

GENERICALLY SPEAKING, OR,  
USING DISCOURSE REPRESENTATION  
THEORY TO INTERPRET GENERICS

I. INTRODUCTION

In this paper we discuss a proposal for representing the logical form of generic and habitual sentences. The proposal is a development of Schubert and Pelletier (1987), although it stands on its own and can be comprehended without having first read the earlier paper. (Most of what would be missed would merely be a discussion of background literature, and reasons to want a different logical form from those extant in the literature).

In this earlier paper, three different "sophisticated" theories of generics were compared: those of Carlson (1977a, 1977b, 1979, 1982), Chierchia (1982a, 1982b), and Farkas and Sugioka (1983). Various faults were found with all of them. Some faults were minor, specific defects; but more importantly we found that all of them ignored (what we there called) "the most salient feature of habitual and generic statements". At the end of that paper we surveyed two directions for further work. One was a "conservative" proposal which we do not wish to develop further, at least not at this time.<sup>1</sup> The second proposal we mentioned was more radical. It involved the notion of an "ensemble of cases". It is our view that habitual and generic statements rely on a reference to such an "ensemble" for their semantic evaluation. For example, a habitual sentence with an explicit adverb of quantification ("usually") like

1. John usually beats Marvin at ping pong

does *not* say that most of the time John is beating Marvin at ping pong. Rather, the *usually* gathers a certain class of "reference situations", namely all those situations in which John and Marvin play a game of ping pong, and the *usually* is evaluated with respect to this class of situations, counting whether most such situations are such that John beats Marvin. If so, then (1) is true; otherwise it's false. Similarly, when the sentence is generic, such as

## 2. Cats land on their feet

it is *not* evaluated as if it said that at all or most times cats are landing on their feet, but rather a certain class of "cases" or "situations" is set up — such as all those cases where cats drop to the ground — and the sentence is evaluated with respect to those cases. (To account for the nomic import of a sentence like (2), cases in certain "nearby" possible worlds need to be considered along with actual cases — see Sections VIII, XI, and the Appendix, clause (16).) If most of these situations are such that the cats involved land on their feet, then (2) is true; otherwise it's false.

Thus it is our view that semantic evaluation of habitual and generic statements depends on reference to these "ensembles of cases". We think that the relevant ensemble is determined in part or entirely by context and presuppositions, or in part or entirely by restrictive clauses and adverbials. We think there are two kinds of such reference ensembles, closely paralleling the two kinds of uses of adverbs of quantification: ensembles of *situations*<sup>2</sup> (corresponding to "temporal" uses of adverbs of quantification) and ensembles of *objects* (corresponding to "atemporal" uses of adverbs of quantification).<sup>3</sup>

This view of habituals and generics being evaluated with respect to some pre-given ensemble (or set) of situations (or objects) will probably bring to mind a certain group of semantic theories generically known as "Discourse Representation Theories".<sup>4</sup> These theories too attempt to give a semantic evaluation of sentences based on some pre-given context: for them, the pre-given context is previously "processed" text. The goal of such theories is to be able to account for how the "context", according to which one semantically evaluates a given sentence, changes in the sentence-by-sentence (indeed, clause-by-clause) reading or "processing" of an entire text. The crucial test in such theories (so far, at any rate) has been to account for pronoun anaphora, both within and across sentences. Another issue under investigation has to do with the "sequencing of reported events" in the text so as to account correctly for the observed use of tenses and tense adverbs in the text. Still further developments would be to investigate how discourse can allow pronoun reference to, for example, "plural objects" in a reasonable manner.<sup>5</sup>

Our theory will be in this general vein. However, we disagree on various details, especially on the interpretation of "donkey sentences";

and we hope to give a somewhat better account of tense than those which have thus far been given. Finally, of course, we will try to show how our discourse theory accounts for various generic sentences. Here we will be partially successful, particularly for episodic generics whose indefinites or bare plurals are confined to the restrictive clause. After a discussion of some deep-rooted difficulties, we sketch a potentially more comprehensive account. One overarching difference between our theory and the most popular of the others (Kamp 1981, Heim 1982) is that ours will be compositional; at least in the weak sense that syntactically identical phrases are uniformly translated, and logical expressions are in turn interpreted independently of the expressions embedding them (relative to a given "context"). (The theory is not "strictly" compositional, in part because it allows quantifier raising and in part because the interpretation of an expression may depend on more than just the intensions of its top-level constituents.) In this, our theory resembles that of Groenendijk and Stokhof (1987).

Let us therefore start with an exposition of the general background for our discourse representation theory, and follow this with a discussion of "donkey sentences" (which provide a clear arena that allows our theory to be distinguished from other discourse representation theories). All of this will be carried on at the intuitive level, after which we introduce some small bit of formalism so as to be able to show to some degree how we view our method as working. (A somewhat more formal account of the inner workings of the theory is given as the Appendix to the paper.)

## II. DISCOURSES AND DISCOURSE REPRESENTATION THEORIES

Consider a "discourse" like

## 3. John is at the door. He is behatted.

Is the second sentence of (3) true? Well . . . it depends upon (a) what the referent of *he* is, and (2) whether this referent is wearing a hat. We have not much to say about how one decides whether *he* denotes John, or some deictically indicated or otherwise salient person, or (perhaps) some previously-mentioned person from earlier in the "discourse". Instead we would recommend a "representation" of this discourse as (ignoring various fine points):

3'. at-door(*j*) · behatted(he)

leaving it to some other "module" to replace the *he* with appropriate (logical form) items. One might call this some kind of "pragmatic disambiguation" — but then again, maybe one wouldn't. But once a choice for *he* has been made, it becomes the duty of the semantic theory to decide whether it is true (in our model or interpretation). One choice for *he* presumably is *j*, and then the question of whether the second sentence is true should amount to whether [behatted] (*[j]*) = 1 — ignoring issues about time and modality. It is this latter step, the semantic evaluation, that we wish to explore here.

The treatment suggested above for intersentential anaphora should, we think, be given also for (certain) intrasentential anaphora. For instance, we think that the same treatment should be accorded such sentences as

4. a. John is at the door and he is behatted.

This should be translated as

4. b. at-door(*j*) & behatted(he).

As is well-known, there can also be such pronominal reference to a quantified noun phrase:

5. a. A man is at the door. He is behatted.  
b. A man is at the door and he is behatted.

For these we would recommend representations like<sup>6</sup>

5. a'.  $(\exists x : \text{man}(x))\text{at-door}(x) \cdot \text{behatted}(\text{he})$   
b'.  $(\exists x : \text{man}(x))\text{at-door}(x) \ \& \ \text{behatted}(\text{he})$ .

Again there may be numerous choices for "disambiguating" *he*. We draw attention to the possibility of using *x* (in 5a'):

6.  $(\exists x : \text{man}(x))\text{at-door}(x) \cdot \text{behatted}(x)$ .

Of course, this leaves a free *x* in the second sentence. How shall our semantic evaluation treat this? Two choices come to mind: (a) Do a further adjustment on this "logical form" and make the scope of the quantifier found in the first sentence be the *pair* of sentences ("quantifier raising"), (b) Evaluate the second sentence as if the *x* denoted the value of some previously quantified *x* (which made the sentence it

occurred in true — that is, a value which satisfied the open formula to which the quantifier applied). Here we would make the *x* of the second sentence take a value which satisfied the existentially quantified first sentence; that is, we would make it be a man at the door.

The present method, in common with Kamp (1981), Heim (1982), Groenendijk and Stokhof (1987), among others, takes the second strategy. Reasons for this have to do with the facts that not all quantifiers can be "raised" so easily as  $\exists$ , e.g., *no*, *few*, and the like (although it must be admitted that these quantifiers do not readily supply pronoun antecedents either); and also that even  $\exists$  cannot be "raised" over every sentence connective (part of the point of "donkey sentences"). So, the question arises: why not just adopt Kamp's or Heim's theory? As we mentioned before, we find two basic disagreements with them. First is the non-compositionality inherent in their proposals. And second, we find that their interpretation of the crucial "donkey sentences" not to be in accord with our intuitions. (This latter shortcoming is also in Groenendijk and Stokhof). Since the present proposal differs from the others most clearly in the interpretation of "donkey sentences", we now turn to look at them.

### III. DONKEY SENTENCES

This issue of "carrying over variable bindings" from one quantified NP to be used in evaluating an occurrence of a pronoun in another clause or sentence has been extensively discussed in the literature, usually with reference to "donkey sentences" such as<sup>7</sup>

7. If Pedro owns a donkey, he will ride it to town tomorrow.

The discussions of this phenomenon have, in our opinion, been marred by a concentration on (what we take to be) unlikely "readings". Here are seven possible "readings" of (7):<sup>8</sup>

7. a. [Deictic Reading] If Pedro owns a donkey, Pedro will ride [some otherwise specified object, not any donkey mentioned in the antecedent] to town tomorrow  
7. b. [Generic Reading] Pedro has the habitual disposition to generally ride donkeys Pedro owns to town tomorrow  
7. c. [Universal Reading] For any donkey *x*, if Pedro owns *x*, Pedro will ride *x* to town tomorrow

7. d. [Specific Existential Reading] If Pedro owns a certain donkey [e.g., the speaker might "mean" Annabelle], Pedro will ride it to town tomorrow
7. e. [Non-Specific Existential Reading] There is some donkey *x* such that if Pedro owns *x*, Pedro will ride *x* to town tomorrow
7. f. [Definite Lazy Reading] If Pedro owns a donkey, Pedro will ride the donkey Pedro owns to town tomorrow
7. g. [Indefinite Lazy Reading] If Pedro owns a donkey, Pedro will ride some donkey Pedro owns to town tomorrow.

The Deictic Reading occurs when the *it* in the consequent refers to some item referenced by previous discourse or by the speaker (pointing). We shall not discuss this further. The Generic (or habitual) Reading — which is perhaps unavailable with the adverb *tomorrow* in the sentence — predicates some disposition of Pedro. It does not imply that Pedro necessarily will ride to town, but rather that riding-to-town-on-his-donkey is something that Pedro is in the habit of doing — something he generally does. The Universal Reading is often (pre-emptively) called the "standard" reading (e.g., by LePore and Garson 1983), and many theorists take their task to be to show how to deliver it (Hintikka and Carlson 1979, Hornstein 1984, Kamp 1981, LePore and Garson 1983, Heim 1982, Roberts 1987, Groenendijk and Stokhof 1987, among others<sup>9</sup>). We find this a pretty implausible meaning for (7) — for one thing it entails that Pedro will ride *every* donkey he owns into town. It might be counter-argued that this discrepancy arises not from the Universal Reading being a mistranslation of (7), but rather from a Gricean implicature in (7) to the effect that Pedro owns at most one donkey. However, while a situation in which Pedro owns two donkeys and rides one into town does intuitively violate *some* presumption here, it intuitively renders (7) true all the same. Certainly if the speaker had wagered on the truth of (7), he would feel entitled to collect, and it is hard to imagine the counter-claim holding sway, that Pedro after all didn't ride his *second* donkey into town. (We discuss possible implicatures below). The Specific Existential Reading treats the indefinite *a donkey* more or less as a disguised name: the speaker has some specific donkey in mind, say Annabelle, does not commit him- or herself to Pedro's ownership of

Annabelle, but claims that if Pedro *does* own Annabelle he will ride it to town. Such a reading, it seems to us, cannot readily be represented by *any* quantificational analysis of the sentence — at least not on the standard semantics of quantification, which does not permit reference to any *particular* donkey (but see Section XII). Semantically such indefinites behave much like a definite, as argued by Fodor and Sag (1982). Some theorists, not wanting the entailments of the Universal Reading, but yet thinking that some "ordinary" quantificational reading is correct, have suggested that the Nonspecific Existential Reading is appropriate. They want Pedro to perhaps not own any donkeys, but if he does own any he will ride one of them to town. But the Nonspecific Existential Reading does not say this. Rather, it is true (quite vacuously) if there is a donkey (*any* donkey) that Pedro doesn't own. Possibly this is a legitimate meaning of (7), but it surely isn't a natural meaning. The inappropriateness of the Nonspecific Existential Reading shows that a "quantifier raising" type of analysis is mistaken even in these non-quantified-subject donkey sentences.<sup>10</sup>

The Definite Lazy Reading<sup>11</sup> suggests that we can somehow find a suitable replacement for the *it* in (7) by considering the statement made in the antecedent. Our theorists differ in how they think the replacement is to be found. Partee (1972)<sup>12</sup> suggests that there be some syntactic way to find it; Evans (1977) claims that it can be got by "semantic" considerations<sup>13</sup>; and Cooper (1979) and Partee (1978) claim that it is due to "pragmatics" wherein the logical form translation has a free (pragmatic) variable whose value "will be determined by the context of use. According to some contexts of use [this pragmatic variable] will represent the property of being the donkey which [Pedro] owns and thus will correspond to an anaphoric reading of [*it*]" (Cooper 1979: 84). We have called this (and the next reading) "lazy" readings as a way to distinguish the meanings attributed to the donkey sentence *it* from deictic or habitual or bound variable readings; and we call these accounts "lazy readings" in spite of the fact that each of Cooper, Evans, and Partee (1978) are at pains to distinguish their accounts from (what they call) "the pronoun of laziness account". This shows that what we call Lazy Readings are not what this term of art has always meant to each previous investigator. For instance, we do not intend to insist that a lazy reading be able to be read off *directly* from the words used. There is a reason, however, to lump the preceding authors together: they all agree that, however it is to be done, we get a reading by

constructing something from the preceding text. And in particular, for the donkey examples (and this is why it is called the *Definite Lazy Reading*), the *it* is to be read as *definite*: “the donkey Pedro owns” (if he owns one at all). But surely this is going too far . . . is (7) false when Pedro owns two donkeys? — Regardless of how many he rides into town?

We think not. We *do* agree that there is some kind of implicature in (7) which suggests that Pedro owns at most one donkey. But this surely comes from the particulars of donkey-ownership amongst the kind of people who have the name ‘Pedro’. Typically, think North American academics, people named ‘Pedro’ who are in the running for donkey-ownership are poor farmers who certainly wouldn’t own more than one. This feeling is re-enforced by suggesting that Pedro will ride it into town, rather than putting it in his new horse trailer with three others and driving into town. That the implicature comes from such social facts as these and not from any syntactic-semantic features of the sentence under consideration can be seen by considering other, similar sentences:

8. Everyone who has a donkey must donate its services for one day during the festival.

Does anyone seriously think that, if (8) were ordered by the local government, wealthy farmers with two or more donkeys could plead that they were exempt on that ground alone? And against the Universal Reading, surely these wealthy farmers are not required by this order to donate the services of *all* their donkeys. To us, the order (8) seems to say that all donkey owners are required to donate a donkey-day’s service. Consider also

9. If I have a quarter in my pocket, I’ll put it in the parking meter.

Surely I’m not lying if I have two quarters in my pocket, especially if I put one into the meter. But the *Definite Lazy Reading* would have it thus: I do have a quarter so the antecedent is true, but since the *it* in the consequent in effect means “the one and only quarter in my pocket”, the consequent becomes false. And the *Universal Reading* fares equally badly: according to this reading, unless I am lying when I uttered (9), I must empty my pockets of all quarters and put each of them into the parking meter!

We think that the *Indefinite Lazy Reading* comes closest to capturing the intuitions behind these examples, and indeed of all examples of an indefinite NP being the antecedent of *it* in cases like the ones mentioned. For example, we think that in a sentence like

10. Every man who owns a donkey will ride it to town tomorrow

is true just in case every male donkey-owner will ride at least *one* of his donkeys to town tomorrow (again in contrast to Kamp-Heim-Groenendijk and Stokhof, who require such a person to ride them *all* to town tomorrow). We still think there are cases of deictic pronouns, of generic readings of pronominal sentences, and of bound variable anaphora. But for the present type of pronoun we think that this *Indefinite Lazy Reading* expresses the correct truth conditions (under certain assumptions about constraints imposed by the context of utterance), though our own translation (17b below) will not invoke any *ad hoc* phrase as the translation of *it* (such as “a donkey that Pedro owns”). Although we think that there are some types of readings for donkey sentences other than the *Indefinite Lazy Reading*, we think that the *Universal Reading* is just plain wrong. What makes it seem correct in certain cases is its confounding with a “generic” or “habitual” or “gnomic” understanding of these sentences. But everyone agrees that a universal analysis of generics/habituals/gnomics is certainly incorrect; and hence it is incorrect as a reading for donkey sentences. Let us consider

11. If I find a quarter, I’ll give it to you.

A gnomic understanding of (11) would have the sentence expressing a rule of (typical) behaviour on my part. We would in such a case wish to avail ourselves of a Carlson-like *Gn* operator which has the effect of attributing to me the habit of quarter-giving-to-you-when-I-find-one. Note that this “gnomic, rule of behaviour” reading does not imply that I will give you every quarter I find, anymore than the truth of *Birds fly* entails that every bird flies. This gnomic reading is certainly a possible reading of (11), but not the only one. Perhaps more natural is the *Indefinite Lazy Reading*, wherein you desire a quarter and I commit myself to giving you one if I find any. But certainly I do not commit myself to giving you every quarter I find! Nor am I attributing a rule of behaviour to myself — merely that I undertake to give you one quarter.

It was mentioned at the end of Section II above that one strategy to try to get the correct truth conditions for such sentences would be to “do a further adjustment on the logical form which had been initially generated”. One strategy (which we rejected) was simply to “raise” the quantifier so as to allow it to have wider scope. Another strategy might be to perform a “scope widening”, wherein existential quantifiers are changed to universal quantifiers (with an eye towards preserving logical equivalence). But there is compelling evidence against this attempt to do such a further alteration on the “logical form” with the adjustment of the scope of the quantifier. Such a “scope widening”<sup>14</sup> of the existential quantifier in the antecedent, replacing it with a wide-scope universal quantifier, would yield the Universal Reading analysis. Even if, contrary to our claims above, this were the correct understanding of the donkey sentence, it is still not *always* right to do this “scope widening”. Consider a generic sentence such as

12. Usually, if a cat drops to the ground it lands on its feet.

Scope widening for the ostensibly existential *a cat* is thwarted by the presence of the quantificational adverb *usually*; i.e., the sentence simply cannot be paraphrased as “Usually, every cat is such that if it drops to the ground, it lands on its feet”.<sup>15</sup>

One attempt to deal with the difficulty mentioned in the last paragraph is to translate existentials like *a donkey* in contexts like (7) or *a cat* in contexts like (12) as free variables, to be bound at the sentence level by an unselective quantifier. This is the approach taken by Lewis (1975) and his followers (especially Farkas and Sugioka 1983, McCord 1981, Heim 1982). Despite the specific difficulties we enumerated for the proposals of the first two in our earlier paper, the appeal of such an approach lies in the prospect it offers of accounting uniformly for all generic sentences. The approach is problematic, however, from the perspective of compositional semantics, since it interprets indefinites as free variables in some syntactic contexts (especially in restrictive clauses) and as existentially quantified in others.<sup>16</sup> For example, *a tail* in

13. Every dog has a tail.

would be existentially interpreted, while *a bone* in (14a) and (14b) would be interpreted as a free variable (with restrictions):

14. a. When a dog has a bone, it often buries it  
b. A dog often buries a bone if it isn't hungry enough to eat it.

Note that in (14b) *a bone* occurs in the main clause, yet would be treated “as if” it occurred in the restrictive clause. We will be very much occupied with this sort of difficulty in Sections XI and XII, which ultimately confronts any attempt at a compositional analysis.<sup>17</sup>

#### IV. INTRODUCTION TO CONTEXTS, SOME SIMPLE EXAMPLES

In this section we wish to introduce some rudiments of our formal theory (again, for the details, consult the Appendix) and show how it operates on the two examples given above. This will involve riding roughshod over various fine points in our theory, such as its treatment of modality and tense, but it will give the essentials (and symbolism) of the theory.

Instead of the usual “interpretation and valuation function” we wish instead to use the notion of a *context*, and invoke the idea of a *context change*.<sup>18</sup> We write contexts using square brackets, as [ ]. Such a context (completely) specifies values for variables, constants, predicates, indexical terms, *now*, *yesterday*, and the like. Sometimes we wish to consider a “variant context”, for example the result of forcing a variable to take on some particular value from the domain. Such variant contexts are written: [ ]<sub>x:d</sub>, which stands for the result of (re-)interpreting the variable *x* so that it is required to denote *d*, but that all other features of [ ] remain the same. Should we wish, for example, to force the context to talk about some particular time *j* as being *now*, we would write [ ]<sub>now:j</sub>. Since we are taking *now* as one of our “indexical constants”, this amounts to saying “let *j* be now”. If we want to say that a sentence  $\Phi$  is true in a context [ ], we would say  $[\Phi] = 1$ . (We will later relativize truth, and context change, to time and world indices, but avoid this refinement in our preliminary exposition.) In addition to evaluating the truth of a sentence in a context, we wish to consider how a context changes by having just “processed” or “evaluated” a sentence. We use  $\Phi[ ]$  to indicate this *new context* that has resulted from the “processing” or “evaluating” of sentence  $\Phi$  in the (old) context [ ]. So the picture of processing a text  $\Phi_1 \cdot \Phi_2 \cdot \dots \cdot \Phi_n$  is that the context continually

changes from [ ] (the initial context) to  $\Phi_n(\Phi_{n-1}(\dots(\Phi_1[ ])\dots))$ . Along the way we evaluate each sentence for truth or falsity with respect to the context as thus far developed, and suitably alter the context in order to evaluate the next sentence. So, the formal development of this theory must say how to evaluate a sentence in a context and also say how this "processing" will effect an alteration in the previous context. Since we wish to look at some simple examples, we must give some account of those matters that will allow us to treat these examples. We give here just enough to look at the examples, without considerations of tense and intensionality, and without showing how the parts we give fit in with the rest of the theory.

The examples we wish to consider contain indefinite NPs, which we uniformly translate with an existential quantifier (in our restricted quantification manner). To evaluate an existentially quantified sentence for truth/falsity, we appeal to this rule:

$$[(\exists x:\Phi x)\Psi x] = 1 \text{ iff there is a (variant) context } [ ]_{x:d} \text{ such that } [\Phi x]_{x:d} = 1 \text{ and } \Phi x[\Psi x]_{x:d} = 1,$$

where the order of operations in the last expression is understood to be  $(\Phi x([ ]_{x:d}))(\Psi x)$ , i.e.,  $x$  is (re-)interpreted as  $d$  first, then the variant context is transformed by applying  $\Phi x$ , and finally  $\Psi x$  is evaluated in the transformed context. Keep in mind that in the original context, [ ], all values are specified. In particular, a value for  $x$  has been given. For an existential quantifier which uses  $x$  as its variable of quantification, we will want to find a "re-interpretation" of the context in which  $x$  is made to denote some object which makes the unquantified sentence true. If we can find such a context then the existentially quantified sentence was true. Note however that we have added a slight embellishment: when evaluating the "matrix" of the sentence (that is, the portion of the sentence which is not the quantified NP), we alter our context in a certain way, namely by saying that we have just processed the quantified NP. Depending on just what the quantified NP was, this may or may not have any effect on the context in which we are evaluating our "matrix". We think, for example, that atomic sentences (e.g.,  $man(x)$ ) do not cause a further change in the context except possibly for the value of certain reference times (to be discussed later) as well as for the value of [now] which arguably should get incremented as we process a text sentence-by-sentence (we shall not consider this slight complication here); but more complex sentences — that is, more

complex subject NPs (e.g.,  $(man(x) \& (\exists y: donkey(y))owns(x, y))$ , which is our rendition of *man who owns a donkey*) will contribute to a change in the context. So, that is how we would evaluate a sentence with an indefinite NP as subject. The context that is generated from this evaluation is then "passed along" to the next sentence, to be used in evaluating it. Let us return to our previous example:

15. a. A man is at the door. He is behatted.

translated as

15. b.  $(\exists x: man(x))at-door(x) \cdot behatted(he)$ .

and "disambiguated" as

15. c.  $(\exists x: man(x))at-door(x) \cdot behatted(x)$ .

We start the evaluation of this "discourse" with the context [ ], and ask whether the first sentence is true in that context. According to our rule, this is

16.  $[(\exists x: man(x))at-door(x)] = 1$  iff there is a context  $[ ]_{x:d}$  such that  $[man(x)]_{x:d} = 1$  and which is also such that  $man(x)[at-door(x)]_{x:d} = 1$ .

So we try to find some  $d \in D$  (the domain) which, if it were the interpretation of  $x$ , would make  $man(x)$  true (that is, we try to find a man in the domain). If we succeed, we look at a slightly altered context — namely, the context in which we just "processed"  $man(x)$  — and ask whether in that context our  $d$  that we found can be used as the value of  $x$  in  $at-door(x)$ . That is, we ask whether this  $d$  (which we have already ascertained to be a man) is also at the door. Now, we have remarked that we do not think that atomic sentences cause a change in the context, and so the context,  $man(x)[ ]_{x:d}$ , will just be  $[ ]_{x:d}$ . In this context, which is just like our original starting context except that  $x$  is forced to denote  $d$ , we wish to know whether  $at-door(x)$  is true. Well, it is if the man  $d$  we picked is at the door; otherwise it is false.

We now wish to evaluate the second sentence in the context generated from having already "processed" the first sentence. So the question is, how does a context change when one has just "processed" an existentially quantified sentence? The answer we propose is this:

$$(\exists \alpha: \Phi \alpha) \Psi \alpha [ ] = (\Phi \& \Psi) [ ]_{\alpha:d}$$

That is to say, the new context will force  $\alpha$  to be interpreted as  $d$ , and there may be further modification by  $(\Phi \& \Psi)$ . Since in the case under consideration  $\Phi$  and  $\Psi$  are atomic, there is no further modification, and so the new context is just  $[\ ]_{x:d}$ . It is this new context in which we wish to evaluate *behatted*( $x$ ). But since  $x$  is forced to be a man at the door, this second sentence is true in this context just in case  $d$ , the man who is at the door, is wearing a hat. (And since this second sentence, *behatted*( $x$ ), is atomic it will not induce any further context changes which need to be considered in evaluating a third sentence.<sup>19</sup>)

Let us now turn to our evaluation of our "donkey sentence"<sup>20</sup>

17. a. If Pedro owns a donkey, then he will ride it to town

translated as

17. b.  $(\exists x: \text{donkey}(x)) \text{owns}(p, x) \rightarrow \text{rides}(\text{he}, \text{it})$

which might be disambiguated to

17. c.  $(\exists x: \text{donkey}(x)) \text{owns}(p, x) \rightarrow \text{rides}(p, x)$ .

We wish to evaluate the truth of this in the context  $[\ ]$ . Our rule for conditionals is

$$[\Phi \rightarrow \Psi] = 1 \quad \text{iff} \quad [\Phi] = 0 \text{ or } \Phi[\Psi] = 1.$$

That is, a conditional is true in a context if and only if either the antecedent is false in that context or if the consequent is *true in the context which results from modifying the original context by having "processed" the antecedent*. Let us suppose the interesting case, that the antecedent is not false in the original context. As in the previous example, this means that the new context will be just like the old context except that  $x$  will be forced to denote some  $d$  which made *donkey*( $x$ ) and *owns*( $p, x$ ) be true. So, in such a context is *rides*( $p, x$ ) true? That is, does  $[\text{rides}(p, x)]_{x:d} = 1$ ? Well, yes — if the  $d$  picked out before by the evaluation of the antecedent was a donkey Pedro rides to town. No, otherwise.

#### V. TRUE-IN-ENGLISH vs. TRUE-IN-A-CONTEXT

The notion of truth (in a context) which was partially explicated in the preceding section deviates from a more intuitive notion of truth, a notion that we will label "true-in-English". For example, in our discus-

sion of the man at the door, if the initial context had two men at the door only one of whom was behatted, then the second sentence would depend for its truth or falsity upon which of these men was "selected" to be the value of  $x$  in the "processing" of the first sentence. That is, our rules of context-change induced by an indefinite NP *arbitrarily* pick one of all the possible satisfiers of the indefinite, and use that one to evaluate pronomial reference in the following sentences. (Similar remarks also hold for our treatment of times, which we have not yet introduced.) Intuitively though, in the imagined case, *both* sentences should be judged true — unless there be some other, "pragmatic" reason to rule out one of the two men as a possible antecedent for *he*.<sup>21</sup> The position we take here is that in the ordinary notion of "true in English", the conventions of language (both semantic and pragmatic) allow for a good deal of leeway in the interpretation of predicates and terms in any particular context of utterance. In interpreting an utterance, hearers avail themselves of this leeway, i.e., they seek an interpretation that renders it true. In other words, we identify "truth in English" with the *existence* of an idealized context that satisfies conventional constraints on meaning (including constraints imposed by the context of utterance) in which the sentence is true (in the idealized sense). So the question of whether the second sentence of (15) is true-in-English in the imagined situation, amounts to the question of whether there *is* an idealized context, admitted by the actual utterance situation, which renders it true (in the idealized sense). We shall shortly try to make this more precise.

Consider again the sentences in (15), and suppose we are going to make a bet on the truth of the second sentence. If we both agree that the utterance situation is one in which 'he' refers to Adam (who might not be at the door at all), then the bet amounts to whether Adam is wearing a hat; that is, as to whether there is an idealized context in which all objects are assigned either to the set of hat wearers or to its complement, where this assignment agrees with ordinary beliefs (and so on) in those cases in which we have clear feelings about the matter,<sup>22</sup> and in which 'he' refers to Adam. You win if Adam is in the set of hat wearers in that context, and I win if he is in its complement.

Other times it is clear that we are using the pronoun in a way to talk about men at the door. Nonetheless, in some utterance situations, the choice of referent may be narrowed to the man the speaker *intends* to refer to. Again, suppose I utter (15) on the grounds that I answer the



see just one hatless man, and we both agree that it is this person to whom I am referring. I might reasonably be said to have spoken falsely-in-English despite the other, behatted, man at the door whom I do not notice. The reason here seems to be that, in such a case, (15) is being taken as a report of observations made by the speaker, and so the situation precludes unobserved men as possible referents of *he* (or indeed, even of *a man* in the previous sentence) in the utterance. If, on the other hand, there is some aspect of the utterance situation such that (15) need not be regarded as a report of direct speaker observations, or if I in fact see both men, then the second sentence would be true-in-English, since there is an idealized context among those admitted by the actual utterance context that renders it so. So in general we say that in an idealized context *all* meanings/denotations are *fully determinate*. And in such a context we are merely to look at whether the denotation of *he* is behatted; and if so, then the sentence is "true in that (idealized) context", otherwise "false in that (idealized) context". On the other hand, the notion "true in English at (time) *i* and (world) *w*" amounts to saying that *there is* an idealized context which (i) satisfies the preceding discourse (in a way to be spelled out later), (ii) makes the values of the indexical expressions *now*, *here*, etc., be the time and place of speech, etc., and more generally (iii) is "consistent with English" (which means, roughly, that the extensions it assigns to constants and predicates at *i* and *w*, as well as predicates' intensions, are consistent with English speakers' understanding of the original English terms). So a formula  $\Phi$  (translating an English sentence) is *true-in-English at *i*, *w** — relative to a preceding text  $\Phi_1, \Phi_2, \dots, \Phi_n$  — if and only if there is a context space (see Section VII, or the Appendix) containing some context [ ] consistent with English at *i*, *w* and this context is such that  $(\Phi_1 \cdot \Phi_2 \cdot \dots \cdot \Phi_n)^{i, w}[\Phi]^{i, w} = 1$ .

#### VI. SOME ELEMENTARY COMMENTS ON TENSE AND TIME ADVERBS

We now turn our attention to the issue of interpreting tenses and time adverbs within the intuitive theory we have sketched above. The proposed treatment will necessarily be incomplete, and unspecific at certain points, even in the more formal account of the Appendix. Here, though, we merely highlight the salient features that allow us to treat the generics which we are interested in. The treatment we give involves

two main ideas: (1) time adverbs take narrow scope relative to tense, and they do not involve any "shifts" in the time index of evaluation (cf. Richards and Heny 1982); (2) in keeping with most modern theories of tense, we avail ourselves of a "double indexing" method to simultaneously keep track of the time of evaluation and certain reference times, including "now". Our innovation in (2) is that the index which keeps track of the reference times is assumed to be a *vector* or *sequence* of times, one of which can be "in focus" during any specific evaluation of a sentence. We use *r* for this "reference time vector", whose elements are created or replaced in a context-dependent way when a sentence describing an episode is processed. At any stage of sentence evaluation, one of the elements of *r*, written as *r*, is "in focus", and the semantic value of the clause under consideration may depend on the value of *r*.

We consider the following time adverbs: YEST, AT-THAT-TIME, THEREUPON. If  $\Phi$  is an untensed sentence, then YEST( $\Phi$ ), AT-THAT-TIME( $\Phi$ ), THEREUPON( $\Phi$ ) are (temporal) sentences. The "tenses" we consider are: PRES, gPRES, PAST, and aspects PROG, PERF. If  $\Phi$  is a temporal sentence then PRES( $\Phi$ ), gPRES( $\Phi$ ), PAST( $\Phi$ ), PROG( $\Phi$ ), PERF( $\Phi$ ) are (tensed) sentences. PRES serves as simple present, while gPRES is the "generic present", which can occur only in conditional and temporal clauses, or in combination with frequency adverbials. The distinction between PRES and gPRES is needed if one assumes (as we do) that simple present forces evaluation at or near [now], the time of speech; for, in generic/habitual present-tense sentences such as (1), (2), (12) or (14), the cases considered are clearly *not* confined to the time of speech. As set down in the Appendix, the semantics of all five operators involves a shift in the time of evaluation to some other, indefinite (existentially quantified) time, constrained in certain ways relative to the given time of evaluation. In the case of PRES, the new time must nearly coincide with [now], in the case of gPRES, it lies in [present], an extended time stretch reaching into the past, and in the case of PAST, it lies before [now]. The intended use of THEREUPON and AT-THAT-TIME is as "default adverbials" in tensed sentences in a narrative. For example, in

(18) The alarm rang. John woke up.

the default adverbial in the second sentence is assumed to be THEREUPON, which places a reported *event* immediately or shortly after a previously reported *event*. In

- (19) John entered the room. Mary was asleep.

the default adverbial in the second sentence is assumed to be AT-THAT-TIME, which places a reported *state of affairs* at the end of a previously reported *event*, or at the same time as a previously reported *state of affairs*. (Of course, states of affairs may exist prior to and beyond the stipulated time; to affirm a state at one time is not to deny it at others.) We assume that the distinction between predicates describing events and those describing states of affairs is correlated with explicit syntactic features (e.g., a dynamic/static pair of features).

We would translate (20a) as (20b):

- (20) a. Mary left yesterday.  
b. PAST(YEST(leave(*m*))).

In the evaluation of this formula at time *i*, the PAST operator “checks” whether *i* is the current value of [now] and also whether the embedded formula holds at some time *j* before *i*. Thus there is a “backward shift” from *i* to *j*. But in the evaluation of the embedded formula at *j*, the operator YEST merely checks whether *j* lies within the time interval designated in the current context by *yesterday* (viz. the day before *now*) . . . it does *not* try to find a time which is the day before *j*.

The second idea was the use of the reference time sequence *r* to provide temporal connections within and between sentences. As we remarked, one element of *r*, denoted *r*, can be in focus. If we were to “look inside of” *r* we would find a sequence such as  $\langle i_1, i_2, \dots \rangle$ , where the boldface  $i_2$  indicates that it is “in focus”, i.e., it is the value of *r*. As we also remarked, the evaluation of a sentence might add elements to the sequence, and it might change which of the elements is in focus. We *think* that we need only consider cases where the new element in focus is the one immediately to the left of the current one in focus (which corresponds to “shifting forward in time one notch”) or where the new element in focus is the one immediately to the right of the current one in focus (which corresponds to “shifting backward in time one notch”). We indicate this by  $\bar{r}$  and  $\bar{r}$ , respectively. It might happen that evaluation of a sentence requires a shift to the right (for example), but there is no *i* at that location. We will allow this to happen, and say that the focus is undefined.

The way this works, intuitively, can be seen by considering sentences (21):

- (21) John entered the room. He called Mary.

The first sentence creates a reference time sequence consisting of the time of speech, which is in focus, and the time of John’s entering. The second sentence here, translated and disambiguated, is PAST(THEREUPON(*call*(*j*, *m*))), since there is no explicit time adverb in the English sentence. The PAST operator, before doing its evaluation as described earlier, shifts the focus of *r* back in time, so that the THEREUPON clause will be evaluated with the time of John’s entering in focus. THEREUPON then places the event it embeds immediately or shortly after that focal time *r*. Similarly, the second sentence in

- (22) John entered the room. Mary was asleep.

would be translated as PAST(AT-THAT-TIME(*asleep*(*m*))); AT-THAT-TIME affirms the state predication for the moment of time at the end of the reference time *r* (which is again the time of John’s entering). This method deals successfully not only with these sentence pairs, but also with such donkey sentences as

- (23) If Pedro bought a donkey yesterday, he sold it shortly afterwards.

Here, not only is there a “pronomial connection” to be “carried forward” from the antecedent to the consequent, but also a “temporal connection” needs to be made which places the selling shortly after the buying. We deal with this “temporal connection” in essentially the same way as we outlined above for the “pronomial connection” — the reference time is brought forward by the context change induced from having processed the antecedent, to be used in evaluating the consequent. A more complex example is considered in the Appendix; for now we will simply allow the informal intuitive correctness of the method carry us along to our consideration of generics.

We should also say here, since it will figure in our later treatment, that we find certain *when*-sentences ambiguous between a “simple report of an event” and a “general” statement. If, for example, the *if* of (23) were replaced by *when*, we would say that the “antecedent” could be taken in either of these two ways: a report of a single event that happened (perhaps the most natural understanding), and statement about a series of happenings yesterday of Pedro’s buying a donkey. In either case we are called upon to evaluate whether immediately or

shortly thereafter he sold it. The difference is whether there is one such event, or a series of pairs of correlated events. This ambiguity can be eliminated by putting a frequency adverb (*always, often, . . .*) either in the consequent clause or as an entire-sentence adverb. There are no doubt other ways of analyzing this phenomenon than attributing it to ambiguity. E.g., say that it is "unspecific" as to how many donkey-buyings there are, and that the sentence really says that all buyings — including the case where there is but one — were shortly followed by a selling. But we have a somewhat different feeling about the "ambiguity" in that one reading clearly seems to say that there was (at least) one donkey-buying yesterday followed by a selling (of that donkey, shortly afterward) whereas the other reading seems to predicate a habit or tendency on Pedro's part yesterday to sell-donkeys-he-bought-shortly-after-buying-them. And this reading does not require him to sell all his donkeys.

Depending on the sentence, one or the other of the alternative readings can be made more salient.

24. a. When John went to bed, Mary was asleep  
 b. When John went to bed, he wore a nightcap  
 c. When John was going to bed, he was wearing a nightcap  
 d. When John was going to bed, he wore a nightcap  
 e. When John goes to bed, he wears a nightcap

It seems that (24a) is most naturally read as a simple report of what happened on a specific occasion of John's bed-going, and that (24e) is most naturally read as a statement of a habitual practice of John's. The sentences (24b)–(24d) vary in their affinity to one or the other of these understandings. Perhaps they are most easily seen as reporting what happened on a specific occasion of John's bed-going in the past, but they also can be read as making a statement about what John's habits were in the past. (24b), for example, can be seen as saying that, there was a past habit of John's: when he went to bed he wore a nightcap. (24d) can also be seen in this way: *while* John went to bed (but not necessarily when he was in it), he habitually wore a nightcap. Once this understanding has been pointed out, it is easy to get it for progressives: (24c) might state a relationship between two of John's past habits — his habit of going to bed and his habit of wearing a nightcap — and the

relationship might itself be a habitual one. (24a) now can be seen as expressing also a habitual statement, although it is such a strange regularity that we tend to overlook it: it can express that the habitual regularity of Mary-being-asleep-when-John-went-to-bed used to happen in the past. (It is perhaps easier to get this when an adverb is supplied: *When John went to bed, Mary was usually asleep.*) (24e), on the other hand, can be seen perhaps as making factual prediction (not a habitual claim) in a "future present" tense (rather like the "historical present"). We do not insist on this, but it is clear at least in the past and progressive that such sentences are ambiguous in just the way we described. In any case, it is the type of understanding of the sentence expressing a habitual or regular occurrence that we wish to point to, and (as before in the discussion of donkey sentences) call a "generic reading" of these (unmodified) *when*-sentences.

#### VII. A LITTLE FORMALISM, AND "LEGITIMATE $\Phi$ -ALTERNATIVES"

As might have been gathered from the discussion above about "truth in English" and "truth in a context", there are times when we wish to be able to consider *all* the possible new contexts that could be generated from "processing" a sentence in an old context. This is particularly salient when we wish to know all the ways ( $\exists x: \Psi x$ ) $\Phi x$  could have been true, or all the times at which PAST( $\Psi$ ) was true, in order to be able to talk about each or several of those things or times. The current formulation of "truth in a context" gives only one way: that way specified by the context at hand. So, we would like to be able to talk about *other* contexts, sometimes. The point of this section is to define this notion.

A *context space* is a quadruple  $\langle D, W, C, \delta \rangle$ , where  $D$  is a domain of individuals partitioned into objects  $O$ , kinds  $K$  and time intervals  $I$ ,  $W$  is a set of worlds, and  $C$  is a set of *contexts*, all of these being non-empty. An element of  $C$ , a context, is a (total) function on the expressions of the language  $\mathcal{L}$ .  $\delta$  is a (total) function  $\delta: F \times I \times W \times C \rightarrow C$ , called a *context transformation function*, mapping formulas, times, worlds, and contexts into (new) contexts. When we talk about a particular  $\delta$ , we will abbreviate  $\delta(\Phi, i, w, [ ])$  as  $\Phi^i w [ ]$ ; this notation means the context which results from having "processed" or "evaluated"  $\Phi$  in the context  $[ ]$ , at time  $i$  and world  $w$ , when it is understood that

we are talking about a particular context transformation function. We intend  $\delta$  and all  $[\ ] \in C$  to meet various conditions, which are spelled out in the Appendix.

As can be seen from the above definition, the context transformation function  $\delta$  is a *function*; and therefore, at a time and world, given a preceding context and a formula it will always generate the same new context, and thus it will not allow us to consider "other contexts which could have resulted from processing  $\Phi$ ". When we do wish to consider variant contexts we appeal to the notion of a *legitimate  $\Phi$ -alternative* of context  $[\ ]$ , which amounts to considering a context that *could* have been generated by processing  $\Phi$  in context  $[\ ]$  (at  $i, w$ ) using *some* context transformation function  $\delta$ . Various restrictions apply here: we want only to consider context transformation functions which render  $\Phi$  true in  $[\ ]$  (at  $i, w$ ) and we want them to be "legitimate", i.e., to obey the strictures on a context transformation function (given in the Appendix). More formally, we introduce a function  $f_s$  dependent on the context space  $S = \langle D, W, C, \delta \rangle$  which applies to a formula, a time and a world of evaluation, and a particular context, to yield a set of contexts that arise from applying other context transformation functions to that particular context (with the condition that the evaluation of the formula had to be true).

$$f_s(\Phi, i, w, [\ ]) = \{[\ ]' \mid \text{there is a context space } S' = \langle D, W, C, \delta' \rangle \text{ such that } [\ ]' = \delta'(\Phi, i, w, [\ ]) \text{ and } \{\Phi\}^i w = 1 \text{ with respect to } S'\}.$$

Here the phrase "with respect to  $S'$ " is crucial. This is because  $\Phi$  may be compound, and the value of one part of  $\Phi$  may be "conditioned" by the effect on the context of another part; thus the overall value may depend on the context transformation function, and hence on the context space.

Earlier, we outlined two types of context change: changes in variable assignments due to existential quantification, and changes in the reference time sequence  $r$  due to episodic sentences. Henceforth  $\Phi$ -alternatives to a context  $[\ ]$  may be thought of as differing from  $[\ ]$  only in these assignments. (However, a more fully developed theory would also allow for context-dependence of indexical constants as well as of predicate extensions and intensions.)

### VIII. "REFERENCE ENSEMBLES", FREQUENCY ADVERBS, AND GENERICS

We mentioned at the outset of this paper that we find one of the most salient features of habituals and (some) generics to be their (explicit or implicit) reliance on an "ensemble of cases" with respect to which their truth is evaluated. We call the "ensemble of cases" which is relevant to a particular sentence the *reference ensemble* for that sentence. As remarked in the introduction, we think that there are two types of reference ensembles: ensembles of situations and ensembles of objects. To evaluate correctly and accurately the truth of (certain) generics and habituals, one must determine what these reference ensembles are. It is our view that these reference ensembles — whether of situations or of objects — are determined in various ways. One way would be from a previous-sentence context. For example

25. a. John rarely misses

might have as its reference ensemble a group of situations consisting of events wherein John is firing a gun at something, and we might have this made obvious to us by the presence of a previous sentence like

25. b. John is an excellent marksman.

The sentence

26. a. Baboons form a protective circle with males on the outside.

might have a reference ensemble of situations consisting of events where leopards are approaching monkeys, perhaps given by means of a previous sentence like

26. b. Most monkeys flee when leopards approach.

Another way reference ensembles may be determined is by presupposition, either of the VP or by stress, *within* the sentence under consideration. For example

27. Cats usually land on their feet

suggests, by means of the presuppositions of *land*, that the reference ensemble will be cases of a cat dropping to the ground. And the

reference ensemble of situations relevant to (boldface is used to indicate stress)

28. **Leopards usually attack monkeys in trees**

contains those situations in which leopards attack monkeys somewhere, and the sentence then says that in most of these situations the attacks occur in trees. A third way reference ensembles might be determined is by "characterizing properties" of the subject. For example

29. **Bullfighters are often hurt**

seems to require as a reference ensemble, a group of situations in which a bullfighter is participating in a bullfight. And then the sentence says that many of these are situations in which the bullfighter gets hurt.

Some sentences are ambiguous between a generic (or habitual) reading and a "capacity" reading. Consider for example

30. a. This car goes 200 kph

31. a. Kim reads German

32. a. Robin rides horses.

In the "capacity" reading, the sentences mean that the car *is capable of* going 200 kph, that Kim *is able to* read German, and that Robin *knows how to* ride a horse. This sort of reading involves no reference ensemble. (Instead, we suppose that it involves an implicit "is-able-to" operator which modifies the overt predicate.) In the generic/habitual reading the sentences mean that the car often goes 200 kph, that Kim habitually reads German, and that Robin regularly rides a horse. In this reading the presupposed reference ensembles are:

30. b. This car is being driven.

31. b. Kim is reading.

32. b. Robin is riding (an animal).

The examples considered here suggest that when we evaluate any generic or gnomic sentence with respect to a given "index" we do so with reference to an ensemble of situations or of things that may not be extant at that index, but rather at other (especially temporally displaced) indices. The exact characterization of this ensemble (which perhaps also involves a probability distribution, as we shall later

speculate) is a problem for "pragmatics" in that this will involve both linguistic and extralinguistic context. But the formulation of truth conditions with respect to a given index *given* such an ensemble is a problem for semantics. Moreover, it is a problem for semantics to show how *explicit* "case adverbials" and restrictive clauses (as in (33)–(50) below) provide an ensemble with respect to which the embedded matrix clause is evaluated.

33. Usually, when a cat is dropped to the ground, it lands on its feet.
34. Sometimes, when John and Marvin play a game of ping pong, Marvin beats John.
35. Often, when bullfighters are engaged in a bullfight, they get injured.
36. When a cat is dropped to the ground, it usually lands on its feet.
37. When John and Marvin play a game of ping pong, John sometimes beats Marvin.
38. When bullfighters are engaged in a bullfight, they often get injured.
39. When cats are dropped to the ground, they usually land on their feet
40. When a dog gives birth, it gives live birth
41. Small fish are widespread when big fish are rare
42. Lizards are pleased when the sun shines
43. Around the New Year in Edmonton, it usually snows
44. In emergency situations, flight attendants are usually effective
45. Cats dropped to the ground always land on their feet
46. Rats crowded together in a small cage are usually aggressive
47. Dogs with/that have blue eyes are (usually) intelligent
48. Dogs are (usually) intelligent if/when they have blue eyes

49. Dogs dislike cats when they (the cats) have blue eyes  
 50. When cats have blue eyes, they are intelligent.

Following up the suggestions in our earlier paper, we would like to take as our paradigm cases of habitual/generic sentences ones like (33)–(40) and (50); these contain all of the information that appears relevant to the specification of the reference ensemble in an explicit if/when clause. So . . . what were these suggestions? With regard to “episodic” or “situation” examples (like (33)–(40)), we would in essence like to be able to “quantify” over the situations in an ensemble; that is, we want to be able to talk about what happens in many, or most, or all, or some, of the situations in the ensemble. We furthermore have in mind that this quantification is potentially intensional as well as extensional especially when there is no overt adverbial, as in (40) and (50) (i.e., is evaluated with reference to situations in other possible worlds, as well as the actual one); and we wish to be able to make a “referential connection” between the entities in the situations quantified over and the entities referred to in the matrix formula. For example, with regards to the *when*  $\Phi, \Psi$  pattern of sentences like (39) we would like to represent it in some manner such as the following:

- 39'. USUALLY [WHEN ( $\exists x: R(x, \mu(\text{cats}))$ ) drop-to-the-ground( $x$ ),  
 land-on-feet( $x$ )].

That is, we allow the *when* clause to pick out the reference ensemble, and then use the quantificational adverb *usually* that appeared in the  $\Phi$  clause to relate the reference ensemble with the main clause. USUALLY can be thought of as a “quantificational conditional” which takes two arguments. Intuitively, the first is the ensemble of situations, and the second is the matrix formula to be evaluated (with respect to that reference ensemble and in accordance with the evaluation rule for USUALLY). Note, incidentally, that a frequency adverb can syntactically occur explicitly at the sentence level over the entire conditional sentence, as in (33)–(35), or it can occur at (apparently) the VP level in the “matrix” sentence, as in (36)–(38). Semantically speaking, we will treat these two type of modification by a frequency adverb identically: we treat the frequency adverbs as applying to the entire “when-sentence”, as manifested in (33)–(35). (In the logical form we eventually propose, we omit the one-place operator WHEN, since its

effect on its argument can be assimilated to the effect of the two-place operator USUALLY on its first argument, and then we move USUALLY from the above prefix position to infix position, rewriting it as  $\rightarrow_U$  to emphasize its interpretation as a quantificational conditional. But we retain it here for intuitive clarity.) Note however, the “dangling” variable in the matrix formula (the *land-on-feet*( $x$ ) clause), which is not in the scope of any quantifier. As with the donkey sentences, we would like to think of this variable as implicitly bound by the “quantifier phrase” (i.e., the USUALLY-WHEN combination). That is, we have in mind that we will “iterate through” the situations satisfying the WHEN-clause to find choices of  $x$  which render the restriction true, and we will use these choices to evaluate the matrix formula. Just as in the donkey sentences, we would wish to say that, although the scope of the ( $\exists x$ ) quantifier is only the WHEN clause, we can use information from its evaluation to do further evaluation of the matrix clause. The details of this sort of analysis, in Section IX, form the centre-piece of our paper.

We would also want to represent the reference ensemble of objects in a similar manner. For example, (50) might be represented as (50)′:

- 50'.  $G$ [WHEN( $(\exists x: R(x, \mu(\text{cats}))$ )have-blue-eyes( $x$ ))]  
 [intelligent( $x$ )].

Here we have used the WHEN clause to pick out groups of cats-that-have-blue-eyes. The  $G$  here is a two-place quantifier (differing from USUALLY in that it has nomic import) meaning “generally” or “characteristically” or “as a rule” which gathers together those cases described by its first argument for use in evaluating the sentence given as second argument. In this type of case, however, we are apparently not looking at *periods of time* in which there is a cat-with-blue-eyes, but rather at cats-with-blue-eyes themselves — that is, at the *objects*. We will attempt, in Section X, to give an account that unifies these “temporal” and “atemporal” uses of restrictive *when* clauses, but it is highly speculative. In essence, it claims that despite appearances, the quantification in sentences like (50) *does* make reference to times. While it may ultimately prove best to fall back to a “schizoid” account that distinguishes temporal and atemporal *when* clauses (with a Carlson-like analysis of the atemporal examples), our further investigations in Sections XI and XII instead lead us in the direction of Lewis-like unselective quantifiers. However, the approach we sketch avoids radical non-compositionality, retains many of the features of our

analysis of episodic generics, and is coupled to a view that the correct analysis of generics must appeal to structured meanings of some sort.

#### IX. PUTTING IT ALL TOGETHER: EPISODIC GENERICS

As suggested in the last section, we shall take, as our basic generics/habituals, such sentences as

36. When a cat is dropped to the ground, it (usually) lands on its feet.
39. When cats are dropped to the ground, they (usually) land on their feet.
51. When a cat is eating, it is happy
52. When John is driving, he drives fast.

In the terminology of Krifka (1987) these are *I*-generics/habituals. Of course our treatment of (Krifka's) *D*-generics will be different. Such singular generics as

53. The dog is common
54. Water is scarce
55. Ice cream comes in many different flavours

(and others) will receive a representation wherein the predicate *directly* applies to a kind. It should be noted that there are "mixtures" of the two, such as (41) in the last section and the following. (Krifka's taxonomic readings, mixed with *I*-genericity; the example is adapted from one of Godehard Link's).

56. When a species is well-attuned, it usually survives.

Here we are making an *I*-generic statement, but the "instances" we are talking about are themselves kinds. So, this is a generic statement (hence it needn't be universally true, but rather expresses a "law" true about instances of *is a species*); but the instances are kinds, and so what is predicated of these instances is itself a "kind level" property. We intend our theory to accommodate these types of generic statements also.

As remarked in Section VI (on tense), the *when*  $\Phi$  adverb clause,

when applied to a sentence  $\Psi$  without explicit frequency adverb, is ambiguous: on the one hand, it might pick out a particular time interval at which  $\Phi$  is true and claim that *AT-THAT-TIME*( $\Psi$ ) (or *THEREUPON* ( $\Psi$ )) is also true, or it might be used "generically" to pick out (all) times at which  $\Phi$  is true and claim that at most of these times *AT-THAT-TIME*( $\Psi$ ) or *THEREUPON*( $\Psi$ ) is also true. In our representation this ambiguity is manifested by whether there is or isn't supplied the default frequency adverb *G* ("generally" or "characteristically").

We have already illustrated how we wish to treat the "simple report of an event" reading of such sentences (above, Section VI, on tenses). Here we concentrate on the other, generic, reading. Our proposal is to translate sentences of the form

57.  $B$ , when  $\Phi$ ,  $\Psi$

— where  $B$  is a frequency adverb, and *when*- $\Phi$  is one of our *when*-adverbials — as

58.  $[\Phi \rightarrow_B \Psi]$ .

That is, we introduce into our logical form language a series of "quantificational conditionals" (one for each of our frequency adverbs, supplemented by *G* as default). The rules of evaluation for such formulas are (schematically — we associate *always* with "all", *usually* with "most", etc.):

59.  $[\Phi \rightarrow_B \Psi]^{i,w} = 1$  iff for all/most/many/some/no...  
 $[ ]' \in f_s(\Phi, i, w, [ ]), [\Psi]^{i,w} = 1.$

Here we see the use of our "legitimate  $\Phi$ -alternative" function  $f_s$ . Its job is to find all the "alternative ways" (relative to the initial  $[ ]$  and the given  $i, w$ ) that the *when* clause might have been true by considering other objects which satisfy the *when* clause and by considering other times at which some other objects satisfy the *when* clause. If in  $B$ -many of these legitimate alternatives (whatever  $B$  happens to be), the  $\Psi$ -clause is true also, then the whole sentence is true (in the initial world, at the specified time interval of the original context). Again, one might note the similarity to Heim (1982: 190f), although we here *always* translate a singular indefinite NP with an existential quantifier. Part of the reason we can do this is that we are in effect treating quantificational conditionals as adding another level of "iterating" through bindings of indefinites *on top of* the "iteration" (or "search" for a suitable binding)

carried out by the existential quantifier. Thus, there is no need to *suppress* the existential import of indefinites within the restrictive clause of a generic, as in other approaches. Another reason lies in the mechanism we have developed for "carrying forward" both values of indefinites and event times from one clause to the next. In conjunction with our semantics of quantificational conditionals (59), this supplies the required "referential connections" between antecedent and consequent *without* converting indefinites to free variables shared by antecedent and consequent.

The correctness of our method for simple *I*-generics is easily seen at an intuitive level (we will also supply formal details for one example). Consider, for instance

60. Usually, when a cat is eating, it is happy.

We assume that the only form of the present tense possible in a clause with a frequency adverb (operating on the S or VP) is gPRES. We also assume that the tense of a *when* clause and the main clause it modifies must coincide. Then it follows that both clauses of (60) are in gPRES tense.

So, the legitimate alternatives of the antecedent, *when a cat is eating*, will contain every possible cat, and every possible time within the extended present (i.e., within [present]) such that the cat is eating at that time. This is because there *are* context transformation functions (different from whichever one is "given") which will "select" any cat-time combination that "shows" the antecedent to be true. Each alternative context thus generated will encode a choice of cat as a value of the variable quantified in *a cat*, and a corresponding choice of eating-time as value *r*, the focal reference time. (If the sentence were past tense, the eating-time would be encoded as the reference time "to the right of" — i.e., a step backward in time from — *r*; this is because the focus at the *end* of processing a clause is always [now], and this lies "to the immediate left of" a simple past reference time.)

The consequent would be translated with a gPRES operator as well as a default AT-THAT-TIME adverbial, and the pronoun would be disambiguated to the variable quantified by *a cat*, say *x*, in the antecedent. When this is evaluated in one of the alternative contexts generated by the antecedent, gPRES first "checks" whether *x* (as determined in that context) is happy at some time within the extended present, and for such times, AT-THAT-TIME "checks" whether they

are at-the-end-of, or coincident with, the time of *r*. If such a time can usually be found, for the alternative contexts generated, the sentence is true.

It might also be remarked here that, in the case of these sorts of simple generics/habituals with no indefinites in the consequent, there is no distinction between "truth in a context" and "truth in English". Recall that the latter amounts to "truth in *some* (legitimate) context"; but in the case of generics that are true, we have found *all* (legitimate) contexts with respect to the *when* clause and evaluated the consequent as some frequency adverb-quantification of them all. So the generic sentence is true in context [ ] because its consequent is true in certain alternative contexts. But this result is independent of which context we start with (so long as we start at the same time and world).

Our basic account satisfactorily handles many other examples of this ilk, belonging to a certain group of (*I*-generic) generic sentences. For example:

61. When a cat drops to the ground, it usually lands on its feet
62. When Tabby drops to the ground, she always lands on her feet
63. When Fritz speaks, he never speaks German
64. Often, when a bullfighter participates in a bullfight, he is injured
65. When Pedro owns a donkey, he usually beats it

and so on. The crucial points involved in determining which ones our basic account handles are: (1) The sentence should have a *When*  $\Phi, \Psi$  structure with or without an explicit frequency adverb, (2) There should be a name or indefinite NP in the *when* clause but none in the main clause (at least none that should be "iterated over" by the quantifying adverb), and (3) The *when* clause should express an "episodic" predication.

We will shortly come back to generics that do not exhibit one or more of these three properties, but first we will work out in some detail the semantic evaluation of one of the above sentences, (65), to show how our formal mechanism works. This sentence is translated into our logical form as  $(\text{gPRES}((\exists x: Dx)O(p, x)) \rightarrow_v \text{gPRES}(\text{AT-THAT-}$



TIME( $B(p, x)$ )). We assume that  $B$ , the translation of *beats*, incorporates a dispositional or habitual operator, so that it can be read as "is disposed to beat" or "beats habitually". (Obviously, we could have avoided this minor complication by using, say *likes* instead of *beats*.) Since this is non-episodic, the appropriate default adverb is AT-THAT-TIME.

Now,  $[\text{gPRES}((\exists x: Dx)O(p, x)) \rightarrow_U \text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$

- (1) iff for most  $[ ]'$   $\in f_5(\text{gPRES}((\exists x: Dx)O(p, x)), i, w, [ ])$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; i.e.,
- (2) iff for most  $[ ]'$  such that for some  $j$  during [present],  $[ ]' \in f_5((\exists x: Dx)O(p, x), j, w, [ ])$  and  $[(\exists x: Dx)O(p, x)]^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; i.e.,
- (3) iff for most  $[ ]'$  such that for some  $d \in \mathbf{D}$  and for some  $j$  during [present],  $[ ]' \in f_5(Dx \& O(p, x), j, w, [ ]_{x:d})$  and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$  and  $[(\exists x: Dx)O(p, x)]^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; i.e.,
- (4) iff for most  $[ ]'$  such that for some  $d \in \mathbf{D}$  and for some  $j$  during [present],  $[ ]' \in f_5(Dx \& O(p, x), j, w, [ ]_{x:d})$  and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; i.e.,
- (5) iff for most  $[ ]'$  such that for some  $d \in \mathbf{D}$  and for some  $j$  during [present],  $[ ]' \in f_5(O(p, x), j, w, [ ]_{x:d,r:j})$  and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; here the reduction of the conjunction  $(D(x) \& O(p, x))$  to  $O(p, x)$ , in the first argument of  $f_5$ , preserves the equivalence since the last equality entails  $[D(x)]_{x:d}^{i,w} = 1$ , as required by rules (8b) and (6b) of the Appendix;

Now the remaining atomic clause  $O(p, x)$ , like the clause  $D(x)$  just

eliminated from the first argument of  $f_5$ , merely sets  $r$  to  $j$  in the context  $[ ]_{x:d,r:j}$ . But  $r$  is *already*  $j$ , so the equivalence (5) amounts to

- (6) iff for most  $[ ]'$  such that for some  $d \in \mathbf{D}$  and for some  $j$  during [present],  $[ ]' = [ ]_{x:d,r:j}$  and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]^{i,w} = 1$ ; i.e.,
- (7) iff for most  $[ ]_{x:d,r:j}$  such that  $d \in \mathbf{D}$ ,  $j$  during [present], and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $[\text{gPRES}(\text{AT-THAT-TIME}(B(p, x)))]_{x:d,r:j}^{i,w} = 1$ ; i.e.,
- (8) iff for most  $[ ]_{x:d,r:j}$  such that  $d \in \mathbf{D}$ ,  $j$  during [present], and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $i = [\text{now}]$  and  $[\text{AT-THAT-TIME}(B(p, x))]_{x:d,r:j}^{k,w} = 1$  for some  $k$  during [present] $_{x:d,r:j}$  ( $=$  [present]); i.e.,
- (9) iff for most  $[ ]_{x:d,r:j}$  such that  $d \in \mathbf{D}$ ,  $j$  during [present], and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $i = [\text{now}]$  and  $[B(p, x)]_{x:d,r:j}^{k,w} = 1$  and  $k = \text{end of } [r]_{x:d,r:j}$  for some  $k$  during [present]; i.e.,
- (10) iff for most pairs  $\langle d, j \rangle$  such that  $d \in \mathbf{D}$ ,  $j$  during [present], and  $[D(x) \& O(p, x)]_{x:d}^{i,w} = 1$ ,  $i = [\text{now}]$  and  $[B(p, x)]_{x:d,r:j}^{k,w} = 1$  for  $k = \text{end of } j$ .

So this says that the original sentence is true just in case for most individuals  $d$  and time intervals  $j$  within the extended present such that  $d$  is a donkey that Pedro owns at time  $j$ , Pedro beats  $d$  habitually at time  $k = \text{end of } j$ . (Note that if  $j$  is an instant,  $k = j$ .) This is just what our previous intuitive explanation had told us we wished; and we take this formal confirmation of our intuitions to be evidence that this way of looking at "contexts" and "reference ensembles" satisfactorily captures the truth conditions for generic sentences of this type. (We will have something more to say about the exact meaning of "most" later on.)

There is one objection, however, that can be raised to these truth conditions. They require Pedro to beat most of the donkeys he owns at any *given* time, not only to beat *some* donkey at most times at which he owns any. While the former is a possible, and natural, reading of the

sentence, so is the latter. As in the case of non-generic sentences, this is particularly clear if one replaces *beats it* in (65) by *rides it to town*, or if one considers generic versions of "parking meter" sentences, such as *If I have a quarter, I always put it in the parking meter*. We will eventually suggest, in Section XII, that the way to obtain the two readings is to associate with any quantificational conditional, such as  $\rightarrow v$ , an additional argument supplying the variables it "controls". If only time is controlled by  $\rightarrow v$ , then only temporal alternatives are generated, and only one donkey need be beaten. If both time and the donkey variable are controlled, we obtain the reading at hand. However, we set aside those tentative revisions of our theory for the time being, assuming instead that alternatives are generated as described.

Finally, we should point out again that if (65) had lacked a frequency adverb, we would have used  $\rightarrow_G$  as "default" conditional. According to clause (16) in the Appendix,  $\rightarrow_G$  quantifies over (or statistically samples) "nearby" worlds, whereas the other quantificational conditionals quantify over (temporally dispersed) cases within the given world only. (We do not want the rather approximate truth conditions in clause (16) to be viewed as committing us to a non-intensional semantics for quantificational conditionals other than  $\rightarrow_G$  relative to other conditionals, and should perhaps treat *all* of them as intensional.)

We now turn our attention to episodic generics that involve a bare plural as subject of the *when*-clause (so that they do not manifest the second of the three characteristics we described as central to our treatment). Our proposal on these is less than firm; still, we think that there is considerable plausibility in our attempt to treat them. An example of this type of generic sentence is

66. When cats drop to the ground, they usually land on their feet.

(We will ignore certain questions involving plurality, such as how many cats are involved in each situation, and why, in this case, we all believe that individual cats are dropping to the ground. See the Coda (on plurals) to this paper for further remarks.) Our suggestion for these generics that have an episodic *when* clause but a bare plural in the antecedent follows our suggestions in the earlier paper (Schubert and Pelletier, 1987). We assume that the "pragmatic component" which does such things as "disambiguate pronouns", will also apply certain meaning postulates relating episodic formulas about *kinds* to episodic formulas about *realizations* of those kinds (i.e., objects); those realiza-

tions will then be available as referents for anaphoric pronouns. So, for example, we would propose a meaning postulate such as

- (MPa). For  $P$  an episodic object-level predicate and  $k$  a kind,  
 $\Box(P(k) \leftrightarrow (\exists x: R(x, k))P(x))$ .

Such a postulate is needed in any case to provide pronoun referents in texts like

67. Cats dropped to the ground. They landed on their feet.

Just as in this text, the postulate can provide the existentially quantified variable needed in (66) to allow interpretation of *they* in accordance with our method for evaluating generics with an indefinite in the antecedent.<sup>23</sup> Thus we would translate (66) as (with  $D$  for "drops to the ground", and  $L$  for "lands on its feet" — ignoring problems with the embedded pronoun):

66. a.  $gPRES(D(\mu(\text{plur}(\text{cat})))) \rightarrow v$   
 $gPRES(\text{THEREUPON}(L(\text{they})))$

and then apply postulate (MPa) to yield (with anaphoric *they* "resolved" to  $x$ )

66. b.  $gPRES((\exists x: R(x, \mu(\text{plur}(\text{cat}))))D(x)) \rightarrow v$   
 $gPRES(\text{THEREUPON}(L(x)))$

which, modulo certain facts about the interpretation of the *plural* kind, *cats*, appears to give just the correct truth conditions, when combined with our semantic interpretation method. The sentence is true just in case for most collections  $c$  of cats and times  $i$  within the extended present such that  $c$  drops to the ground at time  $i$ ,  $c$  land on their feet at a time  $j$  within the extended present, where  $j$  is either immediately or shortly after  $i$ .

## X. THE PROBLEM OF NON-EPISODIC GENERICS

Recall that the third characteristic of those generic sentences which are central to our treatment is their episodic nature. We now examine the possibility of extending our treatment to cover non-episodic generic sentences. We will find that some extensions in this direction are possible, by regarding certain non-episodic sentences as "implicitly" episodic. However, we will ultimately express scepticism about this

approach, after considering further problems encountered in the attempt to develop a unified, compositional account of generic sentences with and without restrictive clauses (see Section XI).

As in our treatment of episodic generics, let us begin with an example involving a *when* clause with an explicit singular indefinite:

68. When a cat has blue eyes, it is usually intelligent.

We would like to treat these sentences in a manner that parallels the treatment of episodic generics, in view of their parallel syntax and analogous meaning (only, with ensembles of individuals taking the place of ensembles of situations). For (68), this seems technically straightforward; we take the logical form to be

$$68'. \quad \text{gPRES}((\exists x: \text{cat}(x))\text{HBE}(x)) \rightarrow v \\ \text{gPRES}(\text{AT-THAT-TIME}(\text{intelligent}(x)))$$

(where HBE is an abbreviation of “has blue eyes” in which we have suppressed any quantification over “eyes”). Much as before, the sentence is true just in case for most cats  $x$  and times  $i$  within the extended present such that  $x$  has blue eyes at time  $i$ ,  $x$  is intelligent at  $i$ .

A reasonable question about this interpretation is whether it even makes sense to talk about quantification over time intervals here. While quantification over time intervals (or episodes) seems clearly appropriate in the episodic generics, shouldn't the quantification in (68) be simply over blue-eyed cats? Or to put the question in a slightly different form, is it even coherent to talk about “most” time intervals during which a cat has blue eyes, in view of the fact that these time intervals can overlap and include each other, and that there are *infinitely* many of them (assuming time to be non-discrete)?

In addressing this question, we should point out that the interpretation of “most time intervals” is potentially problematic even in clearly episodic habitual sentences such as

69. When John has a headache, he is usually irritable.

Here too, there are infinitely many overlapping time intervals during which John has a headache, even if (intuitively) there is just one headache-episode. Indeed, it seems to us that the puzzle illustrated by (68) carries over to all the episodic examples we have considered: to be able to evaluate the truth of such sentences, one must have some systematic or random method of “enumerating” or “sampling” the cases

over which one is quantifying — one cannot merely “consider the domain, simpliciter”. This is especially salient when the quantification is done with one of the “proportional” or “comparative” quantifiers (*usually, rarely, often, half the time, etc.*). For example, one might have in mind some systematic or random method of enumerating blue-eyed cats kept as pets in North American homes (or encountered in one's personal experience, depending on the context, one's degree of “objectivity”, etc.) and determining the proportion of intelligent cats among those surveyed. Presumably the sampling would not be confined to the moment of time at which (68) is uttered, but would also probe past times (conceivably, according to a probability distribution that attaches greater weight to the immediate past than to the remote past). In addition, if one wishes to read (68) as nomic, the sampling would have to extend to “nearby” possible worlds. An explicitly statistical interpretation of quantificational adverbs has been outlined by Åqvist *et al.* (1979); and Bacchus and Schubert (1987) have proposed a probabilistic extension of first-order logic which also allows representation of certain generics as explicit conditional probability statements. We shall not explore these possibilities here, but will simply assume that phrases such as “for most cats  $x$  and time intervals  $i$  such that  $x$  has blue eyes at  $i$ ”, or “for most persons  $x$  and time intervals  $i$  such that  $x$  has a headache at time  $i$ ” *can* be explicated in a technically satisfactory way. On that assumption, we claim to have shown that the truth conditions of non-episodic generics like (68) can be treated as identical to those episodic generics we have already considered.

If a temporal interpretation seemed at first inappropriate for (68), it will seem even more inappropriate for a sentence such as

70. When a number is a prime power of two, less one, it is usually squarefree.

Unlike any of our previous examples (and like some of Lewis's, 1975), this sentence is about entirely atemporal entities, and so it would appear that time should not enter at all into its interpretation. But while this may be the correct view for a mathematician to take, it is arguably not the correct view for a linguist or philosopher of language to take. For in the first place, the *semantic evaluation* of a sentence like (70) is, presumably, tied to a particular time index (or several such indices, as in many theories of tense). In other words, despite the atemporal character of numbers, we need to be able to talk about the truth value

of particular predications about them *at particular times*. Secondly, (70) cannot simply be a statement about the *proportion* of squarefree numbers among the "Mersenne numbers", because proportions are not well-defined for infinite sets. However, proportions (or at least their limit sups and infs) are well-defined for *enumerations* of infinite sets in some order, as well as for *probability measures* over fields of (finite or infinite) sets. So the interpretation of (70), just like that of (68) and episodic sentences, requires some underlying notion of systematically enumerating, or randomly sampling, the individual cases at issue. In particular, (70) might be interpreted with respect to an enumeration of Mersenne numbers in their natural order (though in that case the limiting proportion of squarefree numbers may be 0, making the sentence false), or with respect to some probability measure that assigns relatively high probability to relatively small numbers (perhaps making the sentence true).

The probabilistic interpretation is not implausible, if one considers that informal generalizations like (70) (or like any of our episodic generics) are, after all, based on the individual or collective *experiences* of a human community. Experiences pertaining to numbers, just like experiences pertaining to people and cats, include many encounters with *particular instances* of them, and these may form the basis for a subjective probability distribution (or something idealizable as such) over instances likely to be encountered "in practice".

That some notion of sampling over an extended stretch of time is involved even in non-episodic generic sentences is also suggested by the following anomalous examples:

71. a. ?When a number lies between 114 and 126, it is never prime.  
 b. ?When a cat is among those that John presently owns, it is usually intelligent.

Here the difficulty in associating a temporally extended sampling process with the quantifying adverb seems to hinder their interpretation.

In view of these considerations, we propose to translate (70), consistently with our treatment of episodic sentences, as

$$70'. \quad \text{gPRES}((\exists x: N(x))P(x)) \rightarrow v \text{gPRES}(Q(x)).$$

This says of the ensemble of instances/times-encountered-in-practice of prime powers of two, less one, that they are usually squarefree.

Venturing further, we now turn to generic *when* sentences in which the *when* clause both contains a bare plural and does not have an episodic verb phrase, such as

72. When cats have blue eyes, they are usually intelligent.

At the end of the last section, we were able to extend our "basic" account to deal with some generic *when* sentences containing bare plurals. In doing so, we appealed to a meaning postulate (MPa), applicable to episodic predications about kinds, to provide *realizations* of those kinds as referents of unbound pronouns in the main clause. This solution is not so readily available in the present case, since a non-episodic predicate like *have blue eyes* does not easily induce an existential reading on a bare plural subject. (This was part of "The Fundamental Intuition" of Schubert and Pelletier, 1987). Thus (MPa) cannot reasonably be invoked for (72). Can we perhaps invoke another meaning postulate relating kinds to their realizations, which applies to kinds within *non-episodic* constructions like the sentence complementing *when* in (72)? A plausible candidate (borrowed, like MPa, from Schubert and Pelletier 1987) is

$$\begin{aligned} \text{(MPb). For } k \text{ a kind and} \\ P \in \{\text{white, loyal, soft, blue-eyed, four-legged, } \dots\}, \\ \square(P(k) \leftrightarrow \square_n(My: R(y, k))P(y)) \end{aligned}$$

where  $M$  encodes a notion roughly verbalizable as "most of the relevant", and  $\square_n$  is a weak, necessity-like modal operator, roughly verbalizable as "it is inherent in the nature of things that ...".<sup>24</sup> Let us apply (MPb) to our representation of sentence (72):

$$72'. \quad \text{gPRES}(\text{HBE}(\mu(\text{plur}(\text{cat})))) \rightarrow v \\ \text{gPRES}(\text{AT-THAT-TIME}(\text{I}(\text{they})))$$

to yield

$$73. \quad \square_n(\text{gPRES}((Mx: R(x, \mu(\text{plur}(\text{cat}))))\text{HBE}(x))) \rightarrow v \\ \text{gPRES}(\text{AT-THAT-TIME}(\text{I}(\text{they}))).$$

Is this the logical translation we are seeking? Unfortunately, we must discount it as such, for several reasons. First, in order to evaluate the

consequent of this conditional by our method, we need to know what context-dependent “binding”  $x$  should receive as a result of “processing”  $(Mx: \Phi)\Psi$  — but we have no good answer to this. Second, to use our method, we need to know what alternatives are generated by  $\Box_n \Phi$  — but again, we have no good answer to this. Third, the  $M$  (“most”) quantifier in the antecedent might be seen as an embarrassment if *usually* in (72) were replaced by, say, *rarely*. The new variant of (73) would then say something like “When most cats are blue-eyed, they are rarely intelligent.” And fourth and most crucially, (MPb) is expressly designed to ensure that a sentence like *Cats have blue eyes* will have the same truth conditions as *Cats generally have blue eyes*, i.e., it expresses a nomic, “quasi-universal” generalization. But then (73) must have the same truth conditions as

- 73'. When cats *generally* have blue eyes, they are usually intelligent.

But — though this is a possible reading of (72) — it is surely not the interpretation of (72) we are trying to capture. (Instead, we wish to talk about *individual* cats, saying of each of them that if they have blue eyes then they are intelligent; and then asserting that such a statement is generally true). The problem here is how to introduce a variable on which to “hang” realizations of a kind, so that we can use our method of “carrying forward previous quantificational bindings”.

One more approach, which allows (MPa) to be brought to bear indirectly, is worth mentioning before we confront the most serious problem of all for our theory, that of interpreting *when* generics with indefinites in the main clause (Section XI). This approach is suggested by the following rather puzzling phenomenon. In many cases where no episodic interpretation is available for a clause in isolation, the *when* construction can induce an intuitively episodic reading:

74. a1. People are overweight  
 a2. When people are overweight, they often diet or exercise  
 b1. Dogs have fleas  
 b2. When dogs have fleas, they should wear flea collars  
 c1. Wisdom teeth are a nuisance  
 c2. When wisdom teeth are a nuisance, it is best to have them pulled.

(As usual, *if* could readily be substituted for *when* in these examples). From a compositional-semantics point of view, it should not be possible for one and the same clause to acquire a meaning in one syntactic context which it entirely lacks in another.

Though we will take a different tack on this apparent non-compositionality in Section XII, we draw the “obvious” conclusion here: we are not dealing with instances of one and the same clause in the (1) and (2) examples of (74). In fact, this move is not implausible from a syntactic point of view, if we assume the following sort of structure for *when* adverbials:

75. a. ADVL[when]  $\rightarrow$  *when* S/ADVL[temp].

I.e., we take the embedded clause to have a time-adverbial gap, where this gap originates in the verb phrase of the clause:

75. b. S/ADVL[temp]  $\rightarrow$  NP[subj] VP/ADVL[temp].

Indeed, the oddity of examples with extra time adverbials, such as

76. ? When dogs barked *at that time*, the burglars fled

may lend support to this analysis (though there may be a semantic explanation).

Once we have “breached” the embedded clause, placing a gap in the VP, we can easily ascribe a translation to it differing from that of the gapless clause. In particular, we can arrange for the translation of the sentence predicate within the translation of the *when* clause to be modified by an operator,  $E$ , which is absent from the translation of the corresponding gapless clause. For example, the translation of *People are overweight* in (74a1) would be  $gPRES(O(\mu(plur(person))))$ , while in (74a2) it would be  $gPRES(E(O(\mu(plur(person)))))$  (at least, after its incorporation into the *when* adverbial; this may involve  $\lambda$ -conversions whose details need not detain us here).

How does the presence of  $E$  help us? Suppose that we can assign a formal meaning to  $E$  which makes  $E(P)$  intuitively express something like “is/are exhibiting (enjoying, manifesting) the property of being  $P$ ”. This is not quite an identity operator — the idea is that this should convert a non-episodic to an episodic predicate; i.e., we want to regard

77. People are exhibiting the property of being overweight

as implicitly being about "sm people", rather than about "people in general". Accordingly, the *E*-operator would allow us to apply (MPa) to exactly the same effect as in episodic *when* sentences with a bare plural in the *when* clause. All we need to stipulate is that (MPa) applies not only to the sorts of episodic predicates already indicated, but also to non-episodic predicates operated upon by *E*.

So, returning to (72), the translation based on a "gappy" *when* clause would be

$$72^* \quad \text{gPRES}(E(\text{HBE}(\mu(\text{plur}(\text{cat})))) \rightarrow v \\ \text{gPRES}(\text{AT-THAT-TIME}(I(\text{they})))$$

and after application of (MPa) and disambiguation of *they*,

$$72''' \quad \text{gPRES}((\exists x: R(x, \mu(\text{plur}(\text{cat}))))E(\text{HBE}(x)) \rightarrow v \\ \text{gPRES}(\text{AT-THAT-TIME}(I(x))))$$

Assuming that *E(P)* has the same truth conditions when applied to an *object* as *P*, this translation quantifies over blue-eyed cats (cats exhibiting the property of having blue eyes) as desired.

In principle, this approach also covers bare-plural versions of sentences like (70) about atemporal entities:

$$70^* \quad \text{When numbers are prime powers of two, less one, they are usually squarefree.}$$

However, we would probably be pushing our "episodic" strategy too far, if we were to claim that this sentence is about numbers "exhibiting the property of being prime powers of two, less one (at particular times)". We will indicate possible directions for a more satisfactory analysis after considering further obstacles to a uniform, compositional analysis.

## XI. FURTHER PROBLEMS

A broad class of episodic and non-episodic generics we have so far carefully excluded from formal analysis is illustrated by sentences (78)–(81):

78. A cat usually lands on its feet when it drops to the ground  
79. Cats usually land on their feet when they drop to the ground

80. A cat is usually intelligent if it has blue eyes  
81. Cats are usually intelligent if they have blue eyes.

These (like many examples mentioned in Section VIII) will be recognized as of the type considered in Carlson (1979), though Carlson confined his analysis to atemporal *if/when* sentences like (81). In contrast with all of the sentences we have so far attempted to analyze, these generics contain singular indefinites or bare plurals in the main clause. It is the possible instances, or realizations of these main-clause indefinites that are intuitively involved in the "cases" over which the frequency adverb (or an implicit *generally*) quantifies. This remains true if the *if/when* clauses are fronted, or deleted.

There is a tantalizing similarity between pairs of sentences like (82a) (which is (78) with the *when* clause fronted) and (82b) (previously (36)):

82. a. When it drops to the ground, a cat usually lands on its feet  
b. When a cat drops to the ground, it usually lands on its feet.

Not only are they synonymous, but even the structural differences seem intuitively minor. Yet the variable locus of the indefinites (or of the corresponding pronouns) presents a larger obstacle to a unified analysis of generic sentences than either the episodic/non-episodic (temporal/atemporal) distinction or the singular indefinite/bare plural distinction. Let us amplify.

We were able to suggest some fairly plausible ways of extending our basic analysis, centered around episodic *when* sentences with singular indefinites in the *when* clause, to cover non-episodic generics with singular indefinites, episodic generics with bare plurals, and even non-episodic generics with bare plurals. Conversely, it seems to us that Carlson's analysis could have been extended to deal with episodic sentences such as (79), and perhaps also their singular-indefinite analogues, such as (78) or (82a). For (78), a Carlson-like analysis would have formed a kind, *cats that drop to the ground*, and predicated *usually land on their feet* of that kind. While there are some difficulties concerning the formal interpretation of *cats that drop to the ground* (are the realizations of this kind objects or stages?), these do not seem

insuperable. Similarly, a Carlson-like analysis of (78) would have treated *a cat* as kind-denoting, and indeed Carlson (1977a) had a specific (though in our opinion unsatisfactory) proposal for doing this (Schubert and Pelletier 1987). The analysis of (79) would then have carried over to (78).

But neither our approach nor Carlson's seems capable of bridging the gap, in one direction or the other, between generics like (82a), with a main-clause indefinite, and those like (82b) with a *when*-clause indefinite. Our own procedure, applied to (78), (82a), or (79), requires a "pragmatic component" to find a suitable referent for the pronoun in the *when* clause. But what could it be? One thing is certain, it cannot be simply a replacement by the NP of the main clause, for the sentences

78'. A cat usually lands on its feet when a cat drops to the ground

79'. Cats usually land on their feet when cats drop to the ground

quite obviously say something different from (78)–(79). On the other hand, our method of translating the pronoun as a variable and allowing it to "pick up" its reference from previously quantified sentences does not seem to work either. With regard to (78), were we to have

83.  $gPRES(D(x)) \rightarrow \nu gPRES((\exists x: cat(x))L(x))$

then the  $x$  in the antecedent could take on any value that it may have had in a previous sentence (perhaps constrained by the fact that the initial pronoun was neuter). If instead we were to somehow use the binding of  $x$  acquired in the main clause, then we would be considering an  $x$  which is a cat that lands on its feet. But this is incorrect also: we do not wish to consider cats that land on their feet. What we *really* need is to somehow shift the existential constraint (just the NP) from the main clause to the *when* clause.

This is not impossible, even within a compositional framework, given the resources of  $\lambda$ -abstraction and conversion. For instance, suppose that we particularize our earlier phrase structure rules (75a and 75b), for the "gappy" analysis of *when* adverbials, so as to encode pronoun position as a syntactic feature:

84. a.  $ADV[L[when, pron]] \rightarrow when\ S[pron]/ADV[L[temp], when'(S')]$

84. b.  $S[pron]/ADV[L[temp]] \rightarrow NP[pron, subj]\ VP/ADV[L[temp], \lambda P(VP'(P)(NP'))]$ .

Alongside each rule, we have indicated the corresponding translation of the mother in terms of the translations of the daughters in the usual GPSG fashion (Gazdar *et al.* 1985). The translation for (84b) "transmits" a  $\lambda$ -abstracted variable, associated with the ADVL gap, upward from the VP to the S in the manner proposed by Pollard (1983). Let us further state a sentence formation rule for sentences like (82a), combining a *when* clause having feature [pron] with a sentence having feature [–pron] and a *when*-adverbial gap:

85.  $S \rightarrow ADVL[when, pron]\ S[-pron]/ADV[L[when], S'(ADVL)']$ .

If we now take the logical translation of *when* in (82a) to be

86.  $when' = \lambda W\lambda U\lambda xW(\lambda V(U(V(x))))$

and assume that *drops to the ground* (the gappy VP in (82a)) is translated as  $\lambda R(R(D))$  (intuitively, a  $\lambda$ -abstracted adverbial operating on the *drops to the ground* predicate), then (84b) yields translation  $\lambda P(P(D)(it))$  for *it drops to the ground*, and (84a) in turn yields  $\lambda U\lambda xU(D(x))(it)$  for *when it drops to the ground*. Next, assuming that *usually lands on its feet*, as a VP with a *when*-adverbial gap, is translated as  $\lambda QQ(\lambda S\lambda y(S \rightarrow \nu L(y)))$ , application of (84b) but with [pron] changed to [–pron] yields  $\lambda P[P(\lambda S\lambda yS \rightarrow \nu L(y))](\langle \exists cat \rangle)$  as the translation of the main clause of (82a) (where  $\langle \exists cat \rangle$  is the unscoped translation of *a cat* — see the Coda on scope, or Schubert and Pelletier 1982). Finally (85), whose semantic rule applies the translation of the main clause to the translation of the *when* adverbial, yields  $D(\langle \exists cat \rangle) \rightarrow \nu L(it)$  as a translation of (82a); after scoping, this becomes  $((\exists x: cat(x))D(x)) \rightarrow \nu L(it)$ . (We have neglected tense; the lack of intension operators is in accord with our "inherently intensional" semantics — see the Appendix.)

Thus we have successfully — and compositionally! — *exchanged* the logical subjects of the *when* clause and the main clause, in principle allowing the application of our theory of *when* generics without change. But we have not done so because we think the approach is plausible; on the contrary, we wished to indicate that it is *implausible*, though possible. For one thing, it is *prima facie* implausible that people could

actually *learn* lexical semantic rules like (86). More importantly, it is hard to see how this sort of "λ-magic" could be generalized to deal with *multiple* indefinites in the main clause, as in

- 87. A man often pets a cat when he sees it.
- 88. People often pet cats when they see them.
- 89. A chivalrous man usually helps a woman change a flat tire, if he sees that she is having trouble with it.

Moreover, these additional indefinites can be referred to by definite noun phrases instead of pronouns:

- 90. A cat usually foils a dog by running up a tree, if the dog chases it.

Without significant modification, our approach seems very ill-equipped for dealing with such examples.

Carlson's approach, as one might expect, has the opposite problem. Any attempt to generate the relevant kind for a sentence like (82b) again requires a translation of *when* of such complexity that it is doubtful that people could learn it; and again, the approach breaks down when there is more than one indefinite in the *when* clause, as in

- 91. When a man sees a cat, he often pets it.

In fact, Carlson's approach does not extend readily to sentences with multiple indefinites in the *main* clause, such as (87)–(90) or (for some non-episodic examples)

- 92. A man is usually taller than a woman if he and she are siblings.
- 93. People are afraid of dogs when they believe those dogs to be vicious.

A general sort of remedy which these difficulties suggest is that *both* the main clause indefinites *and* the when-clause indefinites (and perhaps the definites as well) ought to be "raised" somehow to a higher level, where they will combine with the entire *when*-clause plus main clause complex. However, "raising" in any standard sense will give one of the following results: (i) if the frequency adverb is regarded as operating on a single (conditional) sentence, we could raise the indefi-

nites so that they immediately follow the adverb and immediately precede the single (conditional) sentence; i.e., the order of operation is that we combine the indefinites with the (conditional) sentence and then apply the frequency adverb to the result. But it is hard to see how application of the frequency adverb to a *single* entity could possibly give the right truth conditions. (In fact, since we've re-combined the indefinites with the conditional sentence before applying the frequency adverb, we have gained nothing from the raising operation.) We might also raise the indefinites to the very top level, but this would clearly just give us irrelevant wide-scope readings, such as "Some cat is such that when it drops to the ground, it usually lands on its feet". (ii) If the frequency adverb is regarded as operating *separately* on the when-clause and main clause translations, then "raising" of indefinites can only give us the irrelevant wide-scope readings.

## XII. CAN COMPOSITIONALITY BE SALVAGED?

It would appear, from these considerations, that we are forced to adopt some sort of non-compositional approach, such as postprocessing of logical translations to shuffle indefinites into the *when* clause, or treating indefinites as supplying constraints separate from both the *when* clause and the main clause (e.g., in the style of Farkas and Sugioka).

Arguably, this radical conclusion was reached only because we assumed that sentences denote truth values (in a world). Consider again

- 92. A man is usually taller than a woman if he and she are siblings.

The trouble we have in trying to quantify over "reference cases" is that part of the information about what these cases are is in the main clause (i.e., *a man* and *a woman*) and part of it is in the *if* clause. So any straightforward logical translation which leaves the indefinites in the main clause loses their contribution to the "reference cases", given that the denotation of the main clause is just a truth value (at any time and world). We would *not* lose this information, though, if the sentence denotations had more structure — specifically, if the *relational* structure specified by a sentence were still discernible in its meaning. Then the frequency adverb, in operating on the main clause meaning, could still make *separate* use of the "entities" involved in that meaning, and



the relation or property that they partake of. In particular, if these "entities" (corresponding to the NPs of the main clause) are semantically identifiable as "indefinite" — perhaps by being represented as indeterminates in a situation-style semantics — then we could still use them to restrict the "cases" over which we take the quantification to run.

One conclusion we might draw, therefore, is that the case for a situation-based semantics, or in any event one which somehow preserves the relational structure of sentences in their meanings, has been bolstered by the difficulties we have encountered. Though this avenue seems to us very worthy of pursuit, we will not pursue it further here. Instead, we will briefly consider a variant of the approach we have here developed, which is in a sense analogous to a structured meaning approach.

Our sketch of this variant begins with the observation that our semantics for quantificational conditionals *already* "digs beneath the surface meanings" of the clauses it combines. A strictly compositional semantics for a quantified conditional ( $\Phi \rightarrow_U \Psi$ ) would require its intension to be specified strictly as a function of the intensions of  $\Phi$  and  $\Psi$  (perhaps with the intension of  $\Psi$  determined by a context altered by prior "processing" of  $\Phi$ ). But that's not what we have done. Instead, we've availed ourselves of a class of *interpretations* generated by  $\Phi$  from the given interpretation. These interpretations include variable assignments — which certainly are in no sense part of the intension of  $\Phi$ . What's interesting about these variable assignments is that they give us a handle on the "fine-grained" structure of sentence meanings; i.e., they separate out the possible "instances" of indefinites which make the predication as a whole true — something not given by the usual "coarse-grained" intension of  $\Phi$ . So, our use of  $\Phi$ -alternatives seems to be a way of "getting a hold on" the indefinites in the *when* clause separately from the intension of the *when* clause. In a roundabout way, they provide what "situation types" (or perhaps other sorts of structured meanings) would provide more directly.

Now, the difficulties we encountered in the attempt to extend our theory to *when* generics with main clause indefinites were due to our inability to "separate out" the semantic content of these main clause indefinites from the relational content of the main clause. From the above perspective, this is not surprising: our semantics for ( $\Phi \rightarrow_U \Psi$ ) only "digs beneath the surface meaning" of  $\Phi$ , but not of  $\Psi$ . A remedy within our framework, therefore, would consist of some way of gener-

ating possible sets of variable bindings for the main clause, in much the same way as we generated variable bindings for the *when* clause. However, these bindings should respect only the semantic content of the main clause NPs (indefinites, and also definites and pronouns), without regard to the truth of the predication made about them. For example, in

94. When it is cornered by a dog  $y$ , a cat  $x$  sometimes scratches the dog  $y$

(where we have added variables for convenience) we need to know just what "bindings" for  $x$  and  $y$  satisfy "a cat  $x$ " and "the dog  $y$ " respectively in the main clause. We want to use those bindings to restrict the alternative contexts (interpretations) that satisfy the antecedent " $x$  is cornered by a dog  $y$ ", and only then do we want to check what proportion of these restricted contexts satisfy the consequent predication, "a cat  $x$  scratches the dog  $y$ ". We shall use the term "legitimate anchorings" for the main clause bindings to be used in restricting *when* clause contexts. Legitimate anchorings are partial variable-assignment functions whose domain is a nonempty subset of the variables which are existentially or definitely quantified in the main clause, and which assign denotations that satisfy the NPs associated with those variables.<sup>25</sup> Quantificational conditionals will have a third argument (besides antecedent and consequent), namely the list of those variables they "control", i.e., over which they "iterate bindings" (cf. Heim 1982). In part, this additional flexibility is needed because bindings may not be (independently) iterated for all main clause definites and indefinites (e.g., consider *a tree* in *A cat usually runs up a tree when a dog chases it*, or *a tail* in *A dog (always) has a tail*). Also, a definite or indefinite may be within the scopes of several nested quantificational conditionals or quantifiers, any of which may control it, so that a disambiguating syntax is required (e.g., consider *If a person occasionally contributes to a charity when he receives an appeal, he will usually receive further appeals*; here *a charity* may be controlled by *occasionally* or by *usually*, depending on whether *further appeals* is understood as *further appeals from charities* or as *further appeals from that charity*).

So, neglecting time and tense, the translation of (94) would be

- 94'. (The  $x$ : neut( $x$ )) ( $\exists y$ : dog( $y$ )) cornered-by( $x$ ,  $y$ )  $\rightarrow_{S(x,y)}$   
( $\exists x$ : cat( $x$ )) (The  $y$ : dog( $y$ )) scratches ( $x$ ,  $y$ )

(The pronoun *it* can no longer be translated simply as  $x$ , since the

generation of alternative bindings for  $x$  in the antecedent requires that it appear definitely or indefinitely quantified there. Besides, the gender restriction seems like a nice touch.)

We can generate legitimate anchorings in much the same way as we generate  $\Phi$ -alternatives. I.e., roughly speaking, when the embedding conditional controls  $x$ ,  $(\exists x: \Phi)\Psi$  extends by  $\langle x, d \rangle$  the anchorings generated by  $(\Phi \& \Psi)$  with  $x$  fixed at  $d$ , for each  $d$  which satisfies  $\Phi$  (when used as value of  $x$ ). So basically, the difference between the generation of alternative contexts by  $(\exists x: \Phi)\Psi$  and the generation of legitimate anchorings is just that we do not require the value of  $x$  to satisfy  $\Psi$  (as well as  $\Phi$ ). (The  $x: \Phi)\Psi$  is treated identically with  $(\exists x: \Phi)\Psi$ . (We also need to assume that in both cases, the value of  $x$  does not change if it is already defined; i.e., both *definites and indefinites can behave referentially*.) We then use the legitimate anchorings of the consequent (of a quantificational conditional) to restrict the alternative contexts generated by the antecedent, and for the resultant contexts we ask, what proportion of them also satisfy the consequent?

Let us state this new method of evaluating quantificational conditionals a little more formally — though with a good deal taken for granted: we presuppose a revised semantics in which contexts no longer assign values to *all* variables, and in general admit truth value gaps, existential quantifiers no longer assign new values to variables that already have values, the notion of alternative contexts induced by a formula is relativized to a set of “controlled” variables  $x$ , and the sketchy definition of “legitimate anchorings” above has been formalized. Assuming that these revisions can be carried out successfully, we would define the semantics of  $\rightarrow_{B(x)}$  (where  $B$  is  $A, U, O, S, N, \dots$ , and  $x$  is the set of controlled variables) as follows (for a given context space  $S$ ):

$$[\Phi \rightarrow_{B(x)} \Psi]^{i, w} = 1 \text{ iff for all/most/many/some/no } \dots$$

$$[ ]' \in \{ [ ]' \mid [ ]' = [ ]' \cup g_S \text{ for some } [ ]' \in f_S(x, \Phi, i, w, [ ])$$

and some legitimate anchoring  $g_S$  of  $x$  relative to  $\Psi, i, w, [ ]$  such that  $[x]'' = g_S(x)$  for all  $x \in x$  for which  $[x]''$  is defined},

$$[\Psi]^{i, w} = 1.$$

Note that the “alternative contexts” function  $f_S$  now has  $x$ , the set of controlled variables (allowed to assume alternative values) as an additional argument. We have *extended* the alternative contexts, using the union operation, to include variables that may occur in the

consequent without coreferential occurrences in the antecedent. At the same time we have *eliminated* contexts which do not agree with any legitimate anchoring of the consequent, at all  $x \in x$  where they are defined. Thus, definites or indefinites in the consequent can be “iterated” over even if they do not occur coreferentially in the antecedent (as in *Cats are intelligent*, or in *Cats rarely flee from dogs if the dogs are very small*); whereas definites or indefinites in the antecedent can be “iterated” over only if they occur coreferentially in the consequent.

We have so far glossed over the *times* that may be implicitly referenced by the tense and time adverbials of the main clause. One of these, too, may be included in its legitimate anchorings, and in the case of episodic clauses, *must* be included.

For example, sentence (94) is of a type for which we previously suggested introduction of a default adverb THEREUPON in the main clause. Now *a cat THEREUPON scratches the dog* contains an implicit indefinite reference to the time of the scratching, as well as an implicit definite reference to the time of the antecedent event. It is the latter which is here the natural choice of time to be controlled by *sometimes*. In a sentence like

95. The world always turns

where there is no explicit or implicit *when* clause, and hence no default time adverbial in the main clause, it would be the implicit indefinite time “generated” by gPRES which is controlled by *always*.

There is a slight notational problem for time, since there are no explicit time variables which can be included among “controllees” of the quantificational conditional. We will not try to solve this rather minor problem here (but see our last example below).

Finally, it seems that bare plurals (kinds) can be handled in much the same way as singular indefinites. Again we have a slight notational problem, in trying to indicate which bare plural translations are controlled by which quantificational conditionals, if any. The problem could be solved by using term subscripts rather than variables to fix coreference and control (as Heim and others do), but this would be less elegant in other respects. We therefore introduce the somewhat *ad hoc* device of optionally changing a term like  $\mu(\text{cat})$  to the equivalent “quantified” term (The  $x: (x = \mu(\text{cat}))$ ). Then in the definition of legitimate anchorings, we would say that when the embedding condi-

tional controls  $x$ , an expression of the form  $(The\ x: \Phi)\Psi$ , where  $\Phi$  is kind-level with respect to  $x$  while  $\Psi$  is object-level with respect to  $x$ , extends by  $\langle x, d \rangle$  the anchorings induced by  $(\Phi \ \& \ \Psi)$  with  $x$  fixed at  $d$ , for each  $d$  realizing the unique kind satisfying  $\Phi$ .

This more or less completes our sketch of how we might construct a general, uniform theory of generics, which would be capable of accounting for virtually all of the examples we have discussed (in particular the "problematic" ones from (78) onward). For additional clarification, let us write down the translations of a few more sentences (again neglecting tense):

81. a. Cats are usually intelligent when they have blue eyes  
 b.  $(The\ x: plur(T)(x))HBE(x) \rightarrow v(x)$   
 $(The\ x: x = \mu(plur(cat)))I(x)$
93. a. People are afraid of dogs when they believe those dogs to be vicious  
 b.  $(The\ x: plur(T)(x)) (Those\ y: plur(dog)(y))believe(x,$   
 $vicious(y)) \rightarrow_{G(x,y)} (The\ x: x = \mu(plur(person))) (The$   
 $y: y = \mu(plur(dog)))afraid-of(x, y)$
96. a. A cat is intelligent  
 b.  $(\exists x)T(x) \rightarrow_{G(x)} (\exists x: cat(x))I(x)$ .

In all three translations,  $T$  is the universally true predicate,  $\lambda x(x = x)$ . Note that in (96) we have invoked an arbitrary universally true formula as default antecedent (and abbreviated  $(\exists x: T(x))$  as  $(\exists x)$ . In this particular example, it might have been more appropriate to use the presumption that the cat is "extant", i.e., exists (in a realistic sense) at a given time:

96. c.  $(\exists x)extant(x) \rightarrow_{G(x)} (\exists x: cat(x))I(x)$ .

The "extant" presumption could be used quite often as default, though clearly not in examples like

97. A great composer is always remembered.

It is also worth coming back here to the following (commonly discussed) type of example,

98. a. \*A dog is widespread  
 b.  $(\exists x)extant(x) \rightarrow_{G(x)} (\exists x: dog(x))W(x)$

whose anomaly, on this translation, stems from the application of a kind-level predicate  $W$  to an object-level argument  $x$ .

In considering our translations of sentences like (96) lacking an overt restrictive clause, the reader should keep in mind our view that such generics are not "basic", and instead are to be evaluated with a "missing" or "suppressed" *when* clause; and it is our view that this missing clause is to be supplied somehow by a "pragmatic component" which can look at the previous discourse,<sup>26</sup> at characterizing properties of the subject, at presuppositions associated with verbs and stress patterns, etc. Once we have provided a position for such a missing clause, we are obliged to fill it, even in cases where there is no clear need for such a "phantom clause".

As a final example, we come back to donkey sentences:

99. a. When Pedro owns a donkey, he usually rides it to town.  
 b1.  $gPRES,((\exists x: D(x))O(p, x)) \rightarrow v(x, t)$   
 $gPRES(AT-THAT-TIME,((The\ x: neut(x)) (R(p, x))))$   
 b2.  $gPRES,((\exists x: D(x))O(p, x)) \rightarrow v(t)$   
 $gPRES(AT-THAT-TIME,((The\ x: neut(x)) (R(p, x))))$ .

As shown, we now have two possible translations, corresponding to the choice of "controlled" variables. (There is no third possibility with  $x$  only controlled, given our stipulation that a time variable must be controlled.) The first has the same truth conditions as our original analysis (as given by analogy with sentence (65)). But interestingly, the second would be "true in English" even if Pedro always owns numerous donkeys, only one of which he habitually rides to town. This is because the donkey variable  $x$  is not controlled by  $\rightarrow v$ , and so assumes an arbitrary value for each alternative context generated by the antecedent. So, if there are choices of these values which usually render the consequent equal to 1, the conditional as a whole will be "true in English." This brings the analysis of quantified conditionals in line with that of ordinary conditionals and apparently resolves the difficulty inherent in our original analysis of such sentences (that they miss such readings).

### XIII. IN CONCLUSION

Needless to say, our proposals in Sections IV–X, for certain kinds of episodic generic statements, are no more than a preliminary sketch of

what a satisfactory formal account of such statements might look like. We have left open not only many details of the formal semantics, but virtually all details of the mapping from English surface form to logical form. Nevertheless, we hope to have shown that the ideas of (1) indefinites and tenses "loading" reference values into a context, and (2) generic sentences iterating over combinations of such values, are quite promising. The interaction of adverbs, *when*-clauses, indefinites and tenses is rather intricate in our theory, but no more so, we believe, than the subtlety of these phenomena warrants — indeed, there is much room for refinement and elaboration.

In Sections X and XI we considered possible extensions of our theory to cover larger classes of generic sentences, but concluded that generic sentences containing singular indefinites or bare plurals in the main clause were ultimately beyond the reach of our theory, in its present form. Some such sentences are amenable to Carlson's analysis, which in a sense starts at "the opposite end" of the spectrum of generics (emphasizing non-episodic sentences with bare plural subjects); but Carlson's analysis is not extensible to multiple indefinites, or to the types of episodic sentences central to our own analysis. At this point, prospects for a uniform compositional theory seemed poor.

In Section XII, however, we suggested that the apparent non-compositionality stems from the use of unstructured meanings (intensions). We then sketched what further directions one might take in an attempt to get at the "finer-grained" structure of sentence meanings, and to use these in the construction of reference ensembles that combine information from restrictive clauses and main clauses of generic sentences. In this sketch, we strove, as far as possible, to stay within the framework we had already developed, and filled in enough detail to make the feasibility of the enterprise plausible.

However, the proposed semantics of  $\rightarrow_{\mu(x)}$  was not strictly compositional, i.e., it was not defined exclusively in terms of the intensions of its operands (though it *was* defined in terms of the intensions of the *parts* of its operands). Consequently, we think that the correct way to proceed, ultimately, will be one that makes direct use of structured meanings, such as some form of situation semantics. Nevertheless, we expect such a theory to have much in common with the one we have sketched.

The reader who has kept in mind Lewis's theory of frequency adverbs, interpreting these as unselective quantifiers (Lewis 1975), will

have noticed the drift of our theorizing, in Section XII, toward something rather closely resembling Lewis's views. Existential and definite quantifiers lost some more of their autonomy, yielding it up to the "control" of quantifying adverbs. However, unlike some theorists who have followed in Lewis's footsteps, we have continued to insist on translating English definite and indefinite noun phrases uniformly, and not dislocating these arbitrarily from the clauses in which they occur. In this respect, we have tried to adhere to Carlson's compositional methodology.

One slightly unappealing aspect of our theory we have noted is its reliance on "phantom" restrictive clauses in the translation of generic sentences lacking such clauses. Could these phantom clauses be eliminated? We think that this may be possible within a situation-semantic framework. To do so, we would "embed" a situation type or kind (whose instances provide the required ensemble of situations or objects) directly into contexts, presumably as values of certain indexical constants; i.e.,  $\text{WHEN}(\Phi) [ ]$ , the new context generated by having "processed" a *WHEN*-clause, would differ from  $[ ]$  in having its "embedded" situation type restricted to  $\Phi$ -situations or objects. For generic sentences lacking restrictive clauses, the appropriate ensembles would be constrained by context. Frequency adverbs, rather than having syntactically explicit restrictive clauses as arguments, would instead make reference in their truth conditions to the situation type or kind embedded in their context of evaluation. This seems to us a promising direction for further research. In any case, we hope that our investigation will encourage others to work in this challenging area.

#### XIV. CODA ON PLURALITY AND SCOPE AMBIGUITY

The point of this brief Coda is to explain, quickly, how we view plurality and issues involving relative scope of quantifiers (and other items such as connectives and adverbs). A fuller discussion of plurality can be found in Schubert (1982), and of scope in Schubert and Pelletier (1982).

Throughout this paper we have talked about bare plurals. We occasionally represented a bare plural such as *cats* as  $\mu(\text{cat})$  — the kind, *cats* — formed from the predicate *cat* (which is true of individual cats) and our kind-forming operator,  $\mu$ . But since plurals may be used to refer to group or collections of things, we have generally made use of

*plur(cat)*, *plur* being an operator that takes the predicate that is true of individuals and forming the new predicate which is true of arbitrary groups or collections. These groups may have as few as one element in them, in light of such sentence as

100. The stars called "the morning star" and "the evening star" are one and the same.

The sentence would be logically false if "the stars" had to be at least two stars. (There may sometimes be an implicature to the effect that there are, or may be, more than one object, when a plural is used; but the truth conditions should allow for groups of size one.)

So a predicate like *plur(cat)* is true of any arbitrary group of cats. Numerical modifiers — e.g., *three* — are viewed also as predicate modifiers, so that *three(plur(cat))* is a predicate which is true of groups of three cats. Since these are predicates, they should be able to be operated upon by our kind-forming operator,  $\mu$ . But there seems to be a difference in meaning when one attempts to form the kind from a "numericalized" predicate. Certain predicates, it will be recalled, apply directly to kinds — *be extinct*, *be common*, *be rare*, *come in many different flavours*, *be out of stock*, and the like. Such predicates happily combine with paradigm cases of "ordinary" kind-denoting terms:

101. a. Dinosaurs are extinct  
 b. Sparrows are common  
 c. Albino ravens are rare  
 d. Ice cream comes in many different flavours  
 e. Eggs are out of stock.

Yet when numerical modifiers are applied, the result does not seem to combine readily with such predicates, indicating to us that we cannot apply  $\mu$  to the term to yield a term denoting a kind. For example,

102. a. \*12 eggs are out of stock  
 b. \*A dozen eggs are out of stock.

And this is the case even if the store in question only receives eggs packaged in groups of 12, or that there were no eggs in stock, or that only the eggs packaged in groups of 12 were out of stock, etc. The above contrast is of the same sort as that observed between

103. a. A cat is intelligent.  
 b. \*A cat is common.

We therefore propose to treat them analogously. Since we have proposed to translate singular indefinites like that in (103a) (previously (96a)) existentially even under a generic reading, we will assume that bare numerical plurals, as well, are always translated existentially. Thus *12 eggs*, for example, would be uniformly translated as  $\langle \exists \text{ twelve}(\text{plur}(\text{egg})) \rangle$ , just as *a cat* is uniformly translated as  $\langle \exists \text{ cat} \rangle$ . In both cases, the specific/generic ambiguity is accounted for by the absence/presence of an implicit  $\rightarrow_G$  operator. Contrary to our initial hypothesis, then, bare numerical plurals do *not* admit a translation in terms of  $\mu$ . In a formal grammar, this constraint can be implemented by using separate rules for bare non-numerical NPs and bare numerical plurals (see (105b, c) below). Sentences like (104a) would be then translated ambiguously as (b) or (c):

104. a. 12 eggs cost a dollar  
 b.  $\langle \exists x: (\text{twelve}(\text{plur}(\text{egg}))) (x) \text{ cost-one-dollar}(x) \rangle$   
 c.  $\langle \exists x: T(x) \rightarrow G(x) \rangle$   
     $\langle \exists x: (\text{twelve}(\text{plur}(\text{egg}))) (x) \text{ cost-one-dollar}(x) \rangle$

ignoring the exact representation of "cost a dollar". Our predicates would need to be further subdivided into ones which properly can apply only to groups, in addition to the ones which apply to kinds and the ones that apply to individuals. The exact details of this we leave open here: one possible position is that if a predicate applies to an object, it *always* applies as well to groups of objects, and if it applies to a kind, it *always* applies to groups of kinds as well. This would legitimize the application of *cost-one-dollar* to groups  $x$  in (b) and (c) above. However, it leaves open the question of whether (b) is to be interpreted distributively (a dollar per egg) or collectively (a dollar for the lot). A possible answer is that when an individual-level predicate  $P$  is applied to a group  $x$  (syntactically, to a plural NP), it can be translated either without change (yielding a collective reading) or with distributive operator *Distr*, where  $\text{Distr}(P)(x)$  is understood as saying "each member of group  $x$  has property  $P$ ".

In Schubert and Pelletier (1982) a mechanism for generating the relative scopes of quantifiers, adverbs, and coordinators was given. The

picture was that the parsing rules, which in a GPSG-like manner yielded a semantic representation, only yielded an "ambiguous" logical-form representation. Once this ambiguous representation was generated, then certain rules for determining the possible relative scopes were applied, to yield the various possible readings. For example, a quantified NP such as *every cat* is analyzed and translated by rule (105a)

105. a.  $NP \rightarrow DET[+quant] N, \langle DET' N' \rangle$   
 b.  $NP \rightarrow N[-num], \mu(N')$   
 c.  $NP \rightarrow N[+num, plur], \langle \exists N' \rangle$

neglecting various fine points. The angle brackets in (a) and (c) indicate that the "generalized quantifier" they enclose is ambiguously scoped. The translation of a sentence like (106a) is as in (106b):

106. a. Some dog chases every cat  
 b.  $chase(\langle \forall cat \rangle)(\langle \exists dog \rangle)$ .

The two quantifiers can now be "raised" to encompass any sentential formula that embeds them, at the same time introducing variables, with the possible results

107. a.  $(\exists x: dog(x))(\forall y: cat(y)) chase(y)(x)$   
 b.  $(\forall y: cat(y))(\exists x: dog(x)) chase(y)(x)$ .

It is this mechanism which allows us to retain the view that names denote individuals, and also to dispense with dual version of predicates such as *love'* and *love\** (or *love<sup>+</sup>*), which Montague introduced to distinguish the direct translations of English transitive verbs (whose objects are intensionalized property sets) from extensionalized versions (whose objects are individuals).

The same sort of scoping mechanism is used for coordination, adverbs, and other operators such as tense. Thus (108a) is translated as (108b):

108. a. Kim will love Robin or hate Sandy  
 b.  $FUTR[\langle \vee love(Robin) hate(Sandy) \rangle](Kim)$ .

The ambiguously scoped conjunction allows the minimal scoping in

(109a) or the wider scope in (b), or the still wider scope in (c) (with conversion from prefix to infix form):

109. a.  $FUTR[(\lambda x) [love(Robin)(x) \vee hate'(Sandy)(x)](Kim)]$   
 b.  $FUTR[love(Robin)(Kim) \vee hate(Sandy)(Kim)]$   
 c.  $FUTR[love(Robin)(Kim)] \vee FUTR[hate(Sandy)(Kim)]$ .

As it turns out, all three "readings" are equivalent. But if FUTR were *certainly* (for example), (c) would be distinct from (a) and (b). Other examples will make (a) and (b) distinct.

In the "logical form" language described in the Appendix, we do not make use of this feature of our grammar, but rather treat the logical forms as already having gone through this process of disambiguation. Were we to give an explicit grammar for the phenomena discussed in this article, though, we would wish to have our grammar generate this ambiguous logical form, and have some postprocessing to convert it into the format actually used in the Appendix.

#### APPENDIX: SYNTAX AND SEMANTICS FOR A "LOGICAL FORM" LANGUAGE

In this Appendix we try to be somewhat more formally accurate about what our "logical form" language is and how it is semantically to be interpreted. As indicated in the Coda (on scope ambiguity), we have in mind a "layered" approach. The rules for mapping from English surface structure will yield an "ambiguous" logical form. This logical form must first be disambiguated; for the phenomena under consideration here, this will happen in two stages. First there will be a "scope disambiguation" in which our "ambiguously scoped" expressions are given some unambiguous representation, and second there will be replacement of our "pronoun markers" by some constant or variable. These two aspects of generating a representation of a text are not considered in this Appendix; instead, we start with the "layer" which results from this disambiguation.

Our logical form language  $\mathcal{L}$  has constants  $a, b, c, \dots$  (perhaps with subscripts); individual variables  $x, y, z, \dots$  (perhaps with subscripts); indexical constants  $r, now, present, yesterday, then, I, you$  (and possibly

others . . . we leave this matter open for further investigation);  $n$ -place predicate symbols; the connectives  $\sim$ ,  $\&$ ,  $\vee$ , and  $\rightarrow$ ; equality,  $=$ ; restricted quantification of the form  $(Q\alpha: \Phi)\Psi$  where  $Q \in \{\forall, \exists, \text{The, Most, Few, No, } \dots\}$ ,  $\Phi, \Psi$  are (open or closed) formulas, and  $\alpha$  is a variable; certain operators ("tense" operators: PRES, gPRES, PAST, PROG, PERF; "temporal adverbs": YEST, THEREUPON, AT-THAT-TIME; and "quantificational conditionals":  $\rightarrow_A, \rightarrow_U, \rightarrow_G, \rightarrow_S, \rightarrow_N, \rightarrow_O$  — corresponding to *always, usually, generally, sometimes, never, often*); and a kind-forming operator  $\mu$  which takes a one-place predicate (this includes the case of having other positions of an  $n$ -place predicate filled with a constant or bound with a quantifier) and forms a term; a plurality-forming operator *plur* which takes a one-place predicate (including, as before, the case of having other positions "filled") and forms a new (plural) predicate;  $\lambda$ -abstraction (over individual variables); and numerical adjectives (two, three, . . .) which take a (plural) predicate and form a predicate.

The constants and variables are sorted into *object-* and *kind-* constants/variables, where that distinction may sometimes be emphasized by superscripting the former with "o" and the latter with "k". The predicate symbols correspondingly have their argument positions sorted as being object-level or kind-level (and this sorting may sometimes be emphasized by sequences of "o" or "k" superscripts). The syntax is quite ordinary, generally written  $G(F(a, b, \dots))$  which indicates that the sentential operator  $G$  is applied to the formula  $F(a, b, \dots)$ , and the latter means that the predicate  $F$  is applied to the constants/variables  $a, b, \dots$ . The results of applying term-forming operators are generally written  $G(F)$ , where  $G$  is the term forming operator and  $F$  is the argument it applies to. We will often use English-like expressions rather than simply abstract symbols for predicates and names, so that, for example, we might write  $\mu(\textit{dog})$  for the result of applying the term-forming operator  $\mu$  to some abstract predicate  $F$  and relying on a "translation scheme" to go from *dog* to  $F$ . We also regard an expression of the form  $F(x, y)$  as equivalent by definition to  $(F(x))(y)$  or to  $F(x)(y)$  — thus we may regard many-place predicates as function-valued single-place functions that absorb one argument at a time. (However, in the main text we often violate this convention for purposes of keeping our discussion in line with usual first-order notation. For example, *Pedro owns Annabelle* is usually translated as  $O(p, a)$ ; our "categorical grammar" version would be  $O(a)(p)$  — that is, "owns Annabelle" is true of Pedro — which by our convention becomes

$O(a, p)$ , just the reverse of the usual notation! In this formal Appendix we are more careful to obey our conventions.)

For our semantics, we assume a domain  $\mathbf{D}$  of individuals (sorted into objects  $\mathbf{O}$ ,<sup>27</sup> kinds  $\mathbf{K}$ , and a set of time intervals  $\mathbf{I}$ ), and a set of possible worlds  $\mathbf{W}$ , all of which are non-empty. Intuitively,  $\mathbf{O}$  contains not only (single) objects, but also *groups* or *collections* of such objects. We leave open the exact structure of  $\mathbf{I}$ , but intend its elements to be thought of as time intervals having such relations as "during", "before", "in the vicinity of", etc., defined on them. Finite time intervals are assumed to have a beginning and an end, thought of as "instants" of time — intervals whose beginning and end coincide. For our present purposes, we need not impose a further structure on  $\mathbf{K}$ , although we have in mind that it will form a "lattice of kinds" — more or less in the same way we explained towards the end of Pelletier and Schubert (1985) with respect to count terms formed from mass terms (e.g., *a wine*, viewed as being formed from *wine*).

Instead of the usual notion of an interpretation and its extension to a valuation function, we will define the notion of a *context*,  $[\ ]$ , though for us, that notion is inextricably bound up with the notion of *context change*, resulting from the evaluation of (previous) formulas and their parts with respect to a particular time and world. The following definition is intended to formalize these notions in a way which meets our present needs.

A *context* is a (total) function on the expressions of  $\mathcal{L}$ , yielding appropriate values in our previously-given domains along with 0 and 1, and various functions on these domains. A *context transformation function*  $\delta$  is a (total) function on wffs of  $\mathcal{L}$ , times, worlds, and contexts into contexts. If  $F$  is the set of wffs of  $\mathcal{L}$ , then  $\delta: F \times \mathbf{I} \times \mathbf{W} \times C \rightarrow C$ . A *context space* is a quadruple  $\langle \mathbf{D}, \mathbf{W}, C, \delta \rangle$  where  $\mathbf{D}$  is the set of individuals (sorted into objects, kinds, and time intervals),  $\mathbf{W}$  is the set of worlds,  $C$  is a non-empty set of contexts,  $\delta$  a context transformation function, and  $\delta$  and each of the  $[\ ] \in C$  meet the following conditions. (We abbreviate  $\delta(\Phi, i, w, [\ ])$ , where  $\Phi$  is a wff,  $i \in \mathbf{I}$ ,  $w \in \mathbf{W}$ , and  $[\ ]$  is a context, as  $\Phi^i.w[\ ]$ . Intuitively it designates the (new) context which is generated from having already "processed"  $\Phi$  in the (old) context  $[\ ]$  — it will always be clear which  $\delta$  is intended.)<sup>28</sup>

1.  $[\alpha] \in \mathbf{O}$ , for  $\alpha$  an object constant or variable.  
 $[\alpha] \in \mathbf{K}$ , for  $\alpha$  a kind constant or variable.

2. [now], [present], [yesterday], ...  $\in I$ , with the constraints that [now] during [present], [yesterday] during [present] (i.e., *present* denotes an "extended present"), [yesterday] is the day before [now], ... etc. We leave these constraints unformalized. [you], [I] ...  $\in O$ .
3.  $[r]$  is a sequence of one or more elements of  $I$ , where one element is distinguished as "being in focus". The element in focus is designated by  $r$ , and  $[r] \in I$ . It is allowed to have something "in focus" which is not in the sequence (and then we say that the focus is undefined); this can happen in two ways: by having it undefined to the right or to the left. Undefined to the left is denoted by  $\_r$ , undefined to the right is denoted  $r\_$ .
4.  $[F] \in D_1 * D_2 * \dots * D_n * I * W$ , for  $F$  an  $n$ -place predicate symbol, where  $D_m$  is  $O$  or  $K$ , if  $F$  is sorted as being object-level or kind-level in its  $m$ th argument. Here  $A * B$  denotes the set of functions from  $A$  to  $B$ ,  $A * B * C$  denotes the set of functions from  $A$  to the set of functions from  $B$  to  $C$ , and so on.

In some of the remaining clauses, we will use the notation  $[ ]_{\alpha:d}$  to denote a context identical with  $[ ]$  except that the denotation of the constant or variable  $\alpha$  is  $d$ . When  $\alpha$  is *now*, the meaning of this notation is slightly enhanced: the indexicals *r*, *present*, *yesterday*, etc., are appropriately reset along with *now*, so that the first element of  $r$  shares the denotation of *now*, so that *present* denotes a time encompassing the time denoted by *now* and extending sufficiently far into the past, so that *yesterday* denotes the day before the time denoted by *now*, etc. When we mention these variant contexts, we keep all values of every other feature of the context fixed. A notational convention used is that  $[F]^a$  indicates application of the function  $[F]$  to argument  $a$ . More generally,  $[F]^{a,b,\dots,n}$  indicates successive application of  $[F]$  to  $a, b, \dots, n$ . Should there be sufficient superscripts to designate *all* the possible argument-positions of  $F$ , then the value will either be 1 or 0. In all of the constraints, whenever we say that the value of some (metalinguistic) expression equals 1 if and only if some condition holds, we mean that its value is 1 under that condition and is 0 otherwise. (No truth value gaps). It might be noted that, as given in clause 6, this semantics is

"inherently intensional". Application of a predicate function to an argument is not interpreted as mapping an extension into an extension at each world, but rather as mapping an intension into an intension. This has been accomplished by making the times and worlds be the *last*, rather than first, arguments to which a context is applied. An advantage of this formulation is that no analogue of Montague's intension operator is needed, not even for intensional locutions. Quantifiers and truth-functional connectives, however, are extensional, and this is reflected in the constraints concerning them, which are assumed to hold for all  $i \in I$  and  $w \in W$ . Starting with the sixth condition, we subdivide the conditions into  $a$  and  $b$  parts, where the  $a$ -part provides a constraint on the *value* of a certain type of formula, while the  $b$ -part provides a constraint on the *context change* induced by "processing" this type of formula. A text  $S_1 \cdot S_2 \cdot \dots \cdot S_n$  is assumed to induce a total change:  $S_n^{i,w}(S_n^{i,w}(\dots(S_1^i[ ])\dots))$  in the initial context  $[ ]$ , relative to time  $i$  and world  $w$ . We now return to the conditions that each context and transformation function must meet.

5.  $[\lambda\alpha\Phi] = \{ \langle d, [\Phi]_{\alpha:d} \rangle \mid d \in O \text{ or } d \in K, \text{ depending on whether } \alpha \text{ is an object variable or a kind variable} \}$
6. If  $\Phi$  is a predicate, then
  - a.  $[\Phi\alpha] = [\Phi]^a$ , where  $a = [\alpha]$ .  $\Phi$  is object level if  $\alpha$  is an object term, and is kind level if  $\alpha$  is a kind term.
  - b.  $\Phi\alpha^i \text{ " } [ ] = [ ]_{r,i}$ , if  $\Phi$  is monadic and  $[\Phi\alpha]^i \text{ " } = 1$  (true atomic predications leave context unchanged except that the time "in focus" is set to the "episode time").  
 $= [ ]$  if  $\Phi$  is  $n$ -adic for some  $n > 1$ .
7.
  - a.  $[\sim\Phi]^i \text{ " } = 1$  iff  $[\Phi]^i \text{ " } = 0$
  - b. There are (at least) two plausible alternative hypotheses for context change due to processing a negated sentence. We will not decide between them, as this is not crucial to our concerns.
    - (i)  $\sim\Phi^i \text{ " } [ ] = [ ]$ , i.e., the context is "restored" to the value it had before  $\sim\Phi$  was evaluated (even though evaluation of the embedded  $\Phi$  may have involved various context changes itself). On this view the



pronoun in *Kim does not have a favourite professor; he is tall* cannot be interpreted as referring to Kim's favourite professor, even if Kim has one: the reference that would have been induced for *a favourite professor* by further processing of the first clause (from 11b, below) is unavailable outside the negative context.

- (ii)  $\sim \Phi^{i,w}[\ ] = \Phi^{i,w}[\ ]$ , i.e., the effect is just as for the unnegated sentence. On this view the pronoun *he* (above) can be interpreted as referring to Kim's favourite professor. This seems useful for sentences like *It's not that I don't have a reason; I'm just not telling you what it is*, where the *it* of the second clause can be interpreted as referring to my (concealed) reason, if I am speaking truthfully in the first sentence. Option (i) blocks such reference into a doubly negated context.
- (iii) Further options have to do with sentences like *I'm not reading a novel; it's a biography*, in which neither (i) nor (ii) seem to work. Here we would want the context induced by processing the first clause (assuming it's true) to provide something like "the book I am in fact reading" as referent, so as to be "picked up" by the *it* of the second clause.
8. a.  $[\Phi \& \Psi]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  and  $\Phi^{i,w}[\Psi]^{i,w} = 1$   
 b.  $(\Phi \& \Psi)^{i,w}[\ ] = \Psi^{i,w}(\Phi^{i,w}[\ ])$
9. a.  $[\Phi \vee \Psi]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  or  $\Phi^{i,w}[\Psi]^{i,w} = 1$   
 b.  $(\Phi \vee \Psi)^{i,w}[\ ] = \Theta^{i,w}[\ ]$  for some  $\Theta \in \{\Phi, \Psi\}$  such that  $[\Theta]^{i,w} = 1$ , if there is such a  $\Theta$ . (Thus for example, in *John has a dog or a cat, and it has fleas*, the pronoun can be interpreted as referring to one of John's dogs if he has dogs but no cats, to one of John's cats if he has cats but no dogs, and to any one of his dogs or cats if he has both. If he has neither we have placed no constraints on possible interpretations of *it*.)
10. a.  $[\Phi \rightarrow \Psi]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 0$  or  $\Phi^{i,w}[\Psi]^{i,w} = 1$

10. b.  $(\Phi \rightarrow \Psi)^{i,w}[\ ] = (\sim \Phi \vee \Psi)^{i,w}[\ ]$ . Then we have the options for negation as listed above. If we take option (i) — negation does not change the context — then this amounts to  $\Psi^{i,w}[\ ]$ ; if we take option (ii), then (using the  $\vee$  context change rule) this will give us one of a set of contexts, some like what we got with option (i) here and some like what we get with option (ii) for negation — depending on whether the antecedent of the conditional is false or the consequent true (or both).

Note that in the rules for the binary connectives, the second formula is evaluated with respect to the context *as altered by* the first. This is critical to our handling of the "donkey sentences" and related problems.

11. a.  $[(\exists \alpha : \Phi)\Psi]^{i,w} = 1$  iff some  $d$  satisfying  $[\Phi]_{\alpha:d}^{i,w} = 1$  also satisfies  $\Phi^{i,w}[\Psi]_{\alpha:d}^{i,w} = 1$ .<sup>29</sup>

It is worth noting that this is equivalent to: some  $d$  satisfies  $[\Phi \& \Psi]_{\alpha:d}^{i,w} = 1$ . Clauses similar to (11a) hold for  $\forall$ , Most, Few, No, etc.

$[(\text{The } \alpha : \Phi)\Psi]^{i,w} = 1$  iff  $[\Phi \& \Psi]^{i,w} = 1$  or else there is a unique  $d \in \mathbf{D}$  satisfying  $[\Phi]_{\alpha:d}^{i,w} = 1$ , and for that  $d$ ,  $\Phi^{i,w}[\Psi]_{\alpha:d}^{i,w} = 1$  (The first possibility corresponds to a "referential" interpretation, the second to a "Russellian" one.)

- b.  $(\exists \alpha : \Phi)\Psi^{i,w}[\ ] = (\Phi \& \Psi)^{i,w}[\ ]_{\alpha:d}$  for some  $d \in \mathbf{D}$  such that  $[\Phi \& \Psi]_{\alpha:d}^{i,w} = 1$ , if such a  $d$  exists. (Thus when the existential assertion is true, some possible value of the variable  $\alpha$  satisfying  $\Phi$  and  $\Psi$  becomes the value of  $\alpha$  in the modified context. This value can then be "picked up" by subsequent clauses.)

— for the quantifiers  $\forall$ , Most, Few, No, ... we again have the options similar to those for negation and the conditional; and again we leave the matter open.

$(\text{The } \alpha : \Phi)\Psi^{i,w}[\ ] = (\Phi \& \Psi)^{i,w}[\ ]$ , if  $[\Phi \& \Psi]^{i,w} = 1$ ;  
 $= (\Phi \& \Psi)^{i,w}[\ ]_{\alpha:d}$ , if  $d$  is the unique element of  $\mathbf{D}$  such that  $[\Phi]_{\alpha:d}^{i,w} = 1$ , and for that  $d$ ,  $\Phi^{i,w}[\Psi]_{\alpha:d}^{i,w} = 1$ .

It is probably worth pointing out that the above quantificational

treatment of indefinites (i.e., as  $\exists$ , interpreted as in 11a) is a unique feature of the present approach to discourse, and one generally thought to be incompatible with the ability of indefinites to provide referents for pronouns (see Heim 1982: Ch. I, Section 1).

Recall that  $r$  is our "time reference vector" and that  $r$  stands for the element of  $r$  that is "in focus". Recall also that we have an operation on  $r$  which "shifts focus" one element to the right ( $\vec{r}$ ) (backward in time) or one element to the left ( $\overleftarrow{r}$ ) (forward in time) of  $r$ , and finally, recall that the element of  $r$  that is in focus might be undefined to the right ( $r_{-}$ ) or undefined to the left ( $_{-}r$ ). Also refer to rule (6b), which is the basic rule for assigning  $r$  a new event time (besides the rule for progressive, 13b). Here then are our clauses for issues having to do with time.

## 12. (Time adverbs)

- a.  $[\text{YEST}(\Phi)]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  and  $i$  is during [yesterday]  
 $[\text{THEREUPON}(\Phi)]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  and  $i$  is immediately or shortly after  $[r]$ .  
 $[\text{AT-THAT-TIME}(\Phi)]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  and  $i = \text{end of } [r]$
- b.  $(A(\Phi))^{i,w}[\ ] = \Phi^{i,w}[\ ]$  for  $A$  a time adverb, if  $[A(\Phi)]^{i,w} = 1$

## 13. (Present and progressive)

- a.  $[\text{PRES}(\Phi)]^{i,w} = 1$  iff  $i = [\text{now}]$  and  $[\Phi]^{i,w} = 1$  for some  $j$  in the vicinity of  $i$   
 $[\text{gPRES}(\Phi)]^{i,w} = 1$  iff  $i = [\text{now}]$  and  $[\Phi]^{i,w} = 1$  for some  $j$  during [present]  
 $[\text{PROG}(\Phi)]^{i,w} = 1$  iff  $[\Phi]^{i,w} = 1$  for some  $j$  which includes  $i$  (ignoring certain modal characteristics of the progressive).
- b.  $(\text{PRES}(\Phi))^{i,w}[\ ] = \Phi^{i,w}[\ ]$  for some  $j$  in the vicinity of  $[\text{now}]$  such that  $[\Phi]^{i,w} = 1$ , if there is such a  $j$  and  $i = [\text{now}]$   
 $(\text{gPRES}(\Phi))^{i,w}[\ ] = \Phi^{i,w}[\ ]$  for some  $j$  during [present] such that  $[\Phi]^{i,w} = 1$ , if there is such a  $j$  and  $i = [\text{now}]$   
 $(\text{PROG}(\Phi))^{i,w}[\ ] = [\ ]_{r,i}$ , if  $[\text{PROG}(\Phi)]^{i,w} = 1$

## 14. (Past and perfective)

- a.  $[\text{PAST}(\Phi)]^{i,w} = 1$  iff  $i = [\text{now}]$  and  $[\Phi]_{\vec{r}}^{i,w} = 1$  for some  $j$  before  $i$   
 $[\text{PERF}(\Phi)]^{i,w} = 1$  iff  $i = [r]$  and  $[\Phi]_{\vec{r}}^{i,w} = 1$  for some  $j$  before  $i$ . (Note:  $[r]$  must be defined.)
- b.  $(\text{PAST}(\Phi))^{i,w}[\ ] = (\Phi^{i,w}[\ ])_{\vec{r}}$  for some  $j$  before  $i$  such that  $[\Phi]_{\vec{r}}^{i,w} = 1$ , if there is such a  $j$  and  $i = [\text{now}]$   
 $(\text{PERF}(\Phi))^{i,w}[\ ] = (\Phi^{i,w}[\ ])_{\vec{r}}$  for some  $j$  before  $i$  such that  $[\Phi]_{\vec{r}}^{i,w} = 1$ , if there is such a  $j$  and  $i = [r]$ .

*Legitimate  $\Phi$ -alternatives* are defined relative to a context space, a formula, a time, a world, and a context. Intuitively, they are all the new contexts that could have been generated from the formula  $\Phi$  and that context, had we been given a context transformation function different from the one specified as part of the given context space. (We assume that the time and world remain constant, and that these new contexts and context transformation functions obey the strictures given about them.) This set is picked out by the function  $f_S$  for a given context space  $S = \langle \mathbf{D}, \mathbf{W}, \mathbf{C}, \delta \rangle$ :

$$f_S(\Phi, i, w, [\ ]) = \{[\ ]' \mid \text{there is a context space } S' = \langle \mathbf{D}, \mathbf{W}, \mathbf{C}, \delta' \rangle \text{ such that } [\ ]' = \delta'(\Phi, i, w, [\ ]) \text{ and } [\Phi]^{i,w} = 1 \text{ with respect to } S'\}$$

15. (Simple temporal *whens*, a predicate over times)

- a.  $[\text{when-}\Phi, \Psi]^{i,w} = 1$  iff  $[\Phi \& \Psi]^{i,w} = 1$  where it is assumed that  $\Psi$  has been translated to incorporate a default adverbial AT-THAT-TIME or THEREUPON
- b.  $(\text{when-}\Phi, \Psi)^{i,w}[\ ] = (\Phi \& \Psi)^{i,w}[\ ]$  if  $[\Phi \& \Psi]^{i,w} = 1$ , where it is assumed that  $\Psi$  has been translated to incorporate default adverbial AT-THAT-TIME or THEREUPON<sup>30</sup>

16. (quantificational and generic conditionals: a schema,  $B \in \{A, U, O, S, F, N\}$ )

- a.  $[\Phi \rightarrow_B \Psi]^{i,w} = 1$  iff for  $B$ -many of the  $[\ ]' \in f_S(\Phi, i, w, [\ ])$ ,  $[\Psi]^{i,w} = 1$   
 $[\Phi \rightarrow_G \Psi]^{i,w} = 1$  iff for "most"  $\langle w', [\ ]' \rangle \in \mathbf{W} \times \mathbf{C}$  such that  $[\ ]' \in f_S(\Phi, i, w', [\ ])$ ,  $[\Psi]^{i,w'} = 1$ , where "most" is to be interpreted in terms of some probability distribu-

tion favouring worlds  $w'$  similar to  $w$ , with regard to the "inherent" or "essential" nature of things. (More crudely, we could just require the worlds  $w'$  quantified over to satisfy some appropriate similarity relation relative to  $w$ ).

- b.  $(\Phi \rightarrow_B \Psi)^i \llbracket \ ] = \llbracket \ ]$  (and likewise for  $\rightarrow_G$ ), i.e., embedded indefinites cannot be referred to outside the conditional. (Of course, indefinites that are "raised" to have wider scope than  $\rightarrow_B$  can be referred to later on, by rule (11b).)

We leave open what the possible worlds "similar to  $w$  with respect to the inherent nature of things" are, and exactly how many contexts counts as  $B$ -many. However, as indicated in the text, we think that complete formalization of the latter notion requires appeal to some method of systematically enumerating, or randomly sampling, the alternative contexts allowed by the antecedent, where the precedence (in an enumeration) or probability (in a sampling process) of a context depends not only on the variable bindings determined by that context, but also on the reference times determined by it (via the value of  $r$ ).

We close this Appendix with a treatment of a somewhat more complex example text, to show our conditions on tense and time adverbials at work:

- a. John entered the room.
- b. Mary had taken down his paintings.
- c. Then she had hung up some cheap posters.
- d. He groaned.

Assuming that these events did transpire as reported, let us verify that (a)–(d) are "true in English", when translated as:

- a'. PAST((The  $x$ : room( $x$ )) enter( $x$ , john))
- b'. PAST(PERF ((The  $y$ : plur (painting) ( $y$ ) & belong-to(john,  $y$ )) take-down( $y$ , mary)))
- c'. PAST(PERF (THEN (( $\exists z$ : plur (poster) ( $z$ ) & cheap( $z$ )) hang-up( $z$ , mary))))
- d'. PAST(THEREUPON (groan(john)))

(We neglect issues related to the relative scopes of quantifiers, adverbs, tense and aspect operators, the relative scopes of adjectives and the

plur operator (which, recall, forms a predicate true of collections of one or more individuals from a predicate true of individuals), and the implicit reference to locations in *take-down* and *hang-up*.) In evaluating (a') at  $i = [\text{now}]$  and  $w =$  the actual world, with  $r$  denoting  $\langle i \rangle$  (a singleton sequence whose element is in focus), we will obtain value 1 iff the formula embedded by PAST has value 1 at some time  $j$  before  $i$  (i.e., before now), with the focus of  $r$  shifted to the right (into the past) from  $i$  (leaving  $r = \langle i \_ \rangle$ , with the focal element undefined). By clause (11a), the embedded formula (beginning with the definite quantifier) has value 1 iff (*room*( $x$ ) & *enter*( $x$ , john)) does. This in turn has value 1 (at the appropriate time  $j$ ) iff  $x$  *already* designates the room John entered. But the definition of "truth in English" quantifier over all possible denotations of  $x$  (since no *variable* assignments are ruled out by conventional English meanings), and so the embedded sentence is true at time  $j$ . Moreover, evaluation of *enter*( $x$ , john) resets  $r$  from  $\langle i \_ \rangle$  to  $\langle ij \rangle$  (by clause (6b)), and after recursive ascent back to the top level of sentence (a'),  $r$  has value  $\langle ij \rangle$  (by clause (14b)), and of course, the sentence is true.

In (b'),  $r$  initially denotes  $\langle ij \rangle$ . The shifts induced by PAST and PERF change this to  $\langle ij \_ \rangle$  for evaluation of the embedded quantified sentence. The effect of the definite, "the paintings belonging to John" (much as in the case of "the room") is to ensure selection of a binding for  $y$  which is indeed the salient collection of paintings. The episodic predication, when evaluated to 1 at some time  $k$ , will change  $r$  to  $\langle ijk \rangle$ , and upon recursive ascent to the top level of sentence (b'), this becomes  $\langle ijk \rangle$ .

Evaluation of sentence (c') again shifts the focus to  $k$ , i.e.,  $r$  again becomes  $\langle ijk \rangle$  as a result of the PAST, PERF operators. The embedded episodic sentence headed by THEN will then cause the iteration over contexts compatible with English to "find" the time  $k'$  at which Mary hung up the cheap posters, where THEN ensures that  $k'$  is immediately or shortly after  $k$ . Consequently the new value of  $r$  becomes  $\langle ijk' \rangle$ , or, after ascent to the top,  $\langle ijk' \rangle$ .

Finally, evaluation of sentence (d') first shifts the focus right one step (due to the PAST operator) giving  $\langle ijk' \rangle$  as value of  $r$ . The sentence embedded by the PAST operator is therefore evaluated with reference to time  $j$ , the time of John's entering (*not* with respect to the times of the events reported in the past perfect). The effect will be to replace the value of  $r$  by  $\langle ij'k' \rangle$ , where  $j'$  is the time of John's groaning (constrained by THEREUPON to be immediately or shortly after  $j$ , the

time of John's entering). After ascent to the top of (d'), the final value of  $r$  is  $\langle ij'k' \rangle$ .

## ACKNOWLEDGEMENTS

We wish to thank the members of the University of Alberta Logical Grammar Study Group for comments and suggestions during the writing of earlier drafts of the paper: Matthew Dryer (Linguistics), Brendan Gillon and Bernard Linsky (Philosophy), and Sven Hurum (Computing Science). Thanks are also due to Gennaro Chierchia for his careful reading and searching critique of an earlier version of this paper. Many of the final touches were put on during the 1987 Summer Linguistics Institute at Stanford where Pelletier conducted a Workshop on Generics and Habituals. We thank Ivan Sag and his staff for coordinating the Institute; and the NSF for a grant which allowed the Workshop to take place. It was truly an intellectually stimulating environment. In this regard, thanks are due to the members of the Workshop both for their comments on this paper and for comments on the entire topic of generics: Greg Carlson, Gennaro Chierchia, Manfred Krifka, Godehard Link, and Alice ter Meulen. Finally, the authors also gratefully acknowledge the aid of NSERC Grants A8818 (LKS) and A5525 (FJP).

## NOTES

<sup>1</sup> Essentially, it attempted to find a middle ground between Carlson's and Chierchia's theories which would permit the simplicity of Chierchia's logical-form representations of generic (and related) sentences to be retained, while remedying the defects that seem to result from his relinquishing Carlson's operator *Gn*. The idea in this "conservative" proposal was to shift some of the burden of providing correct truth conditions from the rules of translation (into "logical form") to the rules of semantic evaluation (of the "logical form"). Intuitively, we "liberalized" the logical syntax of predication slightly at the expense of a slight complication of the rules of evaluation, by allowing "indirect evaluation". One could look at this proposal as if it removed "types" from the syntax of logical form but recaptured all the information thereby omitted within the semantic evaluation of the logical form. Godehard Link informs us that a similar idea is taken by Fine (1985) with respect to his "arbitrary objects": an "ordinary object level" predicate  $F$  applies to an "arbitrary object"  $a$  just in case  $F$  applies to every instance of the arbitrary object. Therefore, *natural numbers are even or odd* is true because the "arbitrary object" *natural number(s)* has this property; but *natural numbers are odd* and *natural numbers are even* are both false.

<sup>2</sup> "Situations" is being used here in an ordinary sense, with no necessary connection to the Situation Semantics of Barwise and Perry (1983).

<sup>3</sup> Some closely related views can be found in McCord (1981) and Aqvist *et al.* (1979). In the former, reference situations or objects are encoded into restrictions on variables bound by unselective quantifiers, while in the latter, an explicitly statistical approach is proposed, though without grammatical underpinnings.

<sup>4</sup> For example, Kamp (1981), Heim (1982), and Groenendijk and Stokhof (1987). The latter authors sharply distinguish their approach from the former two, and do not call their approach "Discourse Representation Theory"; but it nonetheless seems clear that the approaches are quite similar, as can be seen from comparing "Dynamic Predicate Logic" with the "File Card Semantics" of Heim (1982: Chapt. III). We therefore treat them all as variants of one single idea.

<sup>5</sup> Manfred Krifka informs us that Uwe Reilly and Werner Frey have developed a (computerized) natural language understanding system which treats "plural objects" in a Discourse Representation Theory.

<sup>6</sup> We follow the practice of Schubert and Pelletier (1987) in our symbolism. (1) We use "restricted quantification" in an obvious way:  $(\exists x: \Phi x)\Psi x$  is an abbreviation for the unrestricted  $(\exists x)(\Phi x \ \& \ \Psi x)$ ,  $(\forall x: \Phi x)Hx$  is an abbreviation for  $(\forall x)(\Phi x \rightarrow \Psi x)$ . Sometimes we use ' $M$ ' for *most*. (2) Where  $\Phi$  is a common noun, we use  $\mu(\Phi)$  as the name of the *kind*,  $\Phi$ . (3) ' $R$ ' (which stands for "realization") is a relation between objects and the kind which they instantiate:  $R(a, \mu(\Phi))$  says that  $a$  is an instance of the kind,  $\mu(\Phi)$ . Some Carlson-inspired theories also use this  $R$  to describe the relationship between an object and a "momentary stage" or "time slice" of that object, and also for the relationship between a kind and these "momentary stages" of objects. As we argued in the earlier paper, since we have time indices as part of our semantic evaluation mechanism, we have no need of these latter uses of ' $R$ '. Our use of "realization" is restricted to an object's instantiating a kind. (4) *sm* is used to indicate the unstressed 'some'. (5) Some formulas are written in a "categorical grammar style", as for example *loves(kim)(robin)* means: the 2-place operator *loves* combines with *kim* to produce the 1-place *loves(kim)*, which then combines with *robin* to produce the 0-place *robin loves kim*. Some further comments on our use of the "categorical grammar style" and its relation to ordinary first-order notation can be found at the beginning of the Appendix.

<sup>7</sup> We pick a non-quantified version of a "donkey sentence" for discussion. We think that all the points we make carry over to quantified versions, and that furthermore this prevents us from getting involved in pseudo-issues of relative quantifier scope.

<sup>8</sup> By "reading" here we intend the truth-conditions most naturally associated with the following English-like sentences. The sentence (7) has been seen to "mean" each of the following "readings".

<sup>9</sup> Although Heim (1982) does not treat the *if-then* construction as a material conditional, but rather (following Kratzer 1979) as a modal proposition in which the *if* part restricts an "invisible" necessity operator, her analysis nevertheless has the universally quantified material conditional (i.e., the "standard reading") as a consequence. See her 1982: 186-188. Roberts (1987) presents a related theory which also follows Kratzer 1979 in interpreting *if-then* constructions as modal propositions; and like Heim she endorses the "standard reading" of sentences like (7), at least when attention is restricted to the extensional portion of the truth conditions. See her 1987: Chapter 1.

<sup>10</sup> Other arguments against a quantifier raising analysis seem to turn on having

quantified subjects. It would be inappropriate, it is contended, to analyze *Every man who owns a donkey will ride it to town tomorrow* with a wide scope *a donkey*, since then every man would owe the same donkey. But even in these sentences there is the problem of its being vacuous: if there were a donkey which was not owned by every man, the sentence would be true.

<sup>11</sup> The term comes from Geach (1962) who views some pronouns as replacements for a stretch of previous text which we are just too lazy to repeat. Differences from other types of anaphora are most easily seen when the pronoun is a replacement for a stretch of text which itself contains a pronoun, and this contained pronoun becomes "dependent upon" different NPs. Consider *Any person who eats his food with a fork is socially more adept than one who eats it with his fingers* (cf. Karttunen 1969). The *it* here must stand for *his food*, and this new *his* will "depend upon" a different NP from the original *his*.

<sup>12</sup> LePore and Garson (1983) erroneously attribute to Partee (1972) and Evans (1977) the Non-Specific Existential Reading.

<sup>13</sup> "Roughly, the pronoun denotes those objects which *verify* (or that object which verifies) the sentence containing the . . . antecedent" (p. 469).

<sup>14</sup> "Scope widening" as opposed to "quantifier raising". A quantifier raising analysis takes the existential quantifier found in the antecedent and "raises" it to have wide scope, yielding the Non-Specific Existential Reading. The scope widening analysis tries to preserve logical equivalence by changing the existential quantifier to a universal quantifier with wider scope.

<sup>15</sup> There is a reading of (12) similar to this, based on a strictly temporal interpretation of *usually* (i.e., most of the time, cats as a species have the property of landing on their feet). However, even in this reading, a universal quantification of the cat-variable is too strong, since generic sentences do not necessarily apply to all instances of the generic term, but only to "typical" ones.

<sup>16</sup> This particular complaint, that in an "unselective quantifier" approach existentials will sometimes be translated as ordinary bound variables and sometimes as unselective quantifiers, does not directly apply to Heim (1982) who always translates indefinites as free variables. However, it applies indirectly since she binds the appropriate variables by unselective quantifiers (especially those in restrictive clauses) and then existentially quantifies remaining unbound variables ("Existential Closure" of her Chapt. II). The problem manifests itself in an additional way: she sometimes translates *universal* quantifiers as "ordinary quantifiers" and sometimes as "unselective quantifiers". See for example her discussion in 1982: p. 141f. Matters are somewhat different in the "File Change Semantics" of her Chapt. III. This approach is somewhat closer to ours than her Chapt. II approach, at least for the limited class of sentences she concerns herself with there, but we shall not pursue this similarity here. (We still find important differences also, such as her "building existential quantification (of indefinites in the consequent) into the interpretation of the quantificational conditional" — while we always treat indefinites as explicit existential quantification, but again we will not pursue these differences.)

<sup>17</sup> The alternative approach, due to Carlson, of treating generic existentials as denoting certain properties of kinds was also argued (in our earlier paper) to be flawed and would lead to a similar non-uniformity of translation as Lewis's approach.

<sup>18</sup> This method is also pursued in Groenendijk and Stokhof (1987), although their

solution is somewhat different than ours in that it yields the Universal Reading of conditionals. It is akin to ours in that it tries to preserve the compositionality of generating logical form representations from the initial English.

<sup>19</sup> Of course, had we translated *is behatted* as *is wearing a hat*, then the story would be different. In such a case, there would be a further context change induced by the indefinite *a hat*.

<sup>20</sup> We are here interested in the Indefinite Existential Reading, and not in other possible readings such as the Deictic Reading, the Generic Reading, or the Specific Existential Reading (which, following Fodor and Sag (1982), we view as some sort of "referential" reading — see also Section XII).

<sup>21</sup> There are a variety of "pragmatic" reasons why we might rule out one of the two men from consideration. We might, for some reason, explicitly agree that we are talking only about, say, the closest one, or the one we know. More saliently, it is often the case that we agree to talk about only the things we in fact actually do notice; and should one of them be hidden, say, then implicitly we can "agree" that such a man is not relevant to the discourse. Further discussion of this last option is in the next paragraph.

<sup>22</sup> We have in mind here that for some things it is not clear which of these sets they fall into. For example, people just in the process of putting on a hat. The idealized context will make a decision on this; but is not of any interest which decision, so long as the idealized context agrees with "reality" in the clear cases.

<sup>23</sup> (MPa) ignores various fine points about plurals, such as how we know that the collections of cats dropping to the ground here are "really" individual cats doing individual droppings-to-the-ground. In general we think that the issue is more a matter of "world knowledge" than semantics. For example, *When men lift a piano, they . . .* can be either about individual men lifting a piano, or about a collection of men lifting a piano. The referent of *they* in the consequent clause must somehow be able to pick out the relevant denotation. Some pertinent remarks can be found in the Coda (on plurality).

<sup>24</sup> We intend to use this sort of a modal operator to account for the nomic force of typical generics and habituals.

<sup>25</sup> This terminology is inspired by Lønning (1987), whose related work recently came to our attention.

<sup>26</sup> Consider such a sentence in the context of some previous discourse. "At the Universität Tübingen, they have their priorities straight. A student is usually intelligent." Here the "missing reference ensemble" would be students enrolled at Universität Tübingen.

<sup>27</sup> We think a further sub-division of O would be desirable. Perhaps it should contain T (things), A (attributes), E (episodes), and P (propositions), but for present purposes we will not consider such a further subdivision.

<sup>28</sup> Thus, for example, given a context  $\{ \}$ , evaluation of (the translation of) *A man yawned* in that context relative to time  $i$  and world  $w$  yields the new context

$$(\text{PAST}(\exists x: \text{man}(x))\text{yawn}(x))^{i,w} \{ \}.$$

This new context will contain new values for  $x$  (namely, some man who yawned), and for the second element of the reference time sequence  $r$  (namely, the time of his yawning).

<sup>29</sup> The ordering of operations in  $\Phi^{i,w}[\Psi]_{a;d,r;j}^{h,w}$  is:  $((\Phi^{i,w}(\{ \}_{a;d,r;j}))(\Psi))^{h,w}$ ; i.e., unless

bracketing indicates otherwise, constant or variable "resetting" is done first, then the context transformation (if any) is done, then the resulting context is applied to the expression it encloses (here:  $\Psi$ ), and finally the function applications indicated by the superscripts is done.

<sup>30</sup> We recognize that the proposed semantics for simple temporal *whens* is not entirely satisfactory, in that the *when- $\Phi$* -adverbial in such sentences seems to presuppose, rather than assert,  $\Phi$ . A sentence like *When John arrives, Mary will drive him home* seems to presuppose, but not assert, that John will arrive at some (particular, but unspecified) time. In this it is like *At (or shortly after) the time John arrives, Mary will drive him home*, whereas sentences like *When John arrives, Mary drives him home* is like our quantificational conditional.

## REFERENCES

- Aqvist, L., Hoepelman, J., and Rohrer, C.: 1979, 'Adverbs of Frequency', in C. Rohrer (ed.), *Time, Tense and Quantifiers* (Tübingen: Max Niemeyer Verlag), pp. 1–17.
- Aqvist, L. and Guentner, F.: 1976, 'Quantification Theory for Natural Language Based on Multi-Dimensional Modal Logics with Demonstratives', in F. Guentner and M. Guentner-Reutter, *Meaning and Translation* (London: Duckworth), pp. 327–353.
- Bacchus, F. and Schubert, L. K.: 1987, 'Predicates with Probabilities', Univ. Alberta Dept. Science Technical Report.
- Barwise, J. and Perry, J.: 1983, *Situations and Attitudes* (Cambridge: Bradford-MIT).
- Carlson, G.: 1977a, *Reference to Kinds in English*, Univ. Mass. PhD dissertation, available from Indiana University Linguistics Club.
- Carlson, G.: 1977b, 'A Unified Analysis of the English Bare Plural', *Linguistics and Philosophy* 1, 413–456.
- Carlson, G.: 1979, 'Generics and Atemporal *When*', *Linguistics and Philosophy* 3, 49–98.
- Carlson, G.: 1982, 'Generic Terms and Generic Sentences', *Journal of Philosophical Logic* 11, 145–181.
- Carlson, G.: 1985, 'Exceptions to Generic Generalizations', ms. Linguistics, Univ. Iowa.
- Chierchia, G.: 1982a, 'Nominalization and Montague Grammar: a Semantics without Types for Natural Languages', *Linguistics and Philosophy* 5, 303–354.
- Chierchia, G.: 1982b, 'On Plural and Mass Nominals', *Proceedings of the West Coast Conference on Formal Linguistics* 1.
- Cooper, R.: 1979, 'The Interpretation of Pronouns', in F. Heny and H. Schnelle (eds.), *Syntax and Semantics 10: Selections from the Third Groningen Round Table* (N.Y.: Academic Press), 61–92.
- Dowty, D.: 1982, 'Tenses, Time Adverbials, and Compositional Semantic Theory', *Linguistics and Philosophy* 5, 23–55.
- Evans, G.: 1977, 'Pronouns, Quantifiers and Relative Clauses (1)' and 'Pronouns, Quantifiers and Relative Clauses (2): Appendix', *Canadian Journal of Philosophy* 7, 467–536 and 777–798.
- Farkas, D. and Sugioka, Y.: 1983, 'Restrictive *if/when* Clauses', *Linguistics and Philosophy* 6, 225–258.
- Fine, K.: 1985, *Reasoning With Arbitrary Objects* (Oxford: Blackwell's).
- Fodor, J. D. and Sag, I.: 1982, 'Referential and Quantificational Indefinites', *Linguistics and Philosophy* 5, 355–398.
- Gazdar, G., Klein, E., Pullum, G., and Sag, I.: 1985, *Generalized Phrase Structure Grammar* (Oxford: Blackwell's).
- Geach, P.: 1962, *Reference and Generality* (Ithaca: Cornell UP).
- Groenendijk, J. and Stokhof, M.: 1987, 'Dynamic Predicate Logic'. Paper presented at ASL/LSA "Logic and Linguistics" meetings, Stanford.
- Heim, I.: 1982, *The Semantics of Definite and Indefinite Noun Phrases*, PhD dissertation, Univ. Mass.
- Hintikka, J. and Carlson, L.: 1979, 'Conditionals, Generic Quantifiers, and Other Applications of Subgames', in A. Margalit (ed.), *Meaning and Use* (Dordrecht: Reidel).
- Hornstein, N.: 1984, *Logic as Grammar* (Cambridge: Bradford-MIT).
- Kamp, H.: 1981, 'A Theory of Truth and Semantic Representation', in J. Groenendijk, T. Janssen and M. Stokhof (eds.), *Formal Methods in the Study of Language* (Amsterdam: Mathematical Centre-tracts, Univ. Amsterdam).
- Karttunen, L.: 1969, 'Pronouns and Variables', *Proceedings of CLS V*, 108–116.
- Kratzer, A.: 1979, 'Conditional Necessity and Possibility', in R. Bauerle, U. Egli and A. von Stechow (eds.), *Semantics from Different Points of View* (N.Y.: Springer-Verlag).
- Krifka, M.: 1987, 'A Typology of Generics'. Paper presented to Conference on Linguistic and Philosophical Aspects of Generics, Stanford.
- LePore, E. and Garson, J.: 1983, 'Pronouns and Quantifier-Scope in English', *Journal of Philosophical Logic* 12, 327–358.
- Lewis, D.: 1975, 'Adverbs of Quantification', in E. Keenan (ed.), *Formal Semantics of Natural Language* (Cambridge: Cambridge UP).
- Lønning, J. T.: 1987, 'Collective Readings of Definite and Indefinite Noun Phrases', ms. Matematisk Institutt, Universitetet i Oslo, Norway.
- McCord, M.: 1981, 'Focalizers, the Scoping Problem, and Semantic Interpretation Rules in Logic Grammars', Technical Report, Univ. Kentucky.
- Partee, B.: 1972, 'Opacity, Coreference, and Pronouns', in D. Davidson and G. Harman (eds.), *Semantics for Natural Language* (Dordrecht: Reidel), pp. 415–441.
- Partee, B.: 1973, 'Some Structural Analogies Between Tenses and Pronouns in English', *Journal of Philosophy* 70, 601–609.
- Partee, B.: 1978, 'Bound Variables and Other Anaphors', *Proceedings of TINLAP-2*, pp. 79–85.
- Pelletier, F. J. and Schubert, L. K.: 1985, 'Mass Expressions', in D. Gabbay and F. Guentner (eds.), *Handbook of Philosophical Logic, Vol. IV* (Dordrecht: Reidel), forthcoming.
- Pollard, C.: 1983, 'On the Correct Use of Lambda Calculus in Generalized Phrase Structure Grammars', ms. Stanford University.
- Richards, B. and Heny, F.: 1982, 'Tense, Aspect, and Time Adverbials, Part I', *Linguistics and Philosophy* 5, 59–107.
- Roberts, C.: 1987, *Modal Subordination, Anaphora, and Distributivity*. PhD dissertation, Univ. Mass.
- Schubert, L. K.: 1982, 'An Approach to the Syntax and Semantics of Affixes in

- 'Conventionalized' Phrase Structure Grammar', in *Proc. of the Fourth CSCSI/SCEIO Conference* (Univ. of Saskatchewan), pp. 189-195.
- Schubert, L. K. and Pelletier, F. J.: 1982, 'From English to Logic: Context Free Computation of 'Conventional' Logic Translations', *American Journal of Computational Linguistics*, 26-44. Reprinted, with corrections, in B. Grosz, K. Spark-Jones, and B. Webber, *Readings in Natural Language Processing* (Los Altos, Cal.: Morgan Kaufmann), 1986, pp. 293-312.
- Schubert, L. K. and Pelletier, F. J.: 1987, 'Problems in the Interpretation of the Logical Form of Generics, Bare Plurals, and Mass Terms', in E. LePore (ed.), *New Directions in Semantics* (London: Academic Press), pp. 387-453.