

8 Anaphora in Intensional Contexts

CRAIGE ROBERTS

Introduction¹

In the semantic literature, there is a class of examples involving anaphora in intensional contexts, i.e. under the scope of modal operators or propositional attitude predicates, which display anaphoric relations that appear at first glance to violate otherwise well-supported generalizations about operator scope and anaphoric potential. In Section 1, I will illustrate this phenomenon, which, for reasons that should become clear below, I call **modal subordination**; I will develop a general schema for its identification, and show how it poses problems for most theories of scope and anaphoric relations. In Section 2, I will review the main approaches which have been considered in attempting to account for modal subordination and argue that only an approach involving accommodation can account for the full range of examples. The notion of **accommodation** is due to Lewis, who defines it as follows:

If at time t something is said that requires presupposition P to be acceptable, and if P is not presupposed just before t , then - *ceteris paribus* and within certain limits - presupposition P comes into existence at t . (Lewis 1979: 340)

The interesting question, of course, is what the limits on accommodation might be. I believe that the proper account of modal subordination has something to say about this. I will argue this briefly in section 3, where I draw some conclusions and also sketch some problems for further research.

1 The Phenomenon of Modal Subordination

We have come to understand quite a bit about the way that anaphora works in discourse and about its relationship to semantic phenomena such as the

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scopes of quantificational elements. Consider the relation of **anaphoric accessibility** between NPs, where NP *x* is anaphorically accessible to a definite NP *y* (e.g. a pronoun) iff *x* is a potential antecedent for *y* in the discourse in question. The following descriptive generalizations seem quite robust:

Scope constraint on anaphoric relations: If NP *x* is anaphorically accessible to NP *y*, then any quantificational elements which have scope over *x* have scope over *y* as well.

Sentential scope constraint: The maximal scope of a quantificational element is the sentence in which it occurs.

If we ignore definite and indefinite NPs,² these generalizations follow straightforwardly from several formal theories of discourse interpretation developed recently (e.g. those of Kamp (1981), Heim (1982), Barwise (1987), Rooth (1987), and Groenendijk & Stokhof (1990a) – see references and relevant articles in this volume), under fairly standard assumptions about the relationship between anaphora and binding, and between binding and scope. Their combined effects are illustrated by (1)–(3), with anaphoric relations indicated by underlining:

- (1) Every frog that saw an insect ate it.
#It was a fly.
- (2) Usually Fred buys a muffin every morning and eats it at the office.
#It's being baked.
- (3) You should buy a lottery ticket and put it in a safe place.
#It's worth a million dollars.

In each, there is an indefinite NP with scope under a quantificational element (the quantificational determiner, adverb of quantification, or modal in bold face). The NP is anaphorically accessible only to the first of two pronouns, the one which is also under the scope of the quantificational element, and not to the second pronoun, which is outside that scope under the assumption that quantifier scope is sentence-bounded. Because the second sentence in each discourse contains a pronoun with no potential antecedent, the sentence is uninterpretable and hence infelicitous, as indicated by the “#” sign.

Often in natural language discourse, however, we find *prima facie* counterexamples to the scope constraint, as illustrated by (1')–(3'):

- (1') Every frog that saw an insect ate it.
It disappeared forever.
- (2') Usually Fred buys a muffin every morning and eats it at the office.
It's always oat bran.
- (3') You should buy a lottery ticket and put it in a safe place.
It might be worth a million dollars (if you were lucky).

These discourses and many others like them are perfectly acceptable to most speakers, despite the apparent anaphoric relation between a pronoun in the second sentence and an indefinite NP which is under the scope of the boldface quantificational element in the first. One might attempt to account for their acceptability, while retaining classical assumptions about anaphora and binding, by revising the assumption that scope is sentence-bound (see Groenendijk & Stokhof (1990a), Dekker (1993b)). This would be compatible with the observation that in (1')–(3'), each of the second sentences itself seems to be a generalization – over frog-eaten insects, occasions when Fred buys a muffin, or possible lottery tickets, whereas in (1)–(3), the infelicitous second sentences appear to give information about specific entities on specific occasions. But there are two problems with this approach. First, this would leave us without an account of the unacceptability of (1)–(3); from the perspective of the generative tradition, which aims to generate all and *only* the acceptable structures at some level of linguistic analysis, this would be unacceptable. Second, this would yield incorrect truth conditions for many of the relevant examples. E.g. for (2'), we want to derive a reading where on most relevant occasions Fred buys a muffin and on every occasion where Fred buys a muffin, it's oat bran; i.e. the scopes of the two adverbs of quantification are independent of each other. Merely extending the scope of the first adverb of quantification would lead instead to a reading where *always* would have narrow scope with respect to *usually*, resulting in weaker truth conditions than desired and leaving it unclear how to restrict the domain of *always*. Similarly, in (3'), we get a reading where the hearer is instructed that ideally he would buy a lottery ticket and that if he bought one (and was lucky), there's a possibility that it would be valuable. Again, merely extending the scope of *should* would yield a strange reading where it takes wide scope over *might*, so that the possibility would be part of what was claimed to be deontically ideal.

There is a closely related phenomenon involving propositional attitude verbs and “world-creating” predicates more generally (see Baker (1966), Lakoff (1972), Jackendoff (1972), Montague (1973), Morgan (1973), Karttunen (1974), McCawley (1981), and Heim (1992) for earlier discussions of relevant examples). Consider the following:

- (4) Jan expected to get a new puppy soon.
She intended to keep it in her back yard.
- (5) John wants to catch a fish.
He plans to eat it for supper.
- (6) Alice fears there's a squirrel in her kitchen cabinets.
She hopes to trap it alive and turn it loose outside.

In these examples, on the readings of interest, the indefinite NP which is the apparent antecedent of the pronoun has a *de dicto* reading; e.g. in (5) there is no specific fish that John wants to catch. Hence, as in (1')–(3'), we need to explain how the indefinite can both have narrow scope with respect to the

intensional predicate in its main clause, and yet apparently serve as antecedent for a pronoun in subsequent discourse. This is obviously facilitated in (4)–(6) by the presence of another intensional predicate in the second sentence. But note that not all pairs of sentences with predicates that take sentential complements license the anaphoric phenomenon in question. Montague (1973) noted that unlike (7a), which has a *de dicto* reading, (7b) does not:

- (7a) John tries to find a unicorn and wishes to eat it.
 (7b) #John wishes to find a unicorn and tries to eat it.

And Lakoff (1972) notes the following pair:

- (8a) You are required to find a bear and permitted to take its picture.
 (8b) #You are permitted to find a bear and required to take its picture.

As in (7b) and (8b), all the following examples are infelicitous on the *de dicto* readings of the underlined indefinites:

- (9) Jan expected to get a puppy.
 ?#She managed to housebreak it quickly.
 (10) Alice denies that there's a squirrel in her kitchen cabinets.
 #She hopes to trap it alive and turn it loose outside.

Finally, as McCawley (1981) points out, the problem with these examples is related to that found in Geach's (1967) statements of "intentional identity", such as:

- (11) Hob thinks a witch has blighted Bob's mare, and Nob wonders whether she (the same witch) killed Cob's sow.

Again, the interpretation of interest here is one where the speaker does not commit his/herself to the existence of a witch; both the indefinite and the pronoun/definite description are interpreted *de dicto*, as in the cases we've already examined. Since the definite NP and its antecedent do not occur under the scope of the same opacifying predicate, the latter cannot bind the former. Further, as Edelberg (1986) points out, in order for (11) to be true, Nob needn't know anything about Hob or about Bob's mare; e.g. they might both reside in a community whose newspaper has reported the presence of a witch on a destructive rampage. Hence, the example can't be readily explained by treating *she* in the second conjunct as a pronoun of laziness meaning something like *the witch that blighted Bob's mare, or the witch that Hob thinks blighted Bob's mare*.³

It should now be clear why this problem is framed as a question about anaphora in intensional contexts. All the felicitous examples except (1') involve either a modal, an opacifying predicate, or an adverb of quantification

in the second sentence. Following Kripke (1959), Hintikka (1969), and Montague (1973), both modality and opacifying predicates are analyzed semantically as involving quantification over possible worlds. More recently (following Barwise & Perry (1983), Kratzer (1989)) they have been analyzed as quantifying over possible situations, with situations viewed either as concrete entities replacing possible worlds (Barwise & Perry (1983)), or as partial possible worlds (Kratzer (1989b)). Also in recent literature (see the line of development from Lewis (1975) through Barwise & Perry (1983), Kratzer (1989b), Berman (1987), and de Swart (1991)), quantificational adverbs have been analyzed involving quantification over situations, effecting a unification with the semantics of modals and propositional attitudes. Example (1'), illustrating what I elsewhere (Roberts 1987, 1989) called *telescoping*, may be amenable to a similar treatment, where we analyze the second sentence as containing an implicit adverb of quantification with universal force, ranging over the relevant minimal situations, each one containing a single frog and the insect it ate. (But see Poesio & Zucchi (1992) for another view of this phenomenon.)

Roberts (1987) called the phenomenon illustrated by examples like (3') and (13) "modal subordination" because the material under the scope of the modal in the second sentence is semantically subordinate to irrealis propositions considered in previous discourse.

Here I will generalize the term to cover the cases involving intensional predicates, as well. I retain the term *modal subordination* under the common assumption that intensional phenomena in natural language generally involve modality at some level of analysis. Should that prove to be problematic, one might re-name the phenomenon which is illustrated by the examples above *intensional subordination*.

Modal subordination arises not only with anaphora, but with various pre-suppositional elements, as well:

- (12) Usually Fred buys a muffin every morning and eats it at the office.
 He buys [a cup of coffee]_{IF}, too.
 (13) Maxine **should** become a carpenter.
 Her friends **would** discover she could build things, and she'd be very popular on weekends.
 (14) Mary is **considering** getting her Ph.D. in linguistics.
 She **wouldn't** regret attending graduate school.

In each of these examples, the underlined constituent in the second sentence carries a presupposition which, in the discourses in question, is only satisfied by material which is under the scope of the quantificational element or predicate in boldface in the first sentence. Following Heim (1992), in (12) *too* presupposes that it is known by the interlocutors that there is some salient entity which could replace the property denoted by the focused constituent *a cup of coffee* while preserving truth, i.e. there is something else which the interlocutors already know that Fred buys. Further, the bare present tense with a

non-stative verb is interpreted as the generic mood, in recent literature often formalized with an adverbial operator (see Carlson (1977), Wilkinson (1991)). In (13), *discover* presupposes the truth of its complement. But, under the assumption that Maxine isn't already skilled as a carpenter, this presupposition is only satisfied in those deontically ideal worlds where she becomes one, verifying the proposition introduced under the scope of *should* in the previous sentence. The modal auxiliary *would* will have to range over such worlds in which that proposition, that Maxine is a carpenter, is true, in order to satisfy the factive presupposition of *discover*. *Regret* is similarly factive; in (14) it is under the scope of a modal, but (assuming Mary hasn't yet gone to graduate school) its presupposition is only satisfied in those worlds which realize what she is considering, introduced by the previous sentence. Such examples could be multiplied indefinitely, with various combinations of modal auxiliaries and intensional verbs. These presuppositional parallels with the earlier anaphoric examples support the analysis of anaphora as essentially presuppositional, as argued e.g. by Heim (1982).⁴ Hence, a more appropriate title for this paper might be "Presupposition satisfaction in intensional contexts". But for simplicity I will focus on the examples involving anaphora.

The schema in (15) captures the general logical form of examples displaying modal subordination, while that in (16) gives the anaphoric sub-type:

(15) operator_[s ... π ...]
operator_{[intensional]_[s ... presupposition of π ...]}

(16) operator_[s ... NP_x ...]
[-def]

operator<sub>[intensional]_[s ... NP_x ...]
[+def]</sub>

In each discourse there are two sentences, each containing a wide scope operator. In the second sentence, the operator is intensional – the operator logically associated with a propositional attitude predicate, a modal auxiliary, or an adverb of quantification, ranging over situations – though this operator is sometimes implicit, as in (1') and (12). In the general case, some element π under the scope of the operator in the first sentence is presupposed by an element which has narrow scope under the intensional operator in the second sentence. In the sub-case of interest, the presupposition is one of the familiarity of some entity introduced by an indefinite NP_x in the first sentence; i.e. there is an anaphoric relationship to an NP which is inaccessible under the scope constraint on anaphoric relations and the sentential scope constraint.

Note that the operator in the first sentence needn't be intensional, as we see in (17), where it is an auxiliary negation:

(17) John doesn't have a car.
It would be in the garage.

The felicitous reading of the second sentence of (17) might be paraphrased "if John had a car, it would be in the garage."

Finally, note that the schemas in (15) and (16) are logical forms – it is the indicated interpretation which characterizes modal subordination, and not mere surface form. Consider (18):

(18) Since he saved his money last summer, John could buy a car.
He should sell it, if he needs money now.

(18) is superficially similar to the examples in (3') and (13). However, the interpretation which most speakers appear to get for the second sentence presupposes that John did, in fact, buy a car. That is, (18) means "John could buy a car, and hence he did, and now if he needs money he should sell the car he bought", instead of the modally subordinate "John could buy a car; if he did buy a car and he needs money now, he should sell it", where the purchase is purely hypothetical.⁵

Modal subordination forces us to reconsider the otherwise robust scope principles – the scope constraint on anaphoric relations and the sentential scope constraint. Either these must be revised to permit binding across sentences, or if they are to be maintained, an account must be developed for the anaphora in modal subordination which does not involve a direct anaphoric relation between the apparent antecedent and the pronoun or other definite. Merely extending the scope of the first operator in the schema in (16) does not yield the correct truth conditions in all examples, as in (2') above. So the challenge is to find some other way of accounting for the anaphoric relations in question.

2 Analysis of the Phenomenon

The foundation of the account I will give here is an account of the semantics of modality which follows from the work of Kratzer (1977, 1981) and Veltman (1984). Modal elements are notoriously vague semantically, and seem to admit a variety of kinds of interpretations – e.g. epistemic, deontic, alethic, dynamic, etc. The latter has often led to the assumption that modals are multiply ambiguous, leading to a rather large number of lexical entries for a given modal, with the intuitive relations between them left unexplained. Kratzer and Veltman explain the variety without lexical ambiguity, while accounting for vagueness, by assuming that in any given context the domain of a modal operator is pragmatically restricted by a set of "premises" – contextually relevant and salient propositions. For example, the interpretation of *must* which is traditionally called epistemic would be relative to the set of propositions which some salient person, perhaps the speaker, believed to be true; whereas the deontic interpretation would be constrained by propositions reflecting the actual

circumstances (see Thomason (1981)) as well as those reflecting what some authority deems should be the case given those circumstances.

Kratzer (1981) calls the function which pragmatically retrieves these sets of premises for a given modal in a given context of utterance its **modal base**.⁶ The modal base is a function from worlds (or situations) to sets of propositions, where a proposition is a set of worlds (or situations). We can relate the premises given by the modal base for a given world of evaluation to the modal accessibility relations of modal logic, which determine which worlds or situations a modal operator will range over. Given a modal accessibility relation R , the truth of *must* ϕ depends on the truth of ϕ in all those worlds accessible to the world of evaluation under R . Since *must* has universal force, *must* ϕ is true in w relative to R iff for all w' such that $\langle w, w' \rangle \in R$, ϕ is true in w' . A modal base f is a function from worlds to sets of propositions. We can characterize R as relating any world w to a set of worlds where the premises assigned to w by its (contextually-given) modal base f are all true: $R \subseteq W \times W$ such that for all $w, w' \in W$, $\langle w, w' \rangle \in R$ iff $w' \in \cap f(w)$. Since a proposition is a set of worlds, those where the proposition is true, the intersection of a set of propositions is itself a set of worlds – all those worlds where all the propositions in the set are true; so $\cap f(w)$ is the set of worlds where all the propositions assigned to w by the modal base f are true. Given these definitions, modal bases, like accessibility relations, effectively restrict the domain of a modal operator. Different contexts in which a modal is used yield different modal bases, and the different ways in which different modal bases restrict the domain of the operator yield different “readings” of the modal, which itself, however, is unambiguous. Now we can capture the notion of a “deontic” reading of a given modal in terms of a certain class of modal bases which may be used to restrict it – those which yield, for any world w , the set of propositions which characterize what an individual is obligated or permitted to do in w , according to some authority. Similarly, there are no “epistemic” modals, but only epistemic modal bases – those which characterize what some individual or group of individuals believe in any given world. And we can put constraints on the type of modal bases compatible with a given modal auxiliary, as a way of capturing the types of “readings” (deontic, epistemic, etc.) which that auxiliary can have.

Modal bases are given pragmatically, retrieved by hearers on the basis of contextual clues and knowledge of the world. Technically, they are accommodated. The speaker, in uttering a sentence containing a modal, presupposes a certain modal base – deontic, epistemic, etc. – and assumes that s/he has given the hearer adequate clues to retrieve it.

In order to correctly interpret the utterance, the hearer must accommodate the speaker by assuming the modal base which is presumably intended.

Roberts (1987, 1989) argued that in modal subordination, with reference to a logical form like (16) above, a proposition suggested by the first sentence (specifically, by all or part of the material under the scope of the first operator in (16)) serves as at least one of the premises which restrict the domain of the

intensional operator in the second sentence, i.e. is in the set of propositions given by the modal base for the world of evaluation. Consider again (3'):

- (3') You should buy a lottery ticket and put it in a safe place.
It might be worth a million dollars.

It is intuitively obvious that the modal *might* is restricted by the proposition that the hearer buys a lottery ticket. Kratzer (1981) argues that a conditional *if*-clause specifies one of the premises used to relativize the domain of a modal in the main clause which it modifies, i.e. one of the propositions in the set $f(w)$, the modal base for the world of interpretation w . This predicts that we can paraphrase the obvious interpretation of (3') as (3''), which seems correct:

- (3'') You should buy a lottery ticket and put it in a safe place.
If you bought a lottery ticket, it might be worth a million dollars.

Since *might* only ranges over worlds (or situations) in which the restricting proposition “you buy a lottery ticket” is true, i.e. worlds where the interlocutors know that there is a lottery ticket purchased by the hearer, the familiarity presupposition associated with the pronoun *it* in the second sentence, is satisfied. But the relation between the underlined indefinite NP and pronoun in (3') and other examples of modal subordination is only indirect – it is the proposition which restricts the domain of the modal that satisfies the familiarity presupposition of the pronoun, and not directly the indefinite NP or the proposition to which it contributes.

This illustrates another sense in which assumption of a modal base involves accommodation: Given a world (or situation) of interpretation w , the modal base applied to w yields a set of propositions, say $\{p, q, \dots\}$. Each of those propositions restricts the domain of the relevant modal. We can say, then, that each of these propositions has been *locally accommodated*, in the sense defined by Heim (1983), i.e. it hasn't been accommodated as an asserted proposition, but only under the scope of an operator, here the modal. So in (3'), we can say that the proposition ‘the hearer buys a lottery ticket’ is locally accommodated to serve as part of the domain restriction on the modal *might*.

Along the lines just sketched for (3') and (3''), we might readily paraphrase the most likely reading of (2') as (2''), and that of (6) as (6'):

- (2') Usually Fred buys a muffin every morning and eats it at the office.
It's always oat bran.
(2'') Usually Fred buys a muffin every morning and eats it at the office.
When he buys a muffin, it's always oat bran.
(6) Alice fears there's a squirrel in her kitchen cabinets.
She hopes to trap it alive and turn it loose outside.
(6') Alice fears there's a squirrel in her kitchen cabinets.

Assuming there is a squirrel in her kitchen cabinets, she hopes to trap it alive and turn it loose outside.

On independent grounds, temporal adverbial clauses like that in (2') and free adjuncts like that in (6') have been argued to serve as domain restrictions on operators in the main clause to which they adjoin (e.g. see Stump (1985)). The fact that these paraphrases seem to adequately capture the most obvious interpretations of (2') and (6) supports a domain restriction account of modal subordination.

Given the basic plausibility of such an account, the question which arises is what factors govern this relativization of the domain of the second intensional operator to a proposition suggested by the first sentence. We argued in Section 1 that it cannot in general be a question of extending the scope of the operator in the first sentence. Further, adjacency of the sentences containing these operators isn't necessary, as illustrated by (19) (due to Louise McNally (personal communication)):

- (19a) You should buy a lottery ticket and put it in a safe place.
 (19b) You're a person with good luck.
 (19c) It might be worth a million dollars.

(19c) is modally subordinate to (19a); this corresponds to the intuitively correct paraphrase in (19c'):

- (19c') If you buy a lottery ticket, it might be worth a million dollars.

But (19b) is factual, so that there is no local adjacency in the irrealis mood associated with the general phenomenon of modal subordination schematized in (15). Hence, the explanation doesn't seem to lie in facts about the local structure of discourse, e.g. licensing a local extension of irrealis mood.

Two types of accounts appear to have the greatest explanatory potential, an entailment-based, and hence semantic account, and one which crucially incorporates pragmatic processes, specifically accommodation. Semantic accounts for some of the types of examples outlined above have been offered by Lakoff (1972), Karttunen (1974), McCawley (1981), and Heim (1992), while Roberts (1987, 1989) offered an account which essentially involves accommodation.⁷ I will argue that a purely semantic account is inadequate. However, the two types of accounts aren't really incompatible; assuming that entailment plays a role in licensing the anaphora in some examples does not preclude the necessity of using accommodation in many others. And in fact both have something to offer to our understanding of modal subordination; the lexical entailments of predicates naturally interact with other, contextual factors to constrain the accommodation that is possible in a given example.

The semantic accounts involve explaining both felicitous and infelicitous examples in terms of entailments. For example, Lakoff (1972) and McCawley

(1981) argue that in examples along the lines of (8a) and (4), repeated below, there are logical relations between the two intensional predicates in question (in boldface) which entail the possibility of the highlighted anaphoric relations (underlined NPs). They argue that cases where there is no such entailment fail to support the anaphoric relation, as in (8b). Or there may even be some aspect of the meaning of one of the predicates which precludes the necessary accessibility relation, as in (9) or (10).

- (8a) You are **required** to find a bear and **permitted** to take its picture.
 (8b) #You are **permitted** to find a bear and **required** to take its picture.
 (4) Jan **expected** to get a new puppy soon.
 She **intended** to keep it in her back yard.
 (9) Jan **expected** to get a puppy.
 #She **managed** to housebreak it quickly.
 (10) Alice **denies** that there's a squirrel in her kitchen cabinets.
 #She **hopes** to trap it alive and turn it loose outside.

According to Lakoff, if x requires y to S , this entails that x permits y to S , but the converse does not hold. Hence, in a possible worlds semantics, anything which the speaker requires the hearer to do, such as find a bear, will be true in any world realizing the speaker's permissions to the hearer, but not vice versa. In (8a), this means that in all the speaker's permission worlds, there will be a bear that the hearer found, which then becomes the permitted object of a photo. But in (8b), it is not the case that all the worlds realizing the speaker's requirements are entailed to contain a bear; hence, the example is infelicitous.⁸ With respect to (4), note that our intentions are generally contingent on our expectations about how things will be in the future. Hence, that Jan expects to get a new puppy entails that in all worlds which realize her expectations there is a puppy that Jan owns. These are the worlds which are accessible to her intentions, so that the guarantee of the existence of the puppy licenses the anaphora – i.e. the latter relation is based on a semantic relation of entailment between the embedding predicates.

McCawley bases his account of examples like (9) on the fact that the predicate *manage* is implicative, in the sense of Karttunen (1971). I believe the following retains the basic form of McCawley's argument, while assuming the terminology and assumptions about anaphora of Karttunen (1973), Stalnaker (1979) and Heim (1982, 1983). Among other things, *manage* entails the truth of its complement sentence, and is a hole to presuppositions. Hence, in a theory of presuppositions along the lines of Stalnaker and Karttunen as extended by Heim, its felicitous use requires the satisfaction of the presuppositions of its complement in the common ground of the interlocutors of the conversation. But the first sentence in (9) does not entail that there is a puppy, or that the interlocutors expected a puppy, only that Jan did, and hence does not satisfy the anaphoric presupposition of the pronoun.

With respect to (10), the accessibility relation for the second predicate, *hope*,

is given by the beliefs of the subject, Alice. But, per McCawley's (1981:337) discussion of these verbs, the first sentence entails that Alice does not believe in the existence of a squirrel in her kitchen cabinets.⁹ So instead of an entailment relation to license the anaphoric relation to the pronouns in the complement of *hope*, there is one which precludes it. This contrasts with (6), where one's fears entail one's near-belief, which appears to be sufficient grounds for hope.

- (6) Alice fears there's a squirrel in her kitchen cabinets.
She hopes to trap it alive and turn it loose outside.

Karttunen (1974) grounds his account of examples involving propositional attitudes in a generalization which Heim (1992) paraphrases as follows:

- (20) If ζ is a verb of propositional attitude, then a context c satisfies the presuppositions of " $\alpha \zeta \phi$ " only if $B_\alpha(c)$ satisfies the presuppositions of ϕ , where " $B_\alpha(c)$ " stands for the set of beliefs attributed to α in c .

Given that a set of (believed) propositions satisfies the presupposition of a proposition π iff the set entails π , then this is an entailment-based account of examples involving the attitudes. In a refinement of Karttunen's approach, Heim (1992) presents a detailed examination of examples involving a small set of propositional attitude verbs: *believe*, *want*, *wish*, *intend*, and *be glad that*. Given the presupposition projection properties of these predicates, she develops an account within the framework of context change semantics of how in examples like (21) the presupposition in the second conjunct is filtered by entailments of the first conjunct:

- (21) John believes that Mary is coming, and he wants Susan to come too.

She makes the assumption that, like modals, intensional predicates have modal bases conventionally given as part of their lexical meaning. E.g. consider the meaning of *want*. Let us call the set of all worlds where all the propositions that some individual α believes to be true are true, α 's doxastic alternatives. If we relativize belief to a world of evaluation w (under the reasonable assumption that someone might have different beliefs in different worlds), then α 's doxastic alternatives relative to w are the set of propositions given by a doxastic modal base for α for the argument w . The meaning of *want* is a relation between individuals (possible denotations of the subject) and propositions (possible denotations of the sentential complement) which holds (in a given world w) just in case all the subject's doxastic alternatives (relative to w) where the complement is true are more desirable to the subject than those doxastic alternatives where the complement is false. The doxastic alternatives

in effect provide a local context for the interpretation of *want*, and hence the presuppositions of the complement of *want* must be entailed by the doxastic alternatives. In an example like (21), the first conjunct tells the interlocutors that in all of John's doxastic alternatives Mary is coming. These alternatives then entail the presupposition of the *want* complement, which is that someone besides Susan is coming. Hence, via the lexical semantics of *want*, the first conjunct entails the presuppositions of the second conjunct, satisfying Karttunen's generalization. Though Heim does not adopt Karttunen's (20) for all propositional attitude predicates, her account of the other predicates she considers is also entailment-based, and like Lakoff and McCawley, she assumes that lack of entailment generally leads to infelicity. E.g. along with Karttunen, she predicts that it isn't felicitous to interchange the order of *believe* and *want* in examples like (21). Consider (21'), where the order has been changed, as well as (22)/(22'), which are anaphoric counterparts of (21)/(21'):

- (21') #John wants Mary to come, although he believes that Susan is going to come too.
(22) Patrick believes I'm going to buy him a cello, and he wants to take his cello to France.
(22') #Patrick wants me to buy him a cello, although he believes that his cello is going to take up a lot of space.

The second conjunct of (21') presupposes that John believes that someone besides Susan is going to come, but this is not entailed by the first conjunct, given the semantics for *want* outlined above. Though in (22) Patrick's beliefs are taken into consideration in calculating what he wants, as in (21), in (22') what he wants does not play a semantic role in the determination of what he believes, since most people realize that what they want may not be realized. Hence, the first conjunct in (22') doesn't filter out the (familiarity) presuppositions of the second.

Though entailments clearly play a role in many examples displaying modal subordination, there are at least three arguments that entailment is not a necessary condition for modal subordination, even in those examples where the intensional operator is an opaque verb. First, many of the examples which an entailment-based account would predict to be bad seem to be less than fully infelicitous. Judgments tend to vary from informant to informant, variation which is typical of accommodation-based felicity (indeed predictable, given its nature), but not of entailment. Second, there are a number of types of examples which cannot be accounted for by entailment alone, and must involve the accommodation of the presuppositions in question; this accommodation is local in Heim's sense – it is not accommodation of the relevant propositions to the common ground of the interlocutors, but only as hypothetical premises to restrict the domain of an intensional operator (in the schema for modal subordination in (15), the operator in the second sentence). And third, an

alternative explanation of the infelicitous examples can be given within the context of an account involving accommodation.

We see the first problem, variation in acceptability, in a number of examples. As reported by Heim, (21') and (22') above are acceptable to some speakers under the interpretations in (21'') and (22''). And Cresswell (1988) and Asher (1987) claim that (23) and (24), respectively, can have the readings suggested by (23') and (24') (again, we're interested in *de dicto* readings of the indefinites):

- (21'') John wants Mary to come, although he believes that if she does, Susan is going to come too.
 (22'') Patrick wants me to buy him a cello, although he believes that if I buy him a cello, it is going to take up a lot of space.
 (23) Susan wants a pet. She believes she will look after it.
 (23') Susan wants a pet. She believes that if she gets a pet she will look after it.
 (24) John wants a woman to marry him. He believes he can make her happy.
 (24') John wants a woman to marry him. He believes if a woman marries him he can make her happy.

Technically, in order to generate these interpretations, we modify the modal base for *believe* in each case so that the set of premises which determine Susan's or John's doxastic set includes the proposition indicated by the *if*-clause. This is local accommodation – we do not assume once and for all that Susan believes she'll get a pet or that John believes that a woman will marry him. A similar strategy would suffice to explain the felicity of (5), on at least one reading:

- (5) John wants to catch a fish.
 He plans to eat it for supper.

One's plans are arguably dependent on what one believes. Hence, in order to satisfy the familiarity presupposition associated with the pronoun, one may assume that John's plans are contingent on the fulfillment of his desires – "he plans, if he catches a fish, to eat it for supper", so that again, local accommodation makes the example felicitous.

Of course, accommodation, whether local or global, requires both cooperation and imagination, either of which may be lacking to some degree in our interlocutors. So it shouldn't surprise us that not all speakers are willing or able to derive a felicitous interpretation of such examples. I myself find it more natural to make (21') and (5) felicitous with global accommodation (which is not, then, modal subordination) than with local (modal subordination); e.g. in (21'), to globally accommodate that John believes he can get Mary to come, which then entails the presupposition of the second clause.¹⁰

The second problem, the existence of examples which entailment alone cannot account for, is pointed out by Heim herself, who notes that her entailment-based proposal cannot account for the felicity of examples like (25), which have the same status in her theory as examples like (26):

- (25) John wants Fred to come, and he wants Jim to come too.
 (26) If Mary comes, we'll have a quorum. If Susan comes too, we'll have a majority.

Further, the entailment-based approach cannot, so far as I can see, generalize over the cases involving adverbs of quantification, such as (2') and (12); over many examples of modal subordination involving mixed operators, e.g. (3') and (13), which involve mixed types of modals (the first a deontic, the second epistemic or counterfactual), and (14), with a propositional attitude predicate in the first sentence and a counterfactual modal auxiliary in the second; over examples where the operator in the first sentence is negation, as in (17); or over the Hob/Nob examples, to which I return below. In none of these is there evidence that an entailment of the first clause interacts with the modal base for the second intensional operator to satisfy the presupposition in the second, modally subordinate clause. All appear to be amenable to a treatment involving local accommodation. As Heim notes, "Once this mechanism is invoked, of course, the question arises to what extent it could also have been employed to yield some of the predictions that I took pains to make follow directly from the CCP [Context Change Potential] definitions," i.e. from facts about the lexical semantics of the propositional attitude predicates under investigation. The evident parallels among all these types of examples would appear to weigh in favor of an account involving accommodation, i.e. a partly pragmatic account, where modal subordination often requires the local accommodation of the salient premises to restrict the domain of the intensional operator in the final clause of (15). Of course that does not preclude the possibility that entailments often do license modal subordination, via lexical presuppositions about modal bases, as in Heim's account. Entailment is still a sufficient, though not a necessary condition for modal subordination.

But we need to say more than this to explain the distribution of cases where accommodation cannot take place. How can an accommodation-based account match the correct predications of infelicity made by the entailment-based accounts, as in examples (8b), (9), and (10) above? The crucial thing to note in these examples is that in each, the accommodation which would be necessary in order to plausibly satisfy the presupposition at issue would contradict information in the common ground at the time of processing the second clause, information given as entailments or implicatures of the first sentence or clause. If we assume, as I believe most authors do, that accommodated material must be logically compatible with the local context to which it is accommodated, we can explain the infelicity of these examples in terms of contextual incompatibility. This amounts to a weaker claim than the entailment-based theories.

The latter claim that examples of the sort under consideration are only acceptable when the presupposition of the second clause is entailed by the first. But the accommodation approach predicts that these examples are only unacceptable when there is some incompatibility between the presupposition of the second clause and the information in the common ground of the interlocutors. If this is not the case, then an example could, in principle, be acceptable, so long as the hearers feel that they are licensed to accommodate the relevant proposition(s) by their relevance and salience in prior discourse. Consider again the examples in (7):

- (7a) John tries to find a unicorn and wishes to eat it.
 (7b) #John wishes to find a unicorn and tries to eat it.

Try presupposes that what the referent of its subject believes entails any presuppositions of its complement. Hence, if the unicorn from the first conjunct of (7b) were to serve felicitously as the antecedent of *it*, John would have to actually believe there is a unicorn he'll catch. But since *wish* is a counterfactual-like propositional attitude (see Heim 1992), and does not project its complement's presuppositions onto the belief-worlds of its subject, John's wishing to find a unicorn doesn't entail that John believes he'll find a unicorn, and strongly implicates, at least, that he has some misgivings about it. Further, *wish* is future-oriented: we can only wish for something that isn't, so far as we know, yet true. Hence the first conjunct of (7b) has a negative presupposition, that John mustn't, so far as he knows, have already found a unicorn. But the verb in the second conjunct is also in the present tense, requiring the present truth of its complement's presupposition of the existence of a unicorn John has found. So there are two contradictions here: one between the counterfactual-induced implication of the first conjunct and the presuppositions of the second, the other between the future-oriented presupposition of *wish*, of the form *-believes(j,p,t)*, *t* the utterance time, and the present presupposition of *try*, i.e. *believes(j,p,t)*. These combine to yield the infelicity of the example.

On close inspection, even (7a) is a problem for an entailment-based account: The felicity of the example still cannot be reduced to entailments between *try* and *wish*, for trying to achieve ϕ doesn't entail wishing for ϕ : I might be forced by a villain to try to rob a bank, even though I myself don't wish to rob a bank.¹¹ In order to satisfy the familiarity requirement of the pronoun, we must accommodate that John wishes to find a unicorn (which is arguably the default explanation for why he's trying to find one).

Some of the other examples we have considered involve a contradiction between an implicature generated by the first clause and a presupposition of the second. Consider again (8b):

- (8b) #You are permitted to find a bear and required to take its picture.
 According to an entailment-based account, this example is unacceptable because the first clause doesn't entail that the hearer is required to find a bear.

But I think something more is involved. Giving someone permission to do ϕ also implicates that they are permitted not to do ϕ . This is a scalar implicature: if one were required to do ϕ , then the speaker should have said so, since this would entail its permissibility. Hence, the speaker of (8b) implicates that the hearer is permitted to not find a bear; i.e. there are permission worlds where the hearer does not find one. On the other hand, a prerequisite for taking a bear's picture is to first find one; the second VP presupposes that the hearer finds a bear in all her obligation worlds. But there is a relationship between one's permissions and obligations (relative to the same authority): the permission worlds must be a subset of the obligation worlds. This leads to a contradiction. We cannot accommodate that the hearer finds a bear in all her obligation worlds without contradicting the strong implication that there are obligation worlds where she doesn't find a bear. So, though the entailment does license (8a), what explains the infelicity of (8b) is the pragmatic contradiction: It is pragmatically quite odd to REQUIRE taking the picture but only PERMIT finding the bear, even though there is no direct truth conditional contradiction.

When a presupposition is not satisfied, there are two ways to repair the situation – globally, adding the presupposition to the common ground, or locally, adding it only as a hypothetical premise. On the account of (8b) I just gave, the global accommodation is blocked because of a contradiction with the scalar implicature generated by *permit*. But this leaves open the possibility of a local repair strategy. This reading doesn't come across too readily in the rather outlandish (8b), but seems more readily available in the structurally parallel (27), with the interpretation paraphrased in (27'):

- (27) To a new Ph.D. candidate, just finished with her qualifying examination:
 You are now permitted to write a dissertation, but required to finish it by the end of next year.
 (27') ... but you are required, if you write a dissertation, to finish it ...

Example (28) displays the same pattern, where the predicate in the second sentence requires a stronger commitment on the part of the subject to the truth of the presuppositions of its complement than is entailed by the first sentence.

- (28) Ram is considering getting a cat.
 #?He intends to have it declawed.

If Ram planned to get a cat, which he'd have to do in order to felicitously intend to do something to it, then the speaker in (28) should have said so. Instead, s/he suggested by the weaker assertion that Ram's intent wasn't yet firm. The global repair strategy would require that the hearer assume that in uttering the second sentence the speaker presupposes the Ram believes he'll get a cat. But this would contradict the implicature which the speaker induced by using *consider* in the first clause, and hence is not available. However, the

example improves considerably if the two sentences are spoken by two different speakers. The hearer would then take the second speaker to presuppose that Ram intends to get a cat.¹² This would be a global repair strategy, since if the hearer does not protest, the felicity of the utterance requires adding the proposition to the common ground. The local repair strategy would yield the conditional interpretation of the second sentence, paraphrased in (28').¹³

(28') If Ram gets a cat, he intends to have it declawed.

Another way of talking about the failed presupposition of *intend* in (28) is to say that the predicate's modal base must reflect the actual beliefs of the subject, so far as the interlocutors know. This is a type of limited factivity. (9) illustrates the more classical type of factive verb:

(9) Jan expected to get a puppy.
 ?#She managed to housebreak it quickly.

In terms of the Kratzer/Heim theory of intensional predicates, factive *manage* takes a totally realistic modal base; that is, for each world in the domain of the modal base – the worlds in the interlocutors' common ground – the set of premises which the function yields is just those propositions which are true in that world. In order to relevantly satisfy the familiarity presupposition of *it*, the hearer would have to globally accommodate the proposition that Jan got a puppy. Hence, we might expect this example to be comparable in acceptability to (21'), repeated below, on the interpretation where the hearer globally accommodates the proposition that John believes that Mary will, in fact, come:

(21') #John wants Mary to come, although he believes that Susan is going to come too.
 (21'') John wants Mary to come, although he believes that if she does, Susan is going to come too.

In fact, I think (9b) is somewhat more amenable to global repair than (21'), because expectations are more likely than mere desires to come true. This is perhaps easier to see if we compare (21') with the present tense version of (9), in (9'').¹⁴

(9'') Jan expects to get a puppy.
 She will manage to housebreak it quickly, I'm sure.

The past tense in (9) tends to more strongly implicate that Jan didn't get a puppy – we might be expected to know by now if she did get one, and to make the stronger claim if possible. Hence the tendency to avoid global accommodation in (9). And because of the factive presupposition of *manage*, there is no purely local accommodation possible, unlike the possible

interpretation of (21') in (21''). Factivity in (9) forces the presupposition to "percolate" to the global level, via requiring that the modal base be totally realistic.

The contradiction which explains the infelicity of (10) arises in a different fashion than in the other examples we have considered:

(10) Alice denies that there's a squirrel in her kitchen cabinets.
 #She hopes to trap it alive and turn it loose outside.

As noted above, the contradiction doesn't follow directly from the lexical semantics of *deny* and *hope*, but only from the additional assumption that Alice's denial is an honest one, based on her belief. This is probably the default assumption in a context in which the speaker doesn't give any reason to doubt Alice. But default assumptions don't arise in all contexts. Assuming that the default assumption in (10) is crucial to generating the contradiction which results in its infelicity, we might expect that it could be contextually overridden, and this seems to be the case in the acceptable (10'), where accommodation of Alice's belief that there's a squirrel in her kitchen cabinets is clearly crucial to its felicity:

(10') Alice loves wildlife and dislikes her landlord because he thinks a good wild animal is a dead wild animal.
 So, she denies that there's a squirrel in her kitchen cabinets.
 But really, she hopes to trap it alive and turn it loose outside.

But this raises a question about the examples involving scalar implicatures, such as (8b), (27), (9) and (21). If default assumptions can be overridden, as in (10)/(10'), why can't the offending implicatures be cancelled in these examples, so that the contradiction doesn't arise under global accommodation? A proper answer to this question would take us well beyond the focus of this paper, into a careful examination of conversational implicature.¹⁵ Suffice it to say that I do not believe that implicatures are truly cancelled. Instead, in the classical examples of implicature "cancellation", the hearer comes to understand that s/he originally misunderstood the context of utterance, including the purposes which the speaker intended to address by her utterance.

In a relevant passage, Grice (1989:17) points out that in certain contexts it is difficult to see how the utterance of *x tried to VP* could fail to generate an implicature that *x failed to VP*. The point, though Grice did not make it directly, is that use of a given expression in a certain type of context is both necessary and sufficient to generate a given implicature. The account of implicature in Welker (1994) is intended to be generative in just this sense. On such an account, so-called implicature "cancellation" is really context revision. It is thus the discourse equivalent of the garden-path sentences from psycholinguistics (Ferreira & Clifton 1986), the latter requiring a re-parsing of the sentence in question up to the point of a misleading turn, while implicature

"cancellation" requires a re-construction of the intended context of interpretation, stemming from an improved appreciation on the part of the hearer of the speaker's intentions (or plan). But there is nothing in the examples in question here to suggest that the speaker did not intend the crucial scalar implicatures. E.g. with *permit*, when it is the speaker who is granting permission as in (8), it is difficult to see how to avoid generating the scalar implicature that there is no requirement: If the hearer is REQUIRED to find a bear in (8b), why not just say so? So the implicatures are strong ones, I think unavoidable in the contexts given, and their existence precludes global accommodation of the missing familiarity presuppositions, on pain of contradiction.

Now note that the propositional attitude examples in (8) are analogous to those in (29), with deontic modal auxiliaries replacing the embedding predicates:

- (29) You **must** find a bear. [Then] you **may** take its picture.
 (29') #You **may** find a bear. [Then] you **must** take its picture.

The indicated judgements will follow if we assume that there are restrictions on the deontic modal bases of the auxiliaries *must* and *may* which reflect the relations between one's obligation worlds and permission worlds, so that, relative to a single authority, the worlds which reflect what a subject must do are a subset of the worlds which reflect what she may do. Again, there is a contradiction involved in asserting that one must do something which presupposes something that one needn't do.

The examples in (29) and in (30)–(32) below illustrate how lexical restrictions on the modal bases suitable for particular modal auxiliaries, just as in the case of the propositional attitude verbs, constrain the possibility of modal subordination. The infelicities noted arise because there is a contradiction between the modal base required by the modal and a premise which would have to be locally accommodated in order to satisfy the familiarity presupposition of a pronoun in the context provided:

- (30) John would have bought a car if he'd saved enough money.
 #He must have parked it in the garage.
 (31) John would have bought a car if he'd saved enough money.
 #He must insure it before he drives it to work.
 (32) Because public transportation is unreliable, John should buy a car to commute to work.
 #He would have enjoyed it in the bad weather last winter.
 (32') Because public transportation is unreliable, John should buy a car to commute to work.
 He would enjoy it on the weekends, too.

In (30), we are interested in the reading where we have a counterfactual *would* followed by an epistemic *must*. Infelicity follows from the fact that an epistemic

takes an epistemic modal base, which would have to include the proposition that John bought a car in order for this utterance to be felicitous in this context. But without previous context, the counterfactual conversationally implicates that the speaker believes that John didn't buy a car. Again, the required accommodation would lead to contradiction (pragmatic, since this is only a contextual implication).

In (31), the same first sentence is followed by a deontic *must*. But as mentioned above, alluding to Thomason (1981), deontics presupposes a modal base which reflects the subject's circumstances in all relevant respects: one that yields, for any world, a set of propositions which includes those propositions corresponding to the subject's circumstances. This is because, intuitively, our obligations must correspond to real possibilities open to us under the circumstances in which we find ourselves. The first sentence in (31) leads one to understand that the proposition that John saved enough money to buy a car is counterfactual, and hence that John couldn't and didn't actually buy a car. Then, the presumed counterfactual proposition that John bought a car isn't compatible with the modal base of *must*, which must include the relevant available information about John's circumstances, including the fact that he didn't buy a car. This example contrasts neatly with (18), where the proposition that John bought a car is compatible with what the interlocutors know about John, and hence is globally accommodable.

- (18) Since he saved his money last summer, John could buy a car.
 He should sell it, if he needs money now.

In (32), a counterfactual *would* is preceded by the deontic modal *should*. Deontics has a future-orientation, analogous to that of *wish* (as discussed above in connection with (7)); it is about what John is to do in the future. But *would* in the second sentence is combined with a perfect auxiliary to yield a (presumed) counterfactual claim about the past, presupposing that John had the use of the intended referent of the pronoun at some time in the past. In order to relevantly satisfy the familiarity presupposition of the pronoun, we must accommodate that he bought a car in the past, but this interpretation, "if John had bought a car, he would have enjoyed it on the weekends", would make the utterance irrelevant to John's present obligation, and hence to the first sentence, and that in turn undercuts the assumption that the accommodated premise was relevant. This is another type of infelicity, more subtle than contradiction of an entailment or implication, involving relevance and temporal as well as modal factors. (32'), with non-past *would* is considerably more felicitous.¹⁶

A thorough investigation of how the lexical presuppositions of modals constrain the possibility of modal subordination would take us too far afield.¹⁷ The point here is to see the evident parallels with the examples involving propositional attitude verbs. In both cases, semantic entailments alone are not sufficient to explain all the felicitous examples involving modal subordination,

but they do enter into the explanation of infelicitous examples, along with implicatures and other pragmatic aspects of interpretation. Accommodation must be invoked to account for many examples of modal subordination, and the pragmatic factors discussed then serve as constraints on accommodation, which must always result in a consistent (local) context of interpretation.

There remains one further possible avenue for explanation of modal subordination, by appeal to pronouns of laziness or "E-type" pronouns (see Cooper (1979), Evans (1977, 1980), and Chierchia (1992)). I argue in detail against one account of this type in Roberts (1995). Briefly, in the simplest type of E-type account, there are no built-in constraints on when modal subordination can occur, and in fact, there is no inherent expectation that the pronoun (or other presupposition) will occur in an intensional context, even though its apparent antecedent NP has a *de dicto* interpretation. It might be possible to construct a more sophisticated E-type account which somehow included such constraints, e.g. using modal accessibility relations. But then it seems to me that the resulting account would be very much like that in Roberts (1989), modulo the question of whether definites and indefinites are variables or disguised definite descriptions, an issue which appears to be orthogonal to the question of how to treat modal subordination.

I would argue that we should approach Geach's intentional identity problem, exemplified by (11), as a special case of modal subordination involving accommodation about beliefs. This seems to be basically the view of McCawley (1981: 336-7). He considers examples like (33) (his 11.2.20) and compares them with parallel examples involving "the conduct of normal science", such as (34) (his 11.2.21):

- (11) Hob thinks a witch has blighted Bob's mare, and Nob wonders whether she killed Cob's sow.
 (33) Jake believes that a witch has ruined his crops, and Zeke is convinced that she (the selfsame witch) has cursed his cows.
 (34) Halle believes that English has a productive rule of trisyllable laxing and that that rule is responsible for the vowel alternation in *divine/divinity*, and Keyser is convinced that the same rule is the reason for the shortness of the vowel in such words as *develop*; but Stampe has pretty convincingly demonstrated that English has no such rule.

About these, McCawley says:

The plausibility of these examples depends on the ease with which we can imagine the beliefs of the one person being communicated to and accepted by the other. For example, [(33)] becomes quite strange if one inserts *secretly* before *believes*. It is indeed such migration of beliefs and supposed objects from one person's belief world to those of others that makes it possible for scientific communities to exist. The acceptability of [(33)] reflects not merely the scheme of

worlds and contexts developed here but also knowledge on the part of those accepting [(33)] and [(34)] of a basic mechanism in the sociology of science.

He then acknowledges that the felicity of such examples requires something more than entailment:

[T]his principle of the sociology of science only tells one that the witch and the proposition that she ruined Jake's crops CAN migrate to Zeke's belief world: nothing in that principle or in the first conjunct of [(33)] tells us that they HAVE migrated there.

But this is just where a plausible and natural accommodation comes in. The very names *Hob* and *Nob*, or *Jake* and *Zeke*, are chosen to suggest similarity, to imply that these are members of the same community, as we happen to know of the real-life Halle and Keyser. We know that it is quite common that the same beliefs, be they scientific or superstitious, tend to be held throughout a given community, whether they are spread via journal publication, newspaper article, or gossip. We say this even when we know that not all members of such a community know each other. As noted by Edelberg, Hob and Nob needn't know of each others' beliefs in order for such examples to be felicitous. In fact, I imagine that they needn't know of each others' existence, if the community is large enough. But in order for the example to be felicitous, there must be some ground for claiming that they share beliefs about the same, though perhaps non-existent, witch. We only need accommodate the proposition that, as suggested by their names, Hob and Nob participate in a community whose common ground includes the existence of a witch in the vicinity. It is this assumed community common ground which warrants the identification of the two witches: The rumor about the witch which reached Hob's ears has spread to Nob as well, yielding a reading of the second conjunct something like "Nob wonders whether the witch that his community (including Hob) believes in killed Cob's sow."

The witch in Hob's belief worlds must share certain properties with that in Nob's world, but their beliefs about this witch needn't be identical, as in the case where Hob and Nob don't know of each other's beliefs about her relations to Bob's mare and Cob's sow. This is no different in principle than beliefs about actual persons: I may believe that Mozart died of poisoning, while you believe that he died of a hematoma of the brain, and you and I may not even have met. But should we meet, we would have no problem agreeing that it is the same Mozart about whom we hold these contradictory beliefs – the Mozart in my belief worlds and that in yours are in some sense counterparts. Hence, the problem of intentional identity in examples like (11) reduces to the more general problem of intensional identity, i.e. identity across possible worlds. Such an approach, of course, encounters difficult problems in attempting to specify what it is for two individuals to believe in the existence of the same, possibly mythical entity (see Lewis (1986) and references therein). But as these

problems are not unique to examples like (11), I do not believe that they undermine the basic approach suggested by McCawley. In order to understand examples like (11), both complement clauses must be modally subordinate to assumptions about the community of believers in which Hob and Nob participate. This involves accommodation in the same basic fashion as we saw in examples considered above.

In summary, I have argued in this section that an adequate theory of modal subordination must involve the selection of an appropriate modal base for an intensional operator, and hence of propositions restricting the domain of that operator. In the cases of interest, those propositions will locally satisfy the presuppositions, familiarity or otherwise, of material in the nuclear scope of the operator. While the truth conditions of earlier material may in some cases entail the appropriate modal base for an operator or intensional predicate, explaining the possibility of modal subordination semantically in those cases, in the general case we must admit of the possibility that modal base selection is pragmatically directed, technically involving accommodation. Finally, note that the proposal offered here has the advantage of not requiring the extension of scope beyond the sentence, while respecting the relationship between scope and anaphoric accessibility. Hence, we can maintain the scope principles from Section 1, while providing an account for the whole range of examples involving modal subordination.

3 Conclusions and Remaining Questions

The most obvious conclusions which can be drawn from what we know about modal subordination, as reviewed in Sections 1 and 2, pertain to the nature of anaphora.¹⁸ The clear parallels between anaphora and presupposition projection in modal subordination support the view of anaphora as a presuppositional phenomenon (e.g. as in chapter three of Heim (1982)). Perhaps more controversial, the theory promoted here entails that not all apparent anaphoric relations between two NPs are real, or at least direct. Recall the schema in (16):

- (16) operator [$s \dots NP_x \dots$]
 [-def]
 operator_{intensional} [$s \dots NP_x \dots$]
 [+def]

In cases of modal subordination, the first, indefinite NP is not anaphorically accessible to the later pronoun (or other definite NP). Instead, the occurrence of the apparent antecedent only serves to pragmatically license the accommodation of appropriate material restricting the domain of the intensional operator over the second clause, material which includes a discourse referent that is asserted to have properties corresponding to the descriptive content of the

indefinite NP. The moral is that when we see apparent anaphora in discourse we should not jump to the conclusion that it is direct. Rather, there may be a more indirect relation between the NPs in question. And in fact, I would claim that the existence of such only apparent anaphoric pairs in discourse is widespread, quite apart from examples of modal subordination. So far as I can see any attempt to reduce all apparent anaphora to binding will ultimately run afoul of the scope constraint on anaphoric relations and/or the sentential scope constraint, and end up overgenerating wildly.

Further evidence of the indirectness of the anaphoric relations involved in modal subordination comes from the role in felicity of the grammatical feature of number. Compare the felicitous (17), repeated from above, with (35):¹⁹

- (17) John doesn't have a car.
 It would be in the garage.
 (35) No student has a car.
 It would be in the garage.

The difference in the expression of negation in these examples – the auxiliary negation in (17) vs. the wide-scope negative quantificational determiner in (35) – leads indirectly to their differential acceptability. The first sentence in (17) is about the proposition that John has a car, denying its truth. The relevance of this proposition, and therefore of the car whose existence it pertains to, are what suggest the appropriate understanding of the second sentence, involving accommodation of the counterfactual proposition "John has a car" to restrict the domain of counterfactual *would*. The pronoun in the second sentence is singular in number because there is but a single car in question. The singular pronoun is unacceptable in (35). But a plural *they* improves the felicity of the example, as in (35'):

- (35') No student has a car.
 They would be in the garage.

Because of the quantificational determiner in *no student* (which happens to be downward entailing), there is no single student whose ownership of a single car is being denied; rather, the first sentence in (35)/(35') yields a generalization about students and cars.¹⁹ One reading of (35') involves an implicit restriction of the domain of *would* by the relevant counterfactual proposition that some unspecified number of students have cars. It is the discourse referent corresponding to this set of cars which then satisfies the familiarity presupposition of the pronoun; since the set is likely non-singleton, the discourse referent is plural. Then if we assume that a pronoun must agree in number with the discourse referent which satisfies its familiarity presupposition, we can explain (35)/(35'). Assume that a pair of NPs in a true antecedent/anaphoric relation must agree in number; call this the **Principle of Anaphoric Agreement**. Then though the singular *a car* plays an important role in licensing the use of *they*,

in the second sentence, their relationship must be indirect, not a direct anaphoric relation. I would say that the apparent antecedent only licenses the occurrence of the pronoun, since it is part of what licenses the crucial accommodation. There is much more to be said about this subject. For example, not everyone assumes the Principle of Anaphoric Agreement, a difference which leads to quite different analyses of anaphora in discourse.²⁰ And it remains to be clarified in what sense a discourse referent is "plural." But this topic is too complex to permit fuller discussion here.

Modal subordination can also give us some insight into the nature and function of the common ground between interlocutors in a discourse and of the role of accommodation. It has been claimed (Heim (1983), van der Sandt (1990), Beaver (1992)) that there is a default preference for global accommodation, that is, accommodation of otherwise failed presuppositions to the common ground, rather than local accommodation, where the presupposed material is satisfied by the restriction on an operator's domain. If this generalization is correct, we might reasonably ask why this should be the case. But further, when modal subordination involves accommodation, it is, by the nature of modal subordination, local accommodation restricting the domain of an intensional operator, as described in §2. We have also seen that in some cases, such as (18), repeated here, the resolution of the familiarity presupposition of a pronoun in a discourse with the relevant surface structure is accomplished via global accommodation of the relevant material.

- (18) Since he saved his money last summer, John could buy a car.
He should sell it, if he needs money now.

Why then do we not find global accommodation in all or most examples of the general surface form of interest? Here again, a suggestion by McCawley (1981, §11.2, p.331) points toward an answer to the first question, why global accommodation seems to be the default. He considers examples (36) and (37):

- (36) Tom thinks Alice doesn't know her house is on fire.
(37) Betty: Tom thinks Alice's house is on fire.
Marvin: How on earth could he think that? Surely if Alice's house was on fire, she wouldn't just be sitting in the next room doing a crossword puzzle – she'd be trying to save her collection of James Joyce manuscript from the fire.
Betty: Tom thinks Alice doesn't know her house is on fire.

McCawley says:

Example [(36)] clearly does not semantically presuppose that Alice's house is on fire... Any presupposition embodied in [(36)] is a pragmatic presupposition, that is, a demand that the sentence makes on its context... [(37)] is not so much

that the presupposition of the complement clause [in (36)] is passed on to the whole sentence as that, without additional context as in [(37)], the world of the main clause (or better, the 'context' of the main clause, in the sense of [Karttunen (1973)]) is the only available source of information about Tom's belief world.

This suggests to me that global accommodation appears to be the default not because of any inherent preference for global over local accommodation *per se*. Rather, I will argue, it follows from practical principles for the maintenance of the common ground of the interlocutors, plus the function of accommodation. It has been extensively argued in the literature on counterfactuals that we make the default assumption that counterfactual contexts are as much like the actual world as is compatible with what's explicitly said about them (e.g., see Lewis (1973)). Call this the **principle of optimal realism**. I would argue that we can generalize this claim about counterfactuals to the claim that all hypothetical contexts are assumed to be optimally realistic, whether they are counterfactual or merely characterized by non-asserted propositions. I speculate that the principle of optimal realism is motivated by the need to assure that all interlocutors' assumptions are as similar as possible, whether these are assumptions about the actual world – for which the common ground defines the candidate set – or about hypothetical or counterfactual contexts which aren't spelled out by the speaker are assumed to be identical with what we know about actuality, as reflected in the common ground, at least insofar as this doesn't lead to contradictions with what's explicitly spelled out. This enables us to avoid misunderstanding, while minimizing the need for detailed (and often redundant) description of hypothetical contexts.

Technically, in order for accommodation to satisfy a presupposition, it must take place at the most local level, at least. From the perspective just offered, the question is not whether or why there is a default to global accommodation, but how far "up" the accommodation will percolate from the most local level. For simplicity, let's assume only one level of hypotheticality, which is the local context at which some presupposition ϕ must be accommodated. If we accommodate ϕ at the local level and we also assume the principle of optimal realism, then we will accommodate ϕ to the global level as well unless ϕ is counterfactual or we have some other reason to think that (the speaker thinks that) ϕ may not be actually true. This would explain both why there is a tendency to global accommodation, all things being equal, and also why examples involving modal subordination form a systematic exception to that rule, with no hint of infelicity or difficulty in processing.

When we've already been talking about a counterfactual or hypothetical circumstance with certain properties, so long as that information is relevant and plausibly true in the present hypothetical context as well,²² then we may take it that that prior information is accommodable locally, to enrich the present hypothetical context. But the fact that the information was only discussed hypothetically at least implicates that it is not in the common ground, so far

as the speaker is concerned. In order to avoid any conflict with that implication, the accommodation doesn't percolate to the global level. In cases where local accommodation would conflict with presuppositions about the modal base of the modal or intensional predicate, we can only achieve felicity via global accommodation of the otherwise unsatisfied presuppositions. We see this in (18), repeated just above. Here, the circumstantial modal base of deontics like *should* (as discussed in Section 2) would be incompatible with the purely local accommodation of the proposition that John bought a car, a proposition only hypothetically entertained in the preceding utterance. So, in order to make the example felicitous, we must globally accommodate the proposition, an accommodation which is plausible if we know that owning a car is generally considered desirable, that John had enough money to buy a car, and that people generally do what they want when they can. And we saw forced percolation of accommodated material to the global level in (9), as well, where the factivity of the intensional predicate was reflected in the requirement of a totally realistic modal base.

Behind all this is the assumption that when accommodation is required, the material to be accommodated is both maximally relevant and salient, again in the interest of the maintenance of the common ground. This is especially important in the examples involving pronominal anaphora, since otherwise the descriptive content of pronouns is so impoverished as to make the recovery and accommodation of an intended antecedent impossible.²³

Of course, this approach to explaining the default preference for global accommodation, as well as the systematic class of exceptions involving modal subordination, all hinges on the idea that the purpose of conversation is to build, extend, and maintain a common ground. Insofar as it is a plausible explanation, we might take it to underline the central importance of the common ground in human discourse.²⁴ I think as we begin to appreciate that more fully, and to investigate the types of constraints and strategies which we employ to guarantee the maintenance of the common ground, we will come to understand that accommodation actually is very constrained, and the suspicion that accommodation is too powerful a mechanism to play a part in a falsifiable theory will lose its force.

Finally, I will briefly mention some remaining questions about modal subordination:

The class of examples displaying telescoping, like (1), remains ill-understood, though they obviously involve a natural language counterpart to universal instantiation in logic. See Roberts (1989), Poesio & Zacchi (1992).

Farkas (1993) discusses what she calls "modal anchoring" of NPs in non-intensional contexts, illustrated by her examples (38) and (39):

(38) Mary thought that there was a castle behind the trees.

The castle turned out to be a huge oak tree.

(39) Mary believes that there is a castle in the park.

John believes that the castle is a figment of Mary's imagination.

She describes (38) as a case where "a noun phrase is modally subordinated to a constituent occurring in previous discourse, while the sentence the noun phrase is part of is not modally subordinated," leading to her conclusion that (p.8), "the modal anchoring of the descriptive content of noun phrases is independent of the modal anchoring of the sentence the noun phrase occurs in." This is strongly reminiscent of Enc's (1981) discussion of the temporal anchoring of NPs independently of the tense of the clause in which they occur. It would appear promising to explore this parallel.

Examples like (40), originally due to Partee, are often cited in discussions of anaphora in discourse (see, for example, Heim (1982), Roberts (1987, 1989), Groenendijk & Stokhof (1990a), Dekker (1993b), van der Sandt (1992), Beaver (1992)):

(40) Either there's no bathroom in this house or it's in a funny place.

Generally, a quantificational NP which occurs in one disjunct of a sentence with *or* cannot serve as antecedent to pronouns outside the disjunct, in keeping with the scope constraint. There is no modal or other intensional operator in (40), so it doesn't obviously involve modal subordination. Yet I argued in Roberts (1987, 1989) that there is a relationship to the latter phenomenon, in that the anaphora in (40) also involves accommodation of a presupposition. On the analysis proposed there, disjunctions may be taken to provide alternative answers to a single topic of discussion, here the question of whether there is a bathroom in the house. The first disjunct of (40) asserts a negative answer, while the second disjunct presupposes a positive answer. It is this presupposition which is accommodated, yielding an interpretation like "or there is a bathroom in this house and it's in a funny place". Alternative accounts have been proposed, notably those of Groenendijk & Stokhof and Dekker. But none of these proposals is well-grounded in an independent exploration of the general semantics and pragmatics of disjunctive assertions, and I take it that the problem posed by (40) will remain unresolved until such an exploration is undertaken.

Possibly relevant in this regard is recent work by Portner, in which he has explored in some detail the technical realization of the notion of *mood*, both in complement clauses (Portner 1992) and in matrix clauses (Portner 1993). He proposes that rather than assuming an implicit operator in just those cases, such as (12), in which one is needed to match the schema for modal subordination in (15)/(16), we generalize to assume that all utterances, even indicatives, have what he calls a *modal force*, either universal or existential, and a *modal context*, which determines the domain of the modal force. In modal subordination, the modal context would be influenced by previous irrealis contexts, which I take it would be compatible with the accommodation approach argued for here. This way of treating mood would appear to be particularly promising in accounting for examples such as (41):

- (41) Lisa dreamed she was talking to a raccoon.
 It was telling her how it broke into her garbage can.

Here, the default interpretation of the second sentence does not involve the assumption that there is a real raccoon in question, but instead continues the discussion of the dream raccoon. Though there is no explicit intensional operator with scope over the second sentence, Roberts (1987, 1989) claimed that such examples involve an implicit operator. But, unlike the implicit modals in bare indicative conditionals (Kratzer 1981) or the generic operator in examples with bare present tense (Carlson 1977b, Wilkinson 1991), this is not a kind of operator whose existence has been independently argued for in the literature. Though technically we want a universal quantification over Lisa's dream worlds, grammatically we have a simple indicative utterance, so that the stipulated implicit operator seems to be *ad hoc*. Perhaps Portner's work, exploring the relation between mood in such examples and that in complement clauses, will shed more light on their proper analysis. In disjunctions like (40), neither disjunct is asserted; then mood in Portner's sense, and hence ultimately modality, may prove relevant to its analysis after all, making all such examples cases of modal subordination.

NOTES

- 1 Thanks to Shalom Lappin for suggesting that I write this article. Thanks also to Louise McNally and to Kate Welker for insightful comments on an earlier draft and to Fred Landman, for valuable discussions on several occasions.
- 2 I don't want to take a stand here about whether definite and indefinite NPs are quantificational or are unselectively bound variables. So far as I can see, this problem is tangential to the problem I describe here. On either type of theory, these NPs display a different anaphoric potential than other types of NPs. Unlike NPs with determiners like *every* or *no*, definite and indefinite NPs may be anaphorically accessible across discourse. But unlike proper names, the anaphoric accessibility of definite and indefinite NPs is subject to the scope constraint on anaphoric relations, as we see in the examples below. My point is that apart from definite and indefinite NPs, all the theories cited agree in entailing the sentential scope constraint for quantificational elements.
- 3 See Edalberg for a more detailed description of the problem, and an extended argument against a quantificational analysis of intentional identity.
- 4 I assume Heim's account of the presuppositional character of anaphora, where pronouns and other definites presuppose the familiarity of a discourse referent introduced by an antecedent NP or a deictic act, in the common ground of the interlocutors. The notion of *common ground* is due to Stalnaker (1979), and roughly includes the (maximal) set of propositions held true in common by the interlocutors in a conversation. Technically, Heim extends the common ground to include not only a set of propositions, but also a set of discourse referents (abstract entities

under discussion – see Karttunen (1976)). Satisfaction of the familiarity presupposition introduced by a definite NP requires the existence of a discourse referent in the common ground which is coindexed with the definite. For simplicity here, I will talk of familiarity presuppositions as if they were propositional, specifically a presuppositions of the existence of some entity.

- 5 The interpretation in question is one which arguably involves accommodation. That is, the hearer assumes the truth of the proposition that John did buy a car and hence assumes the existence and familiarity of a car that John bought. This assumption is triggered by the apparent assumption on the part of the speaker, in the second sentence, that John has something familiar to sell; see the discussion in Section 2 of possible modal bases for deontic *should* for an indication of how the speaker's assumption is communicated in this example.
- 6 Actually, there are two functions involved, the modal base and the ordering source the latter crucially involved in the interpretation of deontics and counterfactuals. See Kratzer (1981) for general discussion, Roberts (1989) for application to the theory of modal subordination. Here I will only talk about the modal base, for simplicity.
- 7 According to Heim (1992), Cresswell (1988) also offers an account based on accommodation. However, I have been unable to locate the discussion she alludes to from that volume.
- 8 Some speakers find the example acceptable with local accommodation of the proposition that the hearer finds a bear in the second conjunct. But here, for the sake of argument, I'll assume McCawley's judgment.
- 9 McCawley assumes that denying *p* entails that one doesn't believe that *p*. However, this is arguable, since in denying, one might lie. Hence, the relationship between the complements of *deny* and *hope* is less direct than McCawley would have it.
- 10 I return briefly to consider this tendency to global accommodation in Section 4. Deriving the reading in (21') is easier for me when the complement clause itself has a modal, as in (i):
 - (i) John wants Mary to come, although he believes that Susan would come too.
 Here's one possible explanation for this: Auxiliary *would* tends to suggest some unwillingness on the part of the speaker (in a main clause) or superordinate subject (in an attitude context such as (i)) to directly assert the proposition in question. Since *want* tends to conversationally implicate a lack of belief, using auxiliary *would* for the modally subordinate interpretation in (21'') may be more compatible with the conditional hedging than using the indicative in (21'). The lack of modal subordinate interpretation for the indicative (21') might then be at least partly a result of an implicature based on the availability of the more suitable (i). There are some subtle questions here, since one's wishes needn't all be compatible (see Heim for some discussion), so that one might consistently both wish to rob a bank and not wish to rob a bank. That is, it is important to keep constant the other factors which play a part in determining one's wishes in order to check the sort of entailments at issue here. However, my intuition is that having to do something doesn't entail desiring it. Hence one might try to do something one doesn't wish for, even relative to the same assumptions, because one has to.

12 Again, I don't think a conditional interpretation of the second sentence, as in (27'), is readily available:

- (27') If Ram gets a cat, he intends to have it declawed.
 (27'') Ram is considering getting a cat.
 He would have it declawed.

This is because there is no hint of irrealis mood in the second clause of (27). But (27') is the preferred interpretation of (27''). There, the modal *would* both introduces the irrealis mood required for the modally subordinate interpretation, and conveys Ram's intent, his will, in keeping with the etymology of the auxiliary (hence, adding *intend* to this clause would be redundant for me).

- 13 For reasons that are not entirely clear, I find this less successful than the local repair for (27) given in (27'). But other speakers appear to find local repair equally possible in the two examples.
- 14 This comparison was suggested by Louise McNally (personal communication), who gets a conditional interpretation for the second sentence of (9'). I more readily get the global accommodation suggested in the text. This is the kind of difference in interpretation which we expect with accommodation.
- 15 See Welker (1994) for such a careful study, based on the way in which interlocutors' publicly evident intentions (or *plans*) play a role in generating implicatures.
- 16 Though *should* is in some respects similar in meaning to the semi-modal *have to*, the following is infelicitous, unlike (32'):
- (i) John has to buy a car to drive to work.
 *He would enjoy it on the weekends, too.
- I suspect that *have to* has factive entailments: If John has to buy a car, he will. The strong likelihood that he will do what he has to do is incompatible with the hedge associated with the counterfactual *would*.
- 17 For some discussion of lexical constraints on modal bases, see Kratzer (1981). See Roberts (1994) for discussion and a new proposal about how to capture these constraints.
- 18 On the analysis suggested in Section 2, modal subordination also helps to explain certain apparent contradictions which arise within the theory of presupposition of Stalnaker (1974) see Landman (1986a) for examples and discussion.
- 19 This comparison was suggested by Louise McNally (personal communication), who, however, might not agree with the conclusions I draw from it.
- 20 At least, not in a model with more than one student. And many have argued that use of a quantificational NP in such a context presupposes the existence of multiple entities in the denotation of the CN.
- 21 See, e.g. Groenendijk & Stokhof (1990a) and Dekker (1993b), who do not, though they do not explicitly discuss this principle or its rejection.
- 22 I take plausible truth of a proposition with respect to a set of worlds to entail compatibility with them, i.e. non-empty intersection of those sets of worlds. But there may be other criteria for plausibility, as well.
- 23 See Roberts (1993) for extensive discussion of distinctions between the presuppositions associated with pronouns and those of definite descriptions.
- 24 E.g. contra the arguments of Sperber & Wilson (1986) that there is no utility to such a notion, indeed that one cannot even make sense of it.

9 Quantification, Quantificational Domains, and Dynamic Logic

JEAN MARK GAWRON

1 Introduction

The prototypical example of quantification is an English noun phrase like *every boy*. In standard accounts it is assumed that the domain of quantification, the set of boys, is determined by the syntax, roughly, by the material in the noun phrase excluding the determiner. But it is well known that in general the domain of quantification can be affected by various other factors. The domain can, of course, be constrained pragmatically; the set of boys actually relevant in the discourse may be the set involved in some event or at some location. In some cases, as in some adverbial quantifications, the domain may be unconstrained by the syntax and left to discourse control. The domain may also be affected by focus or by quantificational subordination. This paper collects some of the relevant phenomena, tries to show why a "dynamic" account might be desirable, and presents a brief sketch of a promising approach in the form of a logical fragment based on a revised notion of discourse context.

In Rooth (1985), Rooth (this volume), a technical notion of *alternatives under consideration* is proposed to account for a variety of focus-related phenomena. One way of explaining the intuition behind this technical notion is to identify it with a dynamic property of real discourses: A discourse tracks not just what is known or established as common ground, but also what is merely under discussion. In this paper, in order to explore various non-local ways of affecting quantificational domains, I want to explore two related ideas:

1. The alternatives under discussion should be built into the context in the sense used in dynamic frameworks.
2. Sets of things quantified over should be treated as alternatives under consideration, persisting through the discourse even outside the scope of the quantification.