we can offer the following simple characterization in terms of simultaneous abstraction:<sup>88</sup>

#### Definition 9 Questionhood

Given an  $SU+AE$   $S$ : **Question**( $q$ ) iff there exist a set  $B$ ,  $B \subset |S|$ ,  $p, c \in |S|$ , and a function  $\pi : B \rightarrow |S|$  such that:

1. For each  $b \in B$ : **PlaceHolder**( $c, b$ ).
2. **Abst**( $c, q$ ).
3.  $q\{\pi\} = p$ .
4. **Proposition**( $p$ ).

In such a case, we say that  $p$  is a propositional instantiation of  $q$  (denoted as: *PropInst*( $p, q$ )).

<sup>87</sup>In the ST literature there have been proposals to utilize proposition abstracts to explicate (non-interrogative) quantification. Both Gawron and Peters (1990) and Cooper (1996) have proposed that determiners be analyzed as denoting relations between proposition abstracts and SOA abstracts (that is, as relations). However, as we will see in Chapter 4, the purpose intended for propositional abstracts by Gawron and Peters and by Cooper—essentially to encode domain selection—is achieved equally well by using **FACT ABSTRACTS**.

<sup>88</sup>Note though that this definition does not mean that we are postulating **Question** as an additional structural relation. Rather, it constitutes a 'derivative' notion: since we explicate questions as propositional abstracts and  $SU+AE$ s are required to be  $\lambda$ -structures, any  $SU+AE$  will necessarily contain the class of questions. We, nonetheless, use boldface for the relation 'Question', since it is defined in terms of the structural relations **Abst** and **Proposition**.

Ginzburg (1992), in a related proposal, shows ways to define coordination operations simultaneously for questions and propositions. Definition 10 for conjunction is based on the definition for type conjunction in Cooper 1993. Note that the definition makes sense because we assume the existence of a meet operation on propositions and that the SU+AE is a  $\lambda$ -structure. An entirely analogous definition can be given for disjunction:

**Definition 10 A Conjunction Operation for Questions**

Given a question  $q_1 (= \lambda A.\sigma)$  and a question  $q_2 (= \lambda B.\tau)$ , where  $A \cap B = \emptyset$ :<sup>89</sup>

$$\wedge(\lambda A.\sigma, \lambda B.\tau) =_{def} \lambda A \cup B. \wedge\{\sigma, \tau\}$$

The coordination of interrogatives is a fertile area with various interesting puzzles that we cannot enter into here. Probably the most fundamental of these is the question of how to provide a definition that uniformly applies to propositions and questions. In this respect, the simplicity of the account provided here is interesting to compare with the complicated regime of type shifting required by an EAC account, as demonstrated in detail in Groenendijk and Stokhof 1989.<sup>90</sup>

What of polar questions? We will treat these as propositional abstracts where the set of abstracted elements is the empty set. Given our assumption that the semantic universe is a  $\lambda$ -universe, it follows that such abstracts exist. In general, given our assumptions about the abstraction operation, it follows that an abstract is distinct from its body. This holds also for 0-ary abstracts, as we remarked in section 82. Therefore, in particular, a polar question is distinct from a proposition.

The constraints we posit below will associate:<sup>91</sup>

- (124) a. a use of *Did Bo scream* with the propositional abstract  
 $\lambda\{ \} \text{prop}(s, \langle\langle \text{Scream}; \text{screamer: b} \rangle\rangle)$   
 b. a use of *Who left?* with the propositional abstract  
 $\lambda\{b\} \text{prop}(s, \langle\langle \text{Leave}; \text{leaver: b} \rangle\rangle)$   
 c. a use of *Who annoyed whom?* with the propositional abstract  
 $\lambda\{b,a\} \text{prop}(s, \langle\langle \text{Annoy}; \text{annoyance: } b, \text{ annoyed: } a \rangle\rangle)$

### 3.5.3 Notions of Answerhood

In the previous section, we addressed three of the problems faced by an ‘open proposition’ approach to questions. We turn now to the most fundamental issue for any theory of questions, namely answerhood. When thinking about answerhood, we move away from the assumption that there is a unique answerhood relation that a question needs to encode. Rather, we take the strategy, initiated by Ginzburg (1995a), of viewing answerhood as any of a variety of propositional

<sup>89</sup>Given that the notion of abstraction we employ respects  $\alpha$ -equivalence, it is unproblematic to ensure that this assumption is satisfied.

<sup>90</sup>Recall that the object which constitutes a question in their theory is a partition on the set of possible worlds—type  $\langle\langle s, t \rangle, t \rangle$  in Montagovian terms. Generalized conjunction applied to a partition yields a new, more refined partition. Hence, conjunction applies smoothly to interrogatives to yield a conjoined question. However, generalized disjunction does not, in general, yield as output a partition. Thus, in order to accommodate disjunction Groenendijk and Stokhof are required to posit that this takes place at a higher type, essentially the type of sets of partitions. The consequence of this is, for instance, that within Groenendijk and Stokhof’s system a verb like *know* can be specified to be of type  $\langle\langle s, t \rangle, \langle e, t \rangle\rangle$  for embedded atomic interrogatives and embedded conjunctive interrogatives, but needs to be type lifted to type  $\langle\langle\langle\langle s, t \rangle, t \rangle, t \rangle, \langle e, t \rangle\rangle$  to deal with embedded disjoined interrogatives.

<sup>91</sup>This is actually still an approximation that abstracts away from the issue of the ‘restrictor information’ introduced by *wh*-phrases, a matter we return to in Chapter 4.

properties that can be defined in terms of the question and the semantic structure provided by the universe. Given this, our simple view of what questions are will provide the basis for a rich theory of answerhood that is not constrained by the assumption that one particular notion of answerhood is primary.

Here we consider three notions of answerhood. First, we show how to reconstruct the notion of *strong exhaustiveness*, which is Groenendijk and Stokhof's characterization of the exhaustive answerhood conditions of a question. The emerging notion benefits, we believe, from the partiality that our semantic universe provides. We then show how to define a more inclusive and contextually relativized notion of resolvedness. Finally, we offer a proposal for what *aboutness* amounts to. This constitutes the weakest, i.e. most inclusive notion of answerhood, required in order to characterize the range of coherent, 'direct' responses to a query.

### Strong Exhaustiveness

In order to define the various notions of answerhood, we first introduce two auxiliary notions: *atomic answer* and *simple answer*. A proposition  $p$  is an atomic answer to  $q$  if it is either an instantiation of  $q$  or a conjunct of such an instantiation. A proposition  $p$  is a simple answer to  $q$  if it is either an atomic answer or a negation of such an answer:

#### Definition 11 Atomic and Simple Answerhood

- a.  $AtomAns(p, q)$  iff  $\exists r [ConjOf(p, r) \text{ and } PropInst(r, q)]$
- b.  $NegAtomAns(p, q)$  iff  $\exists r [r = \neg p \text{ and } AtomAns(r, q)]$
- c.  $SimpleAns(p, q)$  iff  $AtomAns(p, q) \text{ or } NegAtomAns(r, q)$

With these notions in hand, we can define the *strongly exhaustive answer* as the meet of the set of true, simple answers:

#### Definition 12 Strong Exhaustiveness

$StrongExhAns(f, q)$  iff  $f = \bigwedge \{p \mid True(p) \text{ and } SimpleAns(p, q)\}$

In order for this definition to make sense, the set of true, simple answers needs to be nonempty. We call a question for which this is the case *decided*:

#### Definition 13 Decidedness Conditions for a Question

A question  $q$  is decided iff  $\{p \mid True(p) \text{ and } SimpleAns(p, q)\} \neq \emptyset$

One difference between the semantic setting in which our semantic theory is formulated and possible worlds theory is that in our account, not all questions are decided.<sup>92</sup> When we discuss the embedding of interrogatives by factive/resolutive predicates in Chapter 8, we suggest that such predicates introduce a presupposition that the requisite question is decided. This is why in such cases the exhaustive answer is well-defined and can serve as an argument to the predicate.

Let us now consider some examples. For a polar question, the strongly exhaustive answer is whichever polar answer is true:

- (125) a.  $q = \lambda\{\} \text{prop}(s, \langle\langle \text{Tall}; m \rangle\rangle)$  (whether Mo is tall)  
 b.  $AtomAns(p_0, q)$  iff  $p_0 = \text{prop}(s, \langle\langle \text{Tall}; m \rangle\rangle)$   
 c. If  $True(p_0)$ , then  $StrongExhAns(f, q)$  iff  $f = \bigwedge \{p_0\} = p_0$ ;  
 If  $True(\neg p_0)$ , then  $StrongExhAns(f, q)$  iff  $f = \bigwedge \{\neg p_0\} = \neg p_0$   
 d.  $q$  is decided iff either  $True(p_0)$  or  $True(\neg p_0)$ .

<sup>92</sup>This is because it is possible that for some proposition  $p$ , neither  $p$  nor its negation  $\neg p$  is true.

Let us consider now a conjunction of polar questions. The strongly exhaustive answer is simply the conjunction of the strongly exhaustive answers to each question:

- (126) a.  $q_1 = \lambda\{ \} \text{prop}(s_0, \langle\langle \text{Tall}; \text{b} \rangle\rangle)$  (whether Bo is tall)  
 b.  $q_2 = \lambda\{ \} \text{prop}(s_1, \langle\langle \text{Hungry}; \text{k} \rangle\rangle)$  (whether Kim is hungry)  
 c.  $q = \bigwedge \{q_1, q_2\} = (\text{by definition 10})$   
 $\lambda\{ \} \bigwedge \{ \text{prop}(s_0, \langle\langle \text{Tall}; \text{b} \rangle\rangle), \text{prop}(s_1, \langle\langle \text{Hungry}; \text{k} \rangle\rangle) \}$   
 d.  $\{p \mid \text{AtomAns}(p, q)\} = \{ \text{prop}(s_0, \langle\langle \text{Tall}; \text{b} \rangle\rangle), \text{prop}(s_1, \langle\langle \text{Hungry}; \text{k} \rangle\rangle) \}$   
 e.  $\text{StrongExhAns}(f, q)$  iff  $f = \bigwedge \{p \mid \text{True}(p) \text{ and } [p = \text{prop}(s_0, \langle\langle \text{Tall}; \text{b} \rangle\rangle) \text{ or } p = \text{prop}(s_0, \langle\langle \text{Tall}; \text{b} \rangle\rangle) \text{ or } p = \text{prop}(s_1, \langle\langle \text{Hungry}; \text{k} \rangle\rangle) \text{ or } p = \text{prop}(s_1, \langle\langle \text{Hungry}; \text{k} \rangle\rangle)] \}$

For a *wh*-question, the strongly exhaustive answer involves conjoining the true atomic answers— instantiations of the propositional abstract, if any such exist—along with those negations of instantiations of the propositional abstract that are true.

- (127) a.  $q_1 = \lambda\{ \text{b} \} \text{prop}(s_0, \langle\langle \text{Available}; \text{b} \rangle\rangle)$  (who is available)  
 b.  $\text{AtomAns}(p_0, q_1)$  iff  $\exists a [p_0 = \text{prop}(s_0, \langle\langle \text{Available}; \text{a} \rangle\rangle)]$   
 c.  $\text{StrongExhAns}(f, q)$  iff  $f = \bigwedge \{p \mid \text{True}(p) \text{ and } \exists a [p = \text{prop}(s_0, \langle\langle \text{Available}; \text{a} \rangle\rangle) \text{ or } p = \text{prop}(s_0, \langle\langle \text{Available}; \text{a} \rangle\rangle)] \}$

This characterization of strong exhaustiveness makes a subtle but important point concerning negative answers. Due to partiality, viz. the fact that  $p$  being false does not make  $\neg p$  true, the negative answers that are conjuncts of the exhaustive answer are true propositions of the form  $\text{prop}(s, \langle\langle \text{Available}; \text{a} \rangle\rangle)$ . In section 3.3.2, we outlined the ST assumptions about when  $\langle\langle \text{Available}; \text{a} \rangle\rangle$  is supported by a given situation. This holds just in case  $s$  carries positive information indicating that  $a$  fails to be available and also that he might be expected to be available. Thus, in our account, the strongly exhaustive answer to a *wh*-question such as *who is available* combines positive information about individuals, concerning those individuals that the situation indicates are available, with a limited amount of negative information, concerning those individuals whose unavailability is explicitly indicated in the situation. This is a useful refinement of Groenendijk and Stokhof's notion of strong exhaustiveness, which is a proposition entailing information about every individual in the world, detailing whether or not they manifest the property at issue.<sup>93</sup>

Finally, an example of conjoining a *wh*-question and a polar question. The strongly exhaustive answer is once again simply the conjunction of the strongly exhaustive answers to each question:

<sup>93</sup>As far as *wh*-questions are concerned, our account as it stands is incomplete. We have not as yet incorporated any notion of domain selection—or any other restrictions on the roles abstracted away beyond those that come from the relation. This means that our answerhood notions will be too inclusive: in (127), for instance, any proposition whatever of the form  $\text{prop}(s_0, \langle\langle \text{Available}; \text{x} \rangle\rangle)$  counts as an atomic answer. In general, given that  $s_0$  is a situation, and therefore, in principle, a partial entity, only a limited number of such propositions and their negations will come out as true. Hence, for an answerhood notion which is based on true answers—such as exhaustiveness—domain selection is relatively unproblematic. However, with respect to other notions of answerhood, such as *aboutness*, where truth does not come into the picture, domain selection is crucial in limiting the answerhood space. The necessary refinement will be introduced in Chapter 4.

- (128) a.  $q_1 = \lambda\{b\} \text{prop}(s_0, \langle\langle\text{Tall};b\rangle\rangle)$  (*who is tall*);  
 $q_2 = \lambda\{k\} \text{prop}(s_1, \langle\langle\text{Hungry};k\rangle\rangle)$  (*whether Kim is hungry*);  
 $q = \bigwedge\{q_1, q_2\}$
- b.  $\{p \mid \text{AtomAns}(p, q)\} =$   
 $\{p \mid \exists a[p_1 = \text{prop}(s_0, \langle\langle\text{Tall};a\rangle\rangle)] \cup \{\text{prop}(s_1, \langle\langle\text{Hungry};k\rangle\rangle)\}$
- c. *StrongExhAns*( $f, q$ ) iff  
 $f = \bigwedge\{p \mid \text{True}(p) \text{ and } [\exists a[p = \text{prop}(s_0, \langle\langle\text{Tall};a\rangle\rangle)] \text{ or } p = \text{prop}(s_0, \overline{\langle\langle\text{Tall};a\rangle\rangle})]$   
 $\text{or } p = \text{prop}(s_1, \langle\langle\text{Hungry};k\rangle\rangle) \text{ or } p = \text{prop}(s_1, \overline{\langle\langle\text{Hungry};k\rangle\rangle})\}$

### Resolvedness

What we have seen so far in this section is that we can reconstruct the notion of strong exhaustiveness that underlies Groenendijk and Stokhof's semantics. We can adopt this as the fundamental notion we use to specify the content of interrogatives embedded by factive/resolutive predicates. Alternatively, in light of the data discussed in section 3.5.1, we can adopt a more inclusive and pragmatically relativized notion of exhaustiveness—the notion of *resolvedness* introduced by Ginzburg (1995a). On this view, the notion of *resolvedness* required for explicating the basic inferential properties of interrogative factive complements is a relative notion: information resolves a given question relative to a goal and an attitudinal (belief/knowledge) state. That is, a given question defines a class of propositions each of which is potentially resolving. Whether a given member of this class,  $p$ , is actually a resolving answer in a given context depends on two additional factors. The first is the goal  $g_0$ , which determines a lower bound for  $p$ . The second factor is the information state,  $IS_0$ , which determines the resources relative to which  $p$  has  $g_0$  as a consequence.

Devising a successful empirical characterization of potential resolvedness is tricky. For example, to say that an item of information  $\tau$  is not potentially-resolving requires one to consider all possible goal/belief-state combinations and to decide that in none of them would the information provided by  $\tau$  be deemed resolving. The difficulty involves only *wh*-questions, however, since it seems clear that for polar questions, potential resolvedness reduces to strong exhaustiveness.

We sketch here one characterization of potential resolvedness, that of Ginzburg (1995a), on the basis of which we will be able to define resolvedness. The intuition is that a potentially resolving answer is one that either indicates that the question is positively resolved or alternatively one that indicates that the question is negatively resolved. What does a question being positively resolved amount to? For a polar question  $\lambda\{ \}p$ , this amounts to entailing  $p$ ; for a *wh*-question  $\lambda\{x\}p(x)$ , this amounts to entailing that  $\lambda\{x\}p(x)$  can be instantiated, and moreover providing some additional sortal information about the instantiator(s) that distinguishes it (them) from other potential instantiators. This intuition can be traced back to Belnap (1982).<sup>94</sup> Examples of positively resolving answers are given in (129b–e) and (130b–d). We claim that, given the right pragmatic circumstances, these examples count as resolving the question, hence licensing utterances such as (129f) and (130e).

<sup>94</sup>“One appealing conjecture is that all and only existence-entailing (or presupposing) terms can be short answers to *what*-questions [Here ‘short answer’ means roughly, in current terms, ‘term that provides resolving information and can be used to respond to a query use of the question’—J.G & I.A.S]. . . . Perhaps each term must be formed from a sortal in the sense of Gupta 1974, together with an existence entailing (or presupposing) quantifier.” (Belnap 1982: 196)

- (129) a. [Aagje is about to give a talk in Odense.]  
 Aagje: Who will show up for the talk?  
 b. Bo: Arne Ness.  
 c. Bo: Several senior Danish logicians.  
 d. Bo: Either Ebbe Sand or Stig Tofting.  
 e. Bo: Every student of Nielsen's.  
 f. Bo explained to us who would show up for the talk.
- (130) a. Leigh: When is the train leaving?  
 b. Morgan: Within 20 minutes.  
 c. Morgan: In a short while.  
 d. Morgan: After the 16:24 shows up.  
 e. Morgan indicated to us when the train would leave.

Note that these examples resolve the questions independently of whether the answers provided in (129) constitute exhaustive information.<sup>95</sup> Hence, this notion of potential resolvedness is a more inclusive notion than exhaustiveness—strong or otherwise. Note also that, according to this definition, answers like the one in (131) are not positively resolving, since they provide no sortal information beyond that already encoded in the question:<sup>96</sup>

- (131) a. Morgan: Who will show up for the talk?  
 Bo: Someone.  
 b. Leigh: When is the train leaving?  
 Morgan: At some time.

We now turn to negative resolvedness. For a polar question  $\lambda\{ \}p$ , this amounts to entailing  $\neg p$ ; for a *wh*-question  $\lambda\{x\}p(x)$  this amounts to entailing that  $\lambda\{x\}p(x)$  is uninstantiable:

- (132) a. Aagje: Who will show up for the talk?  
 Bo: No one, alas.  
 b. Leigh: Why is the train delayed?  
 Morgan: Apparently, for no reason.

The notion of potential resolvedness we have sketched here excludes propositions that are neither positively-resolving nor negatively-resolving, e.g. (133b–e). That is, the notion predicts that propositions would not license attitude reports such as (133f):

- (133) a. A: Who will show up for the talk?  
 b. B: Maybe Ebbe Sand.  
 c. B: It's unlikely anyone will show up.  
 d. B: Few people. No one with any knowledge of Category Theory.  
 e. B: Either Ebbe Sand or no one.<sup>97</sup>  
 f. B explained to us who would show up for the talk.

<sup>95</sup>Exhaustiveness is harder to test for a question like (130a), which has a unique answer.

<sup>96</sup>See Ginzburg 1995a for arguments as to why this is not a pragmatic epiphenomenon, and also for arguments against the common assumption that *wh*-interrogatives carry an existential presupposition.

<sup>97</sup>This example is like one proposed to us by Adam Przepiórkowski (personal communication).

For some of these cases, such as (133b,c), the prediction seems intuitively correct. For cases like (133d,e) intuitions are less clear cut. Insofar as there might be an inclination to view (133d) as potentially resolving, this could be explained away by assuming that it licenses an implicature that strengthens its interpretation to (134), which positively resolves the question since it entails that the question is instantiable.

- (134) Stevie: Those who show up will be few and they will lack any knowledge of Category Theory.

However, no such explanation extends to (133e). For those speakers who feel it to be potentially resolving, a more inclusive notion of potential resolvedness would need to be provided.<sup>98</sup> All these propositions will, in any case, be characterized as constituting information about the question, as discussed below.

We turn now to formalizing and briefly illustrating the notion of potential resolvedness that we have been discussing. The following definition provides a unified proposal for polar and *wh*-questions:

**Definition 14 Potential Resolvedness**

$PotResAns(p, q)$  iff **Proposition**( $p$ ) and **Question**( $q$ ) and

1. *Either: PositivelyResolves*( $p, q$ ). That is, both a. and b. hold:
  - a.  $p$  witnesses  $q$ :  $p \rightarrow_{prop} \bigvee \{r \mid AtomAns(r, q)\}$ .
  - b.  $p$  sortalizes  $q$ : If  $|\{r \mid AtomAns(r, q)\}| \geq 2$ , then there exists at least one  $r$  such that  $AtomAns(r, q)$  and  $r \not\rightarrow_{prop} p$ .
2. *Or: NegativelyResolves*( $p, q$ ). That is,  $p \rightarrow_{prop} \bigwedge \{r \mid NegAtomAns(r, q)\}$ .

Note that potential resolvedness does indeed reduce to strong exhaustiveness for a polar question  $\lambda\{ \}p$ :<sup>99</sup>

- (135) a. If  $q = \lambda\{ \}p$ , then:  
 b.  $AtomAns(r, q)$  iff  $r = p$ ;  $NegAtomAns(r, q)$  iff  $r = \neg p$ .  
 c.  $PotResAns(\psi, q)$  iff **Proposition**( $\psi$ ) and **Question**( $q$ ) and  $True(\psi)$  and:  
 either:  $\psi \rightarrow_{prop} \bigvee \{r \mid AtomAns(r, q)\}$ , i.e.  $\psi \rightarrow_{prop} \bigvee \{p\}$ ; i.e.  $\psi \rightarrow_{prop} p$ ;  
 or:  $\psi \rightarrow_{prop} \bigwedge \{r \mid NegAtomAns(r, q)\}$ , i.e.  $\psi \rightarrow_{prop} \bigwedge \{\neg p\}$ ; i.e.  $\psi \rightarrow_{prop} \neg p$ .

For a simple unary *wh*-question such as *who is available*, the proposal leads to the following characterization:

- (136) a.  $q_1 = \lambda\{b\}prop(s_0, \langle\langle Available; b \rangle\rangle)$  (*who is available*)  
 b.  $AtomAns(r, q)$  iff  $\exists a[r = prop(s_0, \langle\langle Available; a \rangle\rangle)]$   
 c. *PositivelyResolves*( $p, q$ ), that is both (1) and (2) hold:  
 (1)  $p$  witnesses  $q$ :  $p \rightarrow_{prop} \bigvee \{r \mid AtomAns(r, q)\}$ ,  
 i.e.  $p \rightarrow_{prop} \bigvee \{r \mid \exists a[r = prop(s_0, \langle\langle Available; a \rangle\rangle)]\}$   
 (2)  $p$  sortalizes  $q$ : There exists at least one  $r$  such that  $AtomAns(r, q)$  and  $r \not\rightarrow_{prop} p$ .  
 d.  $NegAtomAns(r, q)$  iff  $\exists a[r = prop(s_0, \langle\langle Available; a \rangle\rangle)]$   
 e. *NegativelyResolves*( $p, q$ ) iff  $p \rightarrow_{prop} \bigwedge \{r \mid \exists a[r = prop(s_0, \langle\langle Available; a \rangle\rangle)]\}$

<sup>98</sup>We wish to thank Eric Potsdam and Adam Przepiórkowski for alerting us to this problem.

<sup>99</sup>But the sortal condition does not come into the picture, because the cardinality of the set of atomic answers is 1.

Let us consider this example in more detail. To begin with, consider the answer that B provides in (137a).

- (137) A: Who is available?  
 a. B: Ebbe Sand  
 b. B: Either Ebbe Sand or Stig Tofting.  
 c. B: Several senior Danish logicians.  
 d. B: No one.

This is a member of the set of atomic answers. Hence, in particular, it is potentially resolving. Similar remarks apply to (137b); assuming there are other individuals in the domain apart from Ebbe Sand and Stig Tofting, the proposition expressed by (137b) entails the join of the set of atomic answers, whose truth requires simply the truth of at least one element of the set.

In order to consider the status of answers like (137c,d), we need to consider how quantificational propositions are represented in ST. Cooper (1996) provides a variety of arguments for a reformulation of Generalized Quantifier (GQ) theory using ST tools. Here we present a simplified version of this proposal, mainly because for the moment we will ignore domain selection.<sup>100</sup> A quantified statement denotes a proposition of the form in (138a):

- (138) a.  $\text{prop}(s, \langle\langle \text{QuantRel}; \tau, \varrho \rangle\rangle)$   
 b.  $\text{prop}(s, \langle\langle \text{Every}; \lambda\{b\}\langle\langle \text{Student}; b \rangle\rangle, \lambda\{c\}\langle\langle \text{Run}; c \rangle\rangle \rangle\rangle)$   
     *(every student runs)*  
 c.  $\text{prop}(s, \langle\langle \text{Some}; \lambda\{b\}\langle\langle \text{Student}; b \rangle\rangle, \lambda\{c\}\langle\langle \text{Run}; c \rangle\rangle \rangle\rangle)$   
     *(some student runs)*  
 d.  $\text{prop}(s, \langle\langle \text{Several}; \lambda\{b\}\langle\langle \text{SeniorDanishLogician}; b \rangle\rangle, \lambda\{c\}\langle\langle \text{Available}; c \rangle\rangle \rangle\rangle)$   
     *(several senior Danish logicians are available)*

Here the quantified SOA begins with *QuantRel*, a relation provided by the quantificational determiner. Its relata,  $\tau$  and  $\varrho$ , are one place SOA abstracts, i.e. properties. Simple examples are provided in (138b,c,d).

Cooper suggests that the truth conditions of a quantificational statement can be given in terms of constraints that relate the GQ account to the classical set-theoretic based account. The basic idea is simply that with each determiner relation  $q$  we associate a set theoretic relation  $q^\dagger$  whose relata are sets.

- (139) a.  $s \models \langle\langle \text{QuantRel}; \tau, \varrho \rangle\rangle$  iff  $\text{QuantRel}^\dagger(\{x \mid s \models \tau\{x\}\}, \{x \mid s \models \varrho\{x\}\})$   
 b.  $s \models \langle\langle \text{QuantRel}; \tau, \varrho \rangle\rangle$  iff  
     it is not the case that:  $\text{QuantRel}^\dagger(\{x \mid s \models \tau\{x\}\}, \{x \mid s \models \varrho\{x\}\})$

Thus, if we take *Every*<sup>†</sup> to be set inclusion, *Some*<sup>†</sup> to be non-empty intersection, and *Several*<sup>†</sup> to be intersection with cardinality greater than 1, we have a straightforward treatment of the truth conditions of the propositions in (138b-d). Concretely, we can take the truth conditions of (138d) to be as given in (140):

$$(140) \quad |\{b \mid s \models \langle\langle \text{SeniorDanishLogician}; b \rangle\rangle\} \cap \{c \mid s \models \langle\langle \text{Available}; c \rangle\rangle\}| \geq 2$$

<sup>100</sup>Accounting for domain selection is one the most important motivations for the ST-based formulation. We will return to this issue in Chapter 4.

Given (140), it is clear that (137c) entails the join of the set of atomic answers. Moreover, assuming the universe is not composed exclusively of senior Danish logicians, (137c) sortalizes the question. Hence, (137c) is potentially resolving.

Given partiality and our approach to negation, a negative quantifier such as *no* needs to be characterized in terms that require the supporting situation to actually support a set of negative SOAs about the relevant individuals, as in (141a):

- (141) a.  $s \models \langle \langle \text{No}; \tau, \rho \rangle \rangle$  iff  $\{x \mid s \models \tau\{x\}\} \subset \overline{\{x \mid s \models \rho\{x\}\}}$   
 b.  $s \models \langle \langle \text{No}; \tau, \rho \rangle \rangle$  iff  $(\{x \mid s \models \tau\{x\}\} \cap \{x \mid s \models \rho\{x\}\}) = \emptyset$

Simply assuming (141b) leads to overly weak truth conditions.

Given (141a), it follows that (137d) will be true just in case (142) is true:

- (142)  $\{b \mid s \models \langle \langle \text{Person}; b \rangle \rangle\} \subset \overline{\{c \mid s \models \langle \langle \text{Available}; c \rangle \rangle\}}$

Assuming that  $s$  contains persons, i.e. that the set  $\{b \mid s \models \langle \langle \text{Person}; b \rangle \rangle\}$  is non-empty, it will follow that (137d) is potentially resolving.

The notion of resolvedness emerges by relativizing potential resolvedness to agent information states that supply the necessary knowledge and goal parameters. Nonetheless, one can also show that in many cases such additional parameters are fixed in such a way as to mask their presence. For example, if the goal is assumed to be transparently expressed by the denoted question  $q_0$ , and the limited nature of informational resources is ignored, then resolvedness reduces to exhaustiveness. Thus, the pervasive intuitions about exhaustiveness need not be ignored; they can be seen as default inferences. The following is the definition of *resolves* that can be adopted, stated relative to a notion of consequence and an agent's information state that supplies a GOAL  $g$ .<sup>101</sup>

#### Definition 15 Resolving a Question

$p$  is a proposition that resolves a question  $q$  relative to an information state  $is$ , just in case the following conditions hold:

- a. *Semantic Condition*:  $\text{True}(p)$  and  $\text{PotResAns}(p, q)$ .  
 b. *Pragmatic Relativization*:  $p$  enables the current goal (in IS) to be fulfilled relative to the available inferential resources (of IS).

#### Aboutness

We turn now to *aboutness*, the notion of answerhood that we take to underlie the coherence of 'direct answers' to queries. We propose the following characterization:

#### Definition 16 Aboutness

$\text{About}(p, q)$  iff  $\text{Proposition}(p)$  and  $\text{Question}(q)$  and  $p \rightarrow_{prop} \bigvee \{r \mid \text{SimpleAns}(r, q)\}$ .

The most obvious difference between aboutness and the other notions we have discussed above is that aboutness says nothing about truth. Given (143a), all simple answers are automatically characterized as being about the question. In order to appreciate this, recall from our earlier discussion that:

<sup>101</sup>The notion of 'goal' here is identified with an *outcome* which, intuitively, describes a (typically epistemic) state the agent would like to attain, e.g. *to find Mo's house this afternoon, to know the identity of the President's dinner guests*, etc. See Ginzburg 1995a for discussion and further illustration.

- (143) a. For a polar question:  $\{r \mid \text{SimpleAns}(r, \lambda\{ \}p)\} = \{p, \neg p\}$   
 b. For a unary *wh*-question:  $\{r \mid \text{SimpleAns}(r, \lambda\{b\}p(b))\} = \{p(a_1), \dots, p(a_n), \neg p(a_1), \dots, \neg p(a_n)\}$

However, aboutness is a more inclusive condition than being a *SimpleAns*. Thus, in order for a proposition to be about a polar question  $\lambda\{ \}p$ , it must entail the proposition  $\bigvee\{p, \neg p\}$  (i.e. the proposition  $p \vee \neg p$ ). On a traditional model-theoretic conception, this defining condition is vacuous. However, in the current context, given that  $p$  being false does not require that  $\neg p$  be true, the condition is restrictive. For instance, it will not generally be the case that (144) is true.

$$(144) \text{prop}(s, \langle\langle\text{Leave};j\rangle\rangle) \rightarrow_{prop} \bigvee\{\text{prop}(s, \langle\langle\text{Tall};j\rangle\rangle), \text{prop}(s, \overline{\langle\langle\text{Tall};j\rangle\rangle})\}$$

This is because a situation's containing information about J's leaving does not mean that it must contain information about J's being tall or not tall.

Let us now consider what answers this characterization admits. For a polar question  $\lambda\{ \}p$ , we obtain the following:

$$(145) \quad (\text{About}(r, \lambda\{ \}p)) \text{ iff } (r \rightarrow_{prop} \bigvee\{p, \neg p\})$$

It straightforwardly follows that both  $p$  and  $\neg p$  are about  $\lambda\{ \}p$ . What is more interesting is that—unlike all previous accounts we are aware of—we can also accommodate answers that are weaker than the two polar propositions. Thus, we want to show that ‘weak’ modal information, e.g. *possibly/probably/unlikely*  $p$ , is *about*  $\lambda\{ \}p$ . We confine ourselves here to showing the existence of a notion of *possibly*, whose definition we restrict for simplicity to basic propositions. As is easy to verify, aboutness is upward monotone closed: if  $p \rightarrow_{prop} r$  and  $r$  is about  $q$ , then  $p$  is *About*  $q$ . Hence, given that *probably*  $p \rightarrow_{prop}$  *possibly*  $p$ , once we show that *possibly*  $p$  is *about*  $\lambda\{ \}p$ , it will follow that *probably*  $p$  is *about*  $\lambda\{ \}p$ .

In order to do this, we need a semantics for *possibly* which is compatible with the situation semantics framework that we have adopted. For this purpose, we outline a simplified version of the analysis developed in Vogel and Ginzburg 1999, which builds on Kratzer 1981.<sup>102</sup> Asserting of a proposition  $\text{prop}(s, \sigma)$  that it is *possible* involves drawing attention to the fact that  $\sigma$  is one of the existing alternatives for describing  $s$  and, moreover, that some other situation causally linked to  $s$  does not support  $\bar{\sigma}$  being the case. For example:

- (146) *True*(*Possibly*( $\text{prop}(s, \sigma)$ )) iff there exist  $\tau, s'$  such that:
- CausallyLinked*( $s, s'$ ).
  - $s' \not\models \bar{\sigma}$ .
  - True*( $\bigvee\{\text{prop}(s, \sigma), \text{prop}(s, \tau)\}$ ).
  - $\tau$  and  $\sigma$  are incompatible. That is, for all  $s$ : *True*( $\text{prop}(s, \tau)$ )  $\rightarrow_{prop}$  *True*( $\text{prop}(s, \bar{\sigma})$ ) and *True*( $\text{prop}(s, \sigma)$ )  $\rightarrow_{prop}$  *True*( $\text{prop}(s, \bar{\tau})$ ).

It follows from this definition that:<sup>103</sup>

<sup>102</sup>Vogel and Ginzburg's analysis is formulated using notions from Channel Theory (Barwise and Seligman 1996) that provide an account of the notion of a causal link between situations—an important component of a theory of modality. We abstract away from such notions here, in so far as this is possible.

<sup>103</sup>To prove (147a): if  $\text{prop}(s, \sigma)$  is true, then take  $\bar{\sigma}$  for  $\tau$  in (146) and  $s$  to be  $s'$ . The truth of *Possibly*( $\text{prop}(s, \sigma)$ ) is immediate. To prove (147b): if *Possibly*( $\text{prop}(s, \sigma)$ ) is true, then according to (146) there exists  $\tau$  which is incompatible with  $\sigma$  such that *True*  $\bigvee\{\text{prop}(s, \sigma), \text{prop}(s, \tau)\}$ . In section 3.3.2, we postulated that if a situation  $s$  supports a SOA that is incompatible with  $\sigma$ , then  $s$  supports  $\bar{\sigma}$ . Hence, it follows that  $\bigvee\{\text{prop}(s, \sigma), \text{prop}(s, \bar{\sigma})\}$  is true.

- (147) a.  $\text{prop}(s, \sigma) \rightarrow_{prop} \text{Possibly}(\text{prop}(s, \sigma))$ , but not vice versa.  
 b.  $\text{Possibly}(\text{prop}(s, \sigma) \rightarrow_{prop} \bigvee \{\text{prop}(s, \sigma), \text{prop}(s, \bar{\sigma})\})$

Hence, *Possibly*  $p$  is *about*  $\lambda\{ \}p$ , at least for basic propositions. Thus, we have a notion that begins to capture the meaning of *possibly*, a non-polar modality at any rate, which is an answer about the corresponding polar question.

By similar reasoning, it emerges for *wh*-questions that certain propositions that are not *potentially resolving*, are nonetheless *about*. Example (148) illustrates this:

- (148) a. A: Who will come?  
       B: Possibly John.  
 b. A: Who will show up?  
       B: Either Ebbe Sand or no one.

### 3.5.4 Recap

We have presented a view of questions as propositional abstracts. We have shown how within the ontological setup of ST—in particular the fact that SOAs are distinct from propositions and the closure of the universe under simultaneous abstraction—we can surmount various problems that beset earlier attempts at formalizing the intuition of questions as ‘open propositions’. We have shown how to:

1. ontologically distinguish questions from relations,
2. define a uniform semantic type for questions which covers both polar and *wh*-questions,
3. provide a simple theory of coordination.

Most crucially, given that we do not take any single notion of answerhood as *the* basic, semantic notion of answerhood, we can explicate the variety of answerhood relations needed for semantic and pragmatic theory. The notion of question we have developed constitutes a means of *underspecifying* answerhood.

## 3.6 A TFS Version of the Ontology

In this section, we show how to embed our proposal for a semantic universe into a framework of typed feature structures (TFSs); hence, we render it compatible with recent work in HPSG (for example, Pollard and Yoo 1998 and Sag 1997) and with the overall grammar architecture that we employ throughout this work. This demonstration will involve two tasks: (1) developing a hierarchy of semantic types on the basis of which we can encode semantic objects and (2) providing an interpretation function that maps type feature structures to elements of the semantic universe. To reiterate the analogy with Montague Semantics pointed out in section 3.1: the type feature structures correspond to logical forms of intensional logic; our semantic universe corresponds to a Montagovian structure like (2) above.

Before we turn to these two tasks, a few remarks about context and its role in determining content are in order. Montague (1974a)—and, perhaps more influentially, Kaplan (1989)—distinguish between *meaning* (Kaplan’s term is *character*) and *content*. The semantic object associated with an expression context independently is its meaning. Given a context  $c$ , a meaning can be used to evaluate the content of an expression  $\phi$  in  $c$ . Thus, a common formalization of a mean-

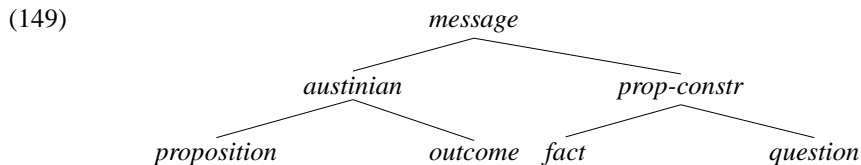
ing is as a *function* from contexts to contents.<sup>104</sup> To a first approximation, then, what the *content* attribute of a sign encodes is the value the meaning function takes, given the values of the contextual parameters, whose values are represented in the attribute C(ONTEXTUAL)-INDICES and in the attribute B(A)CKGR(OUN)D.

This represents a simplification of the meaning/context/content interrelationship. For example, it assumes that *sentences* have contents, rather than viewing content as a notion conversationalists associate with utterances—spatio-temporally located speech events—they perceive. This latter perspective, which as we mentioned in Chapter 1 was pioneered in Barwise and Perry 1983, is required if conversational phenomena such as corrections or requests for clarification are to be accommodated—phenomena that arise because conversationalists do not classify the content of a commonly perceived utterance identically. Adopting such a perspective, one can say that signs as conceived of in this book specify a speaker-oriented view of the conventional content information pertaining to an utterance. That is, we do not, for the most part, make allowance for communicative problems that might lead to an imperfect perception of an utterance on the phonological, syntactic, or semantic level.<sup>105</sup> We will, nonetheless, offer an account of one phenomenon which turns crucially on the existence of a mismatch between speaker and addressee. These are reprise utterances which we discuss in Chapters 7 and 8.

In addition, the view of content we assume here does not in and of itself offer an explanation of how content can have an impact on context, a topic that much research has focussed on since the pioneering work on pronominal anaphora in Discourse Representation Theory, Dynamic Predicate Logic, and Situation Semantics (e.g. Kamp 1981, Heim 1982, Barwise 1985, and Groenendijk and Stokhof 1991b). Although ‘dynamic concerns’ are not a central part of the current work, we do provide a brief sketch of a dynamic view of how context evolves in a dialogue setting, based on the framework developed in Ginzburg 2001. We use this to develop a fairly detailed account of non-sentential utterances in Chapter 8. A novel and interesting feature of our account of ellipsis is that the dynamic effects involve both the semantic and syntactic levels. What gets projected into the context from an utterance comprises syntactic as well as semantic information.

### 3.6.1 Basic Setup

The content of a clause will always be some subtype of the semantic type *message*; an initial sketch of a hierarchy of semantic types is sketched in (149). As we will see shortly, this hierarchy can also be used to specify classes of abstract entities selected by predicates.



<sup>104</sup>Recent work in situation semantics (e.g. Cooper and Poesio 1994 and Ginzburg 1998) formalize meanings as abstracts (in a sense explained above in section 3.3.3), where entities abstracted away from content represent the contextual parameters. We abstract away from the differences between these two formalizations in the current work.

<sup>105</sup>For certain purposes—for instance, describing dialogue interaction—it is more convenient to set things up so that signs specify meanings, not contents (see, for example, Ginzburg 1998, 2001). We could implement such an account without significant complication.

*Message* is the semantic type that is the most basic to communication—its (maximal) subtypes constitute the descriptive contents of basic illocutionary acts such as assertion, querying, commanding, exclaiming and the like;<sup>106</sup> it is also the general semantic type of all finite clauses.

The type *message* has a variety of subtypes: one we postulated already in Chapter 2 is the type *austinian*. *austinian* has as its maximal subtypes *proposition* and *outcome*. These introduce two features, the feature *SIT*, whose value will be the situation involved in the relevant proposition or outcome, and the feature *SOA*. All SOAs, following P&S–94, will be treated in terms of feature structures that allow the features *QUANT(IFIER)S* and *NUCL(EUS)*, both of which are discussed further in Chapters 4 and 5. In addition, *i-soas* are specified for the feature *T(EMPORAL)-PARAM*, whose value corresponds to the temporal parameter of the *SOA*, which gets abstracted away. In concrete terms the value of *T-PARAM* is a parameter whose restriction is a temporal fact—a fact which restricts the (range of entities anchorable to) the parameter to be temporal.<sup>107</sup> We deviate somewhat from P&S–94 in locating the *CTXT* feature at the level of the *sign*, not *synsem*. Moreover, the *BCKGRD* feature will be assumed to be a non-local feature whose value is a set of facts rather than of propositions. Motivation for these changes is provided in Chapters 5 and 8 respectively; Chapter 8 contains additional discussion and refinement of the representation of context.

The other subtype of *message* is the type *prop(ositionally)-constr(ucted)*, so called because its maximal subtypes, *fact* and *question*, involve a proposition in their construction.<sup>108</sup> Concretely, both types introduce a feature *PROP*, whose value is a proposition. Recall that on our semantic theory questions are identified with proposition abstracts. Given this, the type *question* is also appropriate for a feature *PARAMS*, whose value will be a (possibly empty) set of parameters—restriction-bearing indices—corresponding to the set of entities that gets abstracted away. Extensive motivation for this view of the feature *PARAMS*, the *wh*-phrase analogue of *QUANTS*, will

<sup>106</sup> We should stress that the hierarchy presented here is still incomplete in its characterization of the semantic types which can serve as descriptive contents of (conventionalized) illocutionary acts. There clearly exist act-types whose descriptive content is neither a proposition, outcome, fact, or question. Apologies, for instance, can be argued to have an event or situation as their descriptive content. Similarly, calls—exemplified by *Jo!* (*A call from Batumi for you.*)—can be argued to involve a communicative agent as their descriptive content.

<sup>107</sup> Restriction-bearing indices are discussed in more detail in Chapter 4. We omit the restrictions when they are empty.

<sup>108</sup> Note that we have postulated a type *fact* and not a type *possibility*. In our semantic universe it is this latter which constitutes the more general sort, of which facts are a subclass; semantic arguments for this view of facts were given in e.g. (40). However, in developing the grammatical type system we restrict attention to facts since, as far as the grammar developed in the current work goes, the more general type does not seem to be required, e.g. there is no clause type which needs *possibility* rather than *fact*. It is certainly possible that once additional constructions or lexical items receive serious attention, one might need to modify this decision. To take one simple example, one might argue that a predicate such as *hope*, which subcategorizes for declarative clauses, does not select propositions. As (ii) and (iii) show, *hope* resists proposition-denoting nominals and free relatives headed by it cannot have truth/falsity predicated of them:

- (i) Bo hoped that Mo survived the yachting accident.
- (ii) #Bo hoped (for) the claim/hypothesis/forecast.
- (ii) #What Bo hoped (for) was true.

What these data suggest is that when *hope* embeds a(n indicative) declarative clause its semantic argument is not a proposition, nor given the nature of *hope* is it a fact. We leave open the issue of whether one can find additional evidence supporting the need for possibility as a type of denotation. If one did find such evidence, one could accommodate it, for instance, by postulating a supertype *possibility* which would subsume *fact* and a new type *unsubstantiated*.

be provided in Chapter 4.<sup>109</sup> The feature declarations just introduced are summarized in (150). ('IST' again indicates immediate supertype relations.)

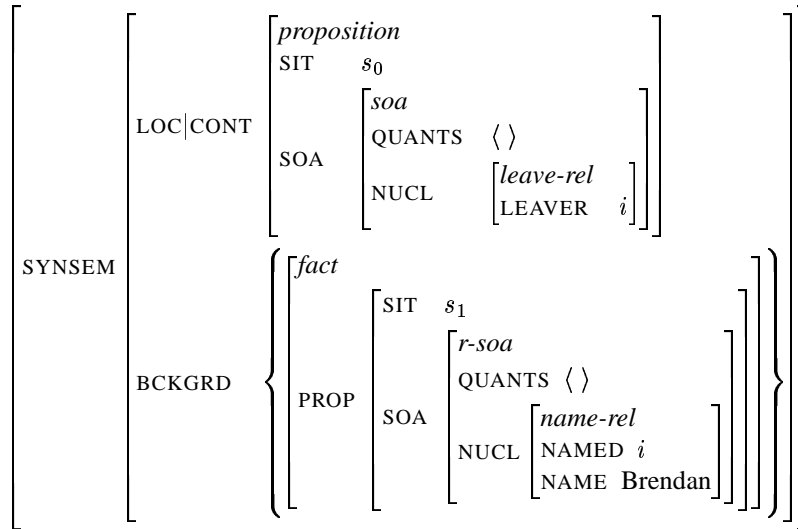
(150) Some Basic Semantic Types:

TYPE	FEATURES/VALUE TYPE	IST
<i>sem-obj</i>		
<i>message</i>		<i>sem-obj</i>
<i>austinian</i>	[SIT <i>situation</i> ] [SOA <i>soa</i> ]	<i>message</i>
<i>proposition</i>	[SOA <i>r-soa</i> ]	<i>austinian</i>
<i>outcome</i>	[SOA <i>i-soa</i> ]	<i>austinian</i>
<i>prop-constr</i>	[PROP <i>proposition</i> ]	<i>message</i>
<i>fact</i>		<i>prop-constr</i>
<i>question</i>	[PARAMS <i>set(param)</i> ]	<i>prop-constr</i>
<i>soa</i>	[QUANTS <i>list(quant-rel)</i> ] [NUCL <i>rel(ation)</i> ]	<i>sem-obj</i>
<i>r-soa</i>		<i>soa</i>
<i>i-soa</i>	[T-PARAM <i>param</i> ]	<i>soa</i>
<i>scope-obj</i>	[INDEX <i>index</i> ] [RESTR <i>set(fact)</i> ]	<i>sem-obj</i>
<i>quant-rel</i>		<i>scope-obj</i>
<i>param(eter)</i>		<i>scope-obj</i>

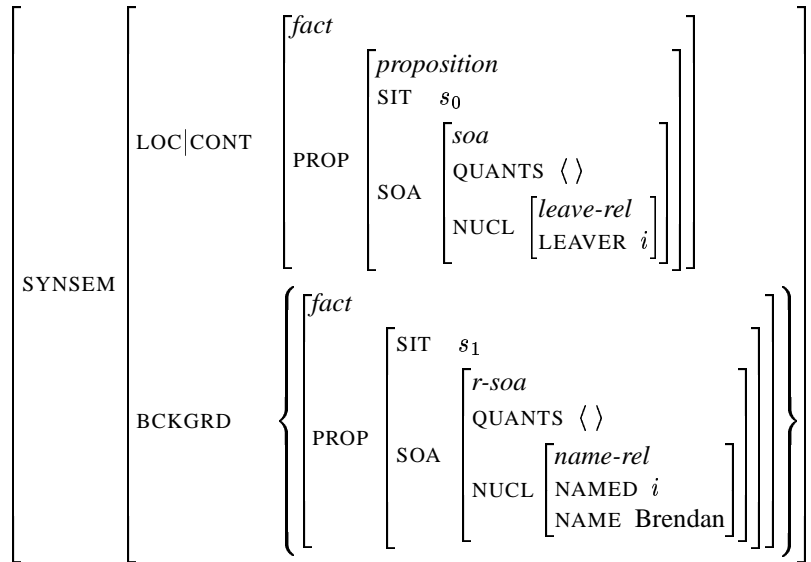
Recall from Chapter 2 that an instance of a specific type must bear an appropriate specification for all features specified as appropriate for that type, as well as for those features that are appropriate for each supertype of that type. Thus, in virtue of inheritance and the type hierarchy given in (150), we permit semantic objects like the following, which are the feature structure analogues of propositions, facts, outcomes, and questions discussed earlier.

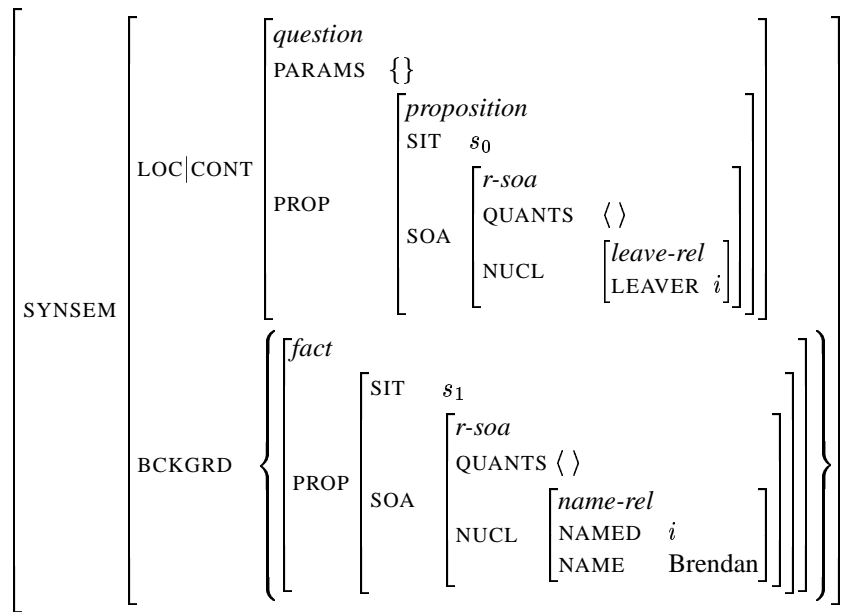
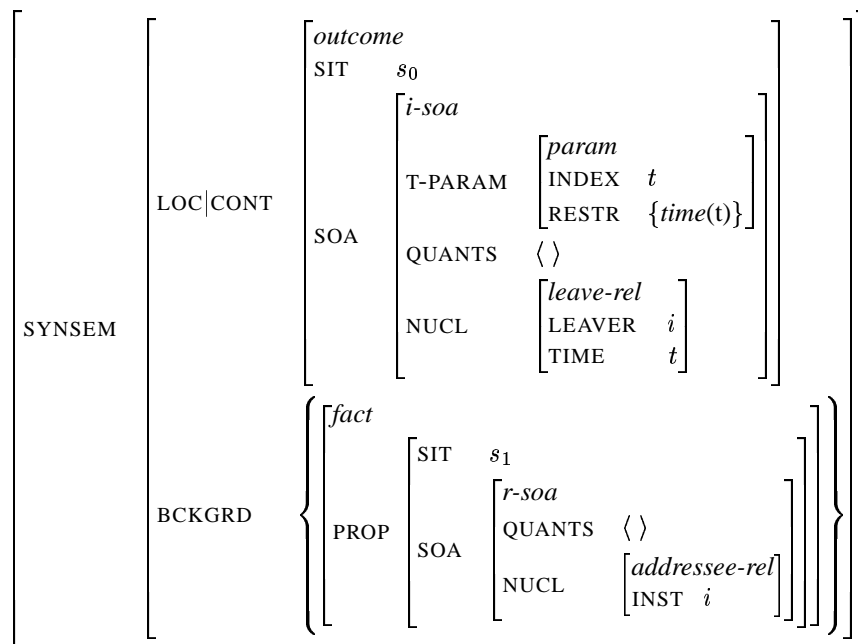
<sup>109</sup>Note that although the feature SIT is not appropriate for *fact* and *question*, tokens of these types *are* situationally relativized, the relativization emerging from the proposition serving as value of PROP.

(151) a. *Brendan left.*



b. *Brendan left.*



(152) a. *Did Brendan leave?*b. *Leave!*

In (152b) we employ an attribute T-PARAM, whose value is the parameter whose index is abstracted over within the outcome. Although one might base a treatment of tense on the assumption that all (temporally located) soas include a specification for this attribute, we will suppress any such specification here and in subsequent discussions, as it is not our intention to offer a

treatment of tense.

### 3.6.2 Interpreting Typed Feature Structures

In this section, we show how to define an interpretation function that maps type feature structures to elements of the semantic universe.<sup>110</sup> For the most part, the definition is straightforward and closely reflects our discussions in previous sections. The exceptions are the clauses for quantification, questions, and negation. These are included here primarily for the sake of completeness. The treatment of questions and quantification is explained in Chapter 4, whereas negation is discussed further in Chapter 8.

#### Definition 17 An Interpretation Function for TFSs

Let  $M = \langle SU+AE_0, I \rangle$  where  $SU+AE_0$  is a situational universe plus abstract entities, as outlined in section 3.4, and  $I$  is an interpretation function defined below.  $c$  is a context, specifying speaker, hearer, loc-utt, etc, as well as an assignment function  $c_f$  from indices to the universe of  $SU+AE_0$ . The BACKGROUND specifies a set of facts that must hold in  $c$ .

We define  $\llbracket a \rrbracket^c$ —the interpretation of  $a$  (a feature structure, feature, or type) with respect to a context  $c$ :

1. If  $a$  is a (subtype of the type) relation, then  $\llbracket a \rrbracket^c = I(a)$  and  $Rel(I(a))$ .

2. If  $a$  is a role feature, then  $\llbracket a \rrbracket^c = I(a)$  and  $ArgRole(I(a))$ .

3. If  $a$  is an index, then  $\llbracket a \rrbracket^c = c_f(a)$ , where  $c_f(a) \in |SU+AE_0|$ .

4. If  $a$  is of the form:

$$\begin{bmatrix} \rho \\ F_1 & v_1 \\ \dots \\ F_n & v_n \end{bmatrix},$$

where  $\rho$  is a subtype of relation,

then  $\llbracket a \rrbracket^c = \left\langle \left\langle \llbracket \rho \rrbracket^c; \llbracket F_1 \rrbracket^c: \llbracket v_1 \rrbracket^c, \dots, \llbracket F_n \rrbracket^c: \llbracket v_n \rrbracket^c \right\rangle \right\rangle$  (a SOA).

5. If  $a$  is of the form:

$$\begin{bmatrix} soa \\ QUANTS & \langle \rangle \\ NUCL & b \end{bmatrix}$$

then  $\llbracket a \rrbracket^c = \llbracket b \rrbracket^c$  and  $\mathbf{Pos}(\llbracket a \rrbracket^c)$ .

6. If  $a$  is of the form:

$$\begin{bmatrix} soa \\ QUANTS & \begin{bmatrix} \text{FIRST} & \text{not-rel} \\ \text{REST} & b \end{bmatrix} \\ NUCL & g \end{bmatrix}$$

then  $\llbracket a \rrbracket^c = \bar{h}$  (the dual of the SOA  $h$ ),

where  $h = \left[ \left[ \begin{bmatrix} soa \\ QUANTS & b \\ NUCL & g \end{bmatrix} \right]^c \right]$ .

<sup>110</sup>Here we follow the program for semantics outlined in Nerbonne 1992 and related work. Semantic interpretation is defined on totally well-typed and sort-resolved feature structures, not on feature structure descriptions.

7. 
$$\text{If } a \text{ is of the form: } \left[ \begin{array}{c} \text{soa} \\ \text{QUANTS} \left[ \begin{array}{c} \text{FIRST} \left[ \begin{array}{c} \delta \\ \text{IND} \quad i \\ \text{RESTR} \quad \Sigma \end{array} \right] \\ \text{REST} \quad b \end{array} \right] \\ \text{NUCL} \quad g \end{array} \right],$$

where  $\delta$  is a subtype of quant-rel,

then  $\llbracket a \rrbracket^c = \left\langle \left\langle \llbracket \delta \rrbracket^c; \lambda\{c_f(i)\} \llbracket \Sigma \rrbracket^c, \lambda\{c_f(i)\} \left[ \left[ \begin{array}{c} \text{soa} \\ \text{QUANTS} \quad b \\ \text{NUCL} \quad g \end{array} \right] \right]^c \right\rangle \right\rangle$ .

8. 
$$\text{If } a \text{ is of the form: } \left[ \begin{array}{c} \text{proposition} \\ \text{SIT} \quad s \\ \text{SOA} \quad \sigma \end{array} \right]$$

then  $\llbracket a \rrbracket^c = \text{prop}(\llbracket s \rrbracket^c, \llbracket \sigma \rrbracket^c)$ .

9. 
$$\text{If } a \text{ is of the form: } \left[ \begin{array}{c} \text{fact} \\ \text{PROP} \quad p \end{array} \right],$$

then  $\llbracket a \rrbracket^c = \text{poss}(\llbracket p \rrbracket^c)$  and  $\text{Fact}(\llbracket a \rrbracket^c)$ .

10. If  $a$  is a set of elements of type fact  
then  $\llbracket a \rrbracket^c = \text{poss}(p)$  and  $\text{Fact}(\llbracket a \rrbracket^c)$ ,  
where  $p = \bigwedge \{g \mid \exists h[h \in a \text{ and } \llbracket h \rrbracket^c = \text{poss}(g)]\}$ .

11. 
$$\text{If } a \text{ is of the form: } \left[ \begin{array}{c} \text{outcome} \\ \text{SIT} \quad s \\ \text{SOA} \quad b \left[ \begin{array}{c} \text{T-PAR} \\ \text{INDEX} \quad t \end{array} \right] \end{array} \right],$$

then  $\llbracket a \rrbracket^c = \text{out}(\llbracket s \rrbracket^c, \lambda\{c_f(t)\} \llbracket b \rrbracket^c)$ .

12. 
$$\text{If } a \text{ is of the form: } \left[ \begin{array}{c} \text{question} \\ \text{PARAMS} \quad \Sigma \\ \text{PROP} \quad b \end{array} \right]$$

then:  $\llbracket a \rrbracket^c = \lambda\{\text{indices}(\Sigma)\}[\text{facts}(\Sigma)] \llbracket b \rrbracket^c$  and  $\text{Question}(\llbracket a \rrbracket^c)$

where **indices** is the function that maps a set of parameters to the set of indices that it contains and **facts** is the function that maps set of parameters to the set of facts that it contains:

$$\text{indices}(\Sigma) =_{\text{def}} \{i \mid \exists p[p \in \Sigma \text{ and } \text{INDEX}(p) = x \text{ and } i = c_f(x)]\}$$

$$\text{facts}(\Sigma) =_{\text{def}} \bigcup \{F \mid \exists p, g[p \in \Sigma \text{ and } \text{RESTR}(p) = g \text{ and } F = \llbracket g \rrbracket^c]\}$$

### 3.6.3 Semantic Universals: selection and clause denotations

We turn finally to two fundamental issues for a semantic framework. The first concerns the description of semantic categories for purposes of semantic selection; the second involves capturing what appear to be semantic universals concerning clausal denotations and selectional properties of predicates. Let us take these points in turn.

As far as we are aware, previous work has not attempted to provide a comprehensive system of semantic categories which would partition the class of clausal embedding predicates according to their selectional requirements.<sup>111</sup> The type distinctions introduced in Montague Semantics, for instance between propositions and questions, provide a starting point for such a system. However, as we have argued in detail in section 3.2, one needs a significantly more refined ontology than Montague Semantics provides. We have motivated the existence of four distinct abstract entity semantic types that clauses can take as their denotation type: questions (q), facts (f), outcomes (o), and propositions (p). Our argumentation rested, in part, on exhibiting classes of predicates that select for one of these semantic types. This provides an additional step toward the development of a system of semantic categories for clausal embedding predicates. Indeed, it raises the issue of what additional, more complex categories exist ('complex' in the sense that they involve entities of more than one class—selection for both facts and propositions, or for both questions and outcomes, etc.). The table in (153) below suggests that such complex categories do exist:<sup>112</sup> these include the resolutive predicates, which select for facts and propositions; decidative predicates, which select for questions and outcomes; and predicates such as *intrigue*, which appears to select for questions, facts, and outcomes.<sup>113</sup> And yet, it is also apparent that not all logically possible categories are instantiated: of the 15 logically possible categories,<sup>114</sup> there is convincing evidence for the existence of 8 classes.

We must leave as an important task for future work—supported by cross-linguistic and corpora-based investigation—a formal characterization of the space of instantiated categories. We hypothesize that the basic ingredients for this characterization will be the (types of) entities we have postulated in our ontology. Note that this will have to involve not solely the four abstract entity semantic types discussed above. For instance, in order to distinguish emotives from other factives one apparently needs to consider event/situation-denoting expressions.<sup>115</sup>

<sup>111</sup>Though there do exist many useful, though not formally grounded, partial categorizations. See, for example, Vendler 1972, Karttunen 1977, and Grimshaw 1979.

<sup>112</sup>This table was compiled on the basis of casual introspection, not on the basis of a corpus study. Given this, our conclusions must be viewed as tentative.

<sup>113</sup>The data regarding this class, specifically whether it actually selects for outcomes is quite subtle and apparently liable to variation across speakers. In the table, we provide what seems to be a relatively acceptable *for*-clause complement. We find similar examples with subjunctives less acceptable:

(i) #It astounded me that Bo be promoted while we remain on 4 shillings a week.

This might suggest that this class actually does not select for outcomes but rather for the type *prop-constr*, which at present remains uninstantiated.

<sup>114</sup>The remaining category involves those predicates that select for none of the 4 abstract entities.

<sup>115</sup>Thus, a 'pure' factive such as *discover* and an emotive such as *regret* differ in their ability to license event-denoting nominals:

(i) Bo regrets/#discovered Mo's departure

A similarly bifurcation affects the class of resolutives:

(ii) Bo announced/#told me Mo's departure

For additional data from Modern Greek bearing on this issue see Ginzburg and Kolliakou 1998.

(153)	Name of class	Repr. members	Evidence	Type selected
	<b>+q</b> (QE predicates)	<i>ask, wonder</i> <i>investigate</i>	section 3.2.1	<i>question</i>
	<b>+p</b> (TF predicates)	<i>believe, deny</i> <i>prove</i>	section 3.2.2	<i>proposition</i>
	<b>+f</b> (factives)	<i>know, discover</i> <i>forget</i>	section 3.2.3	<i>fact</i>
	<b>+o</b> (mandatives)	<i>demand, require</i> <i>want</i>	section 3.2.4	<i>outcome</i>
	<b>+q,+p</b>	??	??	—
	<b>+o,+f</b>	??	??	—
	<b>+o,+p</b>	<i>be-conceivable</i> <i>be-reasonable</i>	It is conceivable: that Bo arrived safely that Bo be promoted soon #whether Bo is promoted #That fact is conceivable	<i>austinian</i>
	<b>+p,+f</b> (resolutives)	<i>tell, guess</i> <i>predict</i>	What Bo told me was false Bo told me: an interesting fact who left #that Mo be promoted #Mo's departure #a question	?
	<b>+q,+f</b>	??	??	<i>prop-constr</i>
	<b>+q,+o</b> (decidatives)	<i>be-resolved</i> <i>decided</i>	The question was who to fire The issue is resolved/decided; So: it was resolved who to fire It was resolved that Billie be fired #The fact is resolved; #The claim is resolved #It is resolved that Billie left	?
	<b>+q,+f,+o</b>	<i>intrigue, astound</i>	examples (33) above; For Bo to get the job would astound me	?
	<b>+q,+f,+o</b>	??	??	—
	<b>+o,+p,+f</b>	??	??	—
	<b>+o,+p,+q</b>	??	??	—
	<b>+f,+p,+q</b>	??	??	—

As we have shown in the course of this chapter, there exist various general patterns concerning subcategorization by clause-embedding predicates. We conjecture that, with possible minor riders—e.g. *in a language with a CN corresponding to 'fact', 'question'*—the following are universal:

1. There are no subjunctive interrogatives (in English).<sup>116</sup>
2. TF predicates do not cooccur with interrogatives or exclamatives.
3. QE predicates cooccur with interrogatives and question nominals.
4. Factives cooccur with declaratives, interrogatives, exclamatives and fact nominals.

The generalization about the lack of subjunctive interrogatives is captured within our system in virtue of the fact that questions are proposition abstracts and, hence, contain an *r-soa* as a constituent. Attempting to build a question out of a subjunctive will fail since the non-finite verb that heads it denotes an *i-soa*. The generalization about TF predicates follows because selection in our system is partly semantic: all TF predicates select for propositions, which neither interrogative nor exclamative clauses denote (see Chapter 6). The generalizations about QE predicates and factives are explained in Chapter 8. These are accounted for via a combination of semantic selection and the denotations we associate with various clause types.

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<sup>116</sup>In this case some additional care is needed in pinning down the category *subjunctive*. Roughly, we might link this with the clause type subcategorized for by mandative predicates which is distinct from (indicative) declarative, assuming such exists.