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ON PLURAL AND MASS NOMINALS AND THE STRUCTURE OF THE WORLD

Gennaro Chierchia

0. INTRODUCTION

Bare plural nominals in English (e.g. dogs, green chairs, students with good grades) have always represented a hard problem for any attempt of theoretical explanation. In recent years, however, G. Carlson [1] has developed a framework which goes some way towards explaining this intricate phenomenon. Carlson's theory depends upon extensions of model-theoretic semantics of natural languages developed within what is often called Montague Grammar (MG).

Carlson makes use of assumptions about the way that speakers of natural language conceptualize the structure of the world in order to analyze a body of linguistic facts. Thus, he is taking up the traditional claim that human languages have an underlying metaphysics, and expressing it within a precise model theoretic framework. His method, as applied to the study of English bare plurals, can be thought of as an exercise in what E. Bach terms English metaphysics[2]. What strikes me as appealing in Carlson's work is that by resorting to an extremely simple hypothesis on the semantic structure of bare plurals, he can make sense of otherwise very puzzling distributional patterns of certain English Noun Phrases (NPs).

In the present paper, I will propose several modifications and extensions of Carlson's approach in terms of the framework of Chierchia 1981, which constitutes an application to natural language semantics of work by N. B. Cocchiarella. Such an analysis, I will try to argue, allows us also to gain insight in the behavior of mass nouns.

Section 1 of this paper will briefly review Carlson's analysis of bare plurals. Section 2 will discuss some of the difficulties inherent in Carlson's analysis. Section 3 will briefly present the semantic framework of Chierchia 1982a. Section 4 will develop a detailed semantics for bare plurals, as well as an outline for a semantics of mass nouns. Both will be argued to be cases of nominalization, i.e. of transformation of an expression denoting a property into something like a proper name.

1. CARLSON ON BARE PLURALS

One common feature of theories of the bare plural developed within the generative tradition is to resort to a phonologically null determiner-like element. These kinds of proposals, however, face the heroic task of explaining how constructions involving bare plurals can display heterogeneous sets of readings like the following:

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(1) dogs are mammals
(1') every dog is a mammal

(2) dogs give live birth
(2') most female dogs give live birth

(3) dogs are intelligent
(3') most dogs are intelligent

(4) dogs are barking in the yard
(4') some dogs are barking in the yard

(5) dogs are numerous
(5') ?

The primed version of (1)-(5) should constitute the most plausible paraphrase with overt determiners of the bare plural NP dogs as used in the corresponding non-primed versions.

One might be tempted to say that the hypothesized null determiner of bare plural NPs like those in (1) is simply ambiguous; it allows for a variety of readings: one universal, one existential, etc. But clearly no simple-minded appeal to ambiguity like this will do; each of (1)-(5) has, in fact, a unique reading. For instance, (1) doesn't have any reading where the "null determiner" has, say, an existential import (under no circumstances could it mean "some dogs are mammals").

In addition to the above mentioned problem posed for the hypothesis of a "null determiner", there are a host of other elements which militate against it. They have to do with the fact that a quantified NP (also if its sole determiner is phonologically unrealized) should bear scope; therefore it should interact with other scope bearing items (like negation, adverbs, other quantifiers). However, Carlson shows that in presence of the latter items, bare plurals fail to display the expected scopal ambiguities. So, for instance, consider the following sentence (from Carlson 1977).

(6) Mary wants to meet some football players.

(6) has two readings. On one reading there are some specific football players that Mary wants to meet. On the second reading, Mary does not have in mind, so to speak, any particular athlete. Consider now the following:

(7) Mary wants to meet football players.

(7) shares with (6) the opaque or narrow scope reading, but lacks the transparent or wide scope one. If there is a phonological null determiner in (7) with an existential import, some explaining will be needed to account for

the lack of wide scope reading. Carlson displays a large number of facts of this sort arguing quite convincingly that bare plurals behave more like proper names than like quantified NPs such as some men. (For a rapid review of the relevant data, see Chierchia, 1982). He accordingly proposes to treat bare plurals as proper names. But names of what?

1.1 Referring to kinds. Carlson's idea is that corresponding to common nouns, whose semantic type in Montague's Intensional Logic (IL) is $\langle e,t \rangle$,[3] there are particular individuals (i.e. objects of type e) that he calls kinds. So, for instance, corresponding to the CN dog,[4] there is in the domain of individuals the kind of dogs, or dog-kind; kinds will be related to the intension of the corresponding CN through devices that we will consider in a moment. Bare plural NPs simply name kinds: dogs in (1) just refers to the kind of dogs, like John refers to John.

A consequence of this hypothesis is that it is to the predicate (rather than to the NP) that the different readings, and in particular the difference between the universal and the existential reading of the bare plural (exemplified by (1) and (4) respectively) should be somehow attributed. The idea is that certain predicates, such as to be a mammal, to be human, to know Latin, concern a "permanent" or "stable" property in individuals; such properties, so to speak, don't use up time. When we attribute the property of being a man to John, we are considering the individual in its entirety, and not a particular event in John's life.

There are, however, other predicates, like to be running to class, to be on the roof, to have eaten a hamburger, which attribute a more temporary property to the subject, concerning an episode or event in his life. Clearly, with respect at least to verbal predicates, this distinction is somehow related to the stative vs. non stative one[5]. Let's agree to call the properties denoted by the first kind of predicates characterizing properties, and the ones denoted by the second kind of predicates episodic properties. The distinction between characterizing and episodic properties is held responsible, by Carlson, for the universal and existential reading of bare plurals, respectively. The way he proposes to implement such a distinction in the grammar is quite suggestive. He assumes that the domain of individuals is further partitioned into objects and stages. Objects are ordinary things, like me, my pen, Luciano Pavarotti, etc. Stages are something like spatiotemporal slices of things; each object organizes a set of stages and makes them stages of one and the same individual. So, for instance, when we say that John ran to class yesterday, we are saying something about a certain spatiotemporal section of John's. Non-state-properties crucially involve stages and thus can be modeled as sets of stages. On the other hand, when we say that John knows Latin, we are considering the object John as a whole; characterizing properties speak of objects and not of local episodes in their histories; this suggests that we can model them as, say, sets of objects.

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Carlson offers a series of independent grammatical criteria upon which t partitioning of English predicative expressions into object-level and stag level predicates is based. This is not the place to go over them (c Carlson, 1977, pp. 66 ff.). The output of such partitioning can be rough summarized as follows. Predicate nominals (like (be) a man) and stative verl (love, hate, know, etc.) apply to objects; adjectives seem to constitute mixed set: some appear to apply to objects (basically those that dislik there-insertion: intelligent, big, red, etc.) others to stages (th complement set of the former: drunk, available, present, etc.). In genera prepositional phraaes (like (be) on the roof) hold of stages, together wit non-stative verbs (run, kill, hit, etc.).

So, according to Carlson's proposal we have at least three disjoint sets o entities in our domain of individuals (usually denoted as D_e in the M literature): kinds, objects and stages. Carlson calls objects and kind together individuals. Let x^s_n, x^o_n, x^k_n, and x^i_n (for each natural number n) b variables of type e ranging over stages, objects, kinds, and individuals respectively. Carlson introduces also two "realization" or "instantiation relations R and R'. Intuitively, R(x,y) holds just in case that x is a individual (i.e. object or kind) and y is one of x's stages, while R'(x,y holds just in case that x is a kind, and y is an object that belongs to it. The interpretation of R and R' is constrained by the following set of meaning postulates (Carlson, 1977, pp.263-264):

(8) $\Box \bigwedge x^o \bigwedge y^s [R(x,y) \rightarrow \bigwedge z^o [R(z,y) \leftrightarrow z = x]]$

(9) $\Box \bigwedge x^o \bigwedge y^k \bigwedge z^s [[R(x,z) \wedge R'(y,x)] \rightarrow R(y,z)]$

(10) $\Box \bigwedge x^s \bigvee y^i [R(y,x)]$

(11) $\Box \bigwedge x^k \bigwedge y^s [R(x,y) \rightarrow \bigvee z^o [R'(x,z) \wedge R(z,y)]]$

(12) $\Box \bigwedge x^k \bigwedge y^k \bigwedge z^o [[R'(x,z) \wedge R'(y,z)] \leftrightarrow x = y]$

(8) guarantees that objects do not share stages; (9) says that if z is a stage of an object that belongs to a kind, z is also a stage of the kind as well; (10) requires that each stage is a stage of some individual; (11) says that if y is a stage of a kind there is an object of that kind such that z is a stage of it; finally, (12) is a sort of extensionality principle for kinds: two kinds are identical iff they have the same instances in every world.

Carlson introduces bare plural NPs in the grammar with the following pair of rules:

S 100. If $\alpha \in P_{CN}$ and α is plural, then $F_{100}(\alpha) \in P_T$, where F_{100} is the identity function.

T 100. If $\alpha \in P_{CN}$, then $F_{100}(\alpha)$ translates as
$\lambda P\ P(\iota x^{k} \Box \bigwedge y^{o}[R'(x^{k},y^{o}) \leftrightarrow \alpha'(y^{o})])$

So, for instance, the NP dogs is going to denote the property-set of that unique kind whose instances are all and only dogs. In this way it is guaranteed that the kind associated with dogs will be an entity closely related to the intension of the corresponding CN, in the sense that the dog-kind will contain all the information contained in the intension of the CN dog.

1.2 Bare plurals and aspectual distinctions. Consider the following sentence:

(13) Students ran a lot (to get to the department party on time).

According to our criteria, (13) should concern stages of students. Its reduced translation into IL, according to the grammar Carlson defines, is (ignoring the adverb):

(14) $P \bigvee y^{s}[R(s,y) \wedge \underline{run}'(y)]$

Where P is the past tense operator (to be read as "it was the case that") and s is $\iota x^{k} \Box \bigwedge z^{o}[R(x,z) \leftrightarrow \underline{student}'(z)]$. So (14) says that it was the case that some instance of the student-kind was running. However, (13) can have also a generic or habitual reading like in:

(15) Students ran a lot (before the new generals paper policy).

In (15) we are not reporting a certain event like in (13), but describing a habit students used to have; thus the criteria used so far push us to take (15) as a statement concerning individuals.

In order to handle generic forms of non stative verb phrases, Carlson introduces an operator Gn'; this should be considered part of the aspectual system of verbs. Semantically, it maps non-state-properties into state-properties. In a multisorted version of IL, its type would be $\langle\langle s,\langle e^{s},t\rangle\rangle, \langle e^{i},t\rangle\rangle$, where e^{s} is the subtype of stages and e^{i} is the subtype of individuals. Carlson tries to give further hints about the semantics of Gn' in the following terms; consider:

(16) John smokes

Smoke is a non stative verb, therefore it is to be viewed as a property of stages. However, (16) has usually a generic reading, and its reduced translation according to Carlson's proposal will be:

(17) $Gn'(\hat{}\underline{smoke}')(j)$

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Where smoke´ is of type $\langle e^s,t\rangle$ and Gn´(^smoke´) of type $\langle e^i,t\rangle$. (17) should mean that there are "enough" stages of John involved in the activity of smoking for us to say that the individual John has the property of being a smoker. In other words, the truth value of (17) should depend somehow on the truth value of the corresponding eventive sentence, whose logical form would be:

(18) $\bigvee y^s[R(j,y) \wedge$ smoke´$(y)]$

Precisely how the truth conditions of sentences like (17) should depend on those of sentences like (18) is not specified.

So, Gn´ is a VP-operator responsible for genericity; in English it happens to be morphologically unrealized, but in other languages it shows up as a real morpheme.[6]

On the basis of the apparatus just outlined, Carlson is able to offer a conceptually simple and promising account of the intriguing behavior of bare plurals. Within the limits of the present paper, there is no space to consider fully the body of data Carlson analyzes and the details of the arguments he offers in favor of his analysis. The reader interested in those is referred to Carlson 1977. There are two aspects of his approach that I regard as particularly appealing. The first concerns the argument given against the idea that in the syntax or in the semantics of the bare plurals there is a determiner with universal or existential import.[7] The second aspect concerns the fact that a set of genuinely linguistic facts (the name-like behavior of bare plurals) is explained in terms of an hypothesis about what entities there are. It is important to point out that all the notions Carlson introduces are in one way or another independently needed in a grammar of English. That we do refer to kinds simply follows from the existence of NPs like that kind of thing. Also the bipartition of English VPs exploits criteria which, problematic as they may be, have nevertheless been independently proposed to handle well established linguistic facts concerning aspectual distinctions between statives and non statives, the behavior of adjectival phrases in there-clauses, etc. Of course, a fuller account of the bare plural will crucially depend on the working out of a general analysis of tense and plural. I think, however, that Carlson´s theory imposes some clear-cut adequateness criteria on such a general theory, and might be viewed as a fragment of it. In tbis perspective, let´s try to analyze in more details some problems into which Carlson´s proposal seems to run.

2. PROBLEMS IN CARLSON´S THEORY

2.1 Kinds of primitives. The way bare plural NPS are introduced in Carlson´s grammar (cf. sbove p20) ensures that an object instantiates a kind, say the kind of dogs iff it is a dog. The dog-kind encodes (via the realization relation R´) all the information encoded in the intension of the CN dog about

what a dog is. This makes one wonder how kinds are different from the intension of CNs. It seems that the only difference between the two amounts to the fact that kinds have an "individual" nature (i.e. they are in the domain of individuals D_e) while intensions of Cns have a "predictable" nature (i.e. they belong to the set of properties $D_{<s,<e,t>>}$). Carlson (1977, p. 97) considers the possibility of analyzing kinds as nominalized intensions of CNs. What I call here the nominalization of CN-intensions amounts to the introduction of NPs denoting kinds as a new "level" of NP (say $\overline{\text{NP}}$) whose semantic type would be $<<s,<<s,<e,t>>,t>>,t>$. Such a move, however, as Carlson also notices, has far-reaching and quite devastating consequences on the overall organization of the grammar. It will force us to duplicate all predicates, since the function associated with a VP in a sentence like Dogs run would be of type $<<s,<e,t>>,t>$, and so could not be the same one associated with a VP in a sentence like John runs, which would be of type $<e,t>$. It is to avoid this duplication of predicates, forced by an adherence to the PTQ type system, that Carlson resorts to "kinds" of type e, together with a realization relation R'.

Unfortunately, though, the sort of type-based problem Carlson is seeking to avoid emerges in many other places, including the analysis of factives (Delacruz 1976), the analysis of the group reading of plurals (Bennett 1976), and the analysis of infinitives (Partee 1977), which seem to require a category switching rule mapping sentences, plural common nouns, and verb phrases, respectively, into noun phrases. Just as is the case when we analyze kinds as intensions of common nouns, this requires the introduction of NPs of a more complex semantic type (see Parsons 1979).

Let's agree to call all syntactic and semantic processes which transform such categories as CNs, VPs, and Ss into noun phrases nominalization processes. It is natural to attempt to treat the formation of English bare plural noun phrases as a particular instance of a nominalization process. Given a uniform analysis of nominalization processes we could hope to do away with such machinery as instantiation relations in favor of regarding kinds as nominalized common nouns. In Chierchia 1982a, I have tried to provide just such a uniform analysis of nominalizations, making essential use of the work of Nino Cocchiarella, and this analysis will be summarized in Section 3 below.

2.2 Stages and objects. According to what Carlson says, stages are to be thought of as temporally limited manifestations of things. Objects are what tie stages together. One way to model these intuitions would be to regard stages as sets of spatiotemporal points and objects as functions from some relevant set of parameters (say, worlds, times, and places) to sets of spatiotemporal points. A metaphysics of this sort has been proposed, within the framework of possible world semantics, by Cresswell (1973). An object would be analyzed as a sort of individual concept. There are various difficulties with this position, however. The development of tense and modal logic in the 60's has had as a common assumption that there are relevant sets of coordinates, including, for example, a set of durationless temporal points,

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with respect to which sentences are evaluated. Consider the following examples:[8]

(19) Mark is running.
(20) run'(m)

Just for the sake of discussion, let's make the dubious assumption that (20) represents the meaning of (19); we can say that (20) is true at a time j iff Mark is among the things that run at j. This seems to be undistinguishable from saying that there is a running stage of Mark at j. In other words the use of time (among other coordinates) as a parameter for the evaluation of sentences seems to make superfluous the notion of stage (for a similar criticism, cf. de Mey 1980).

We can make the same point from another perspective. Let's pursue for a moment the idea that stages are sets of spatiotemporal points and objects individual concepts that have stages as their extension. Let's moreover assume that the logical form of sentences like (19) is not (20) but the following:

(21) $\bigvee y^s[R(m,y) \wedge \underline{run}'(y)]$ where m is Mark

On the hypothesis we are considering, the value of m has to be an individual concept (call it u), not an individual. (21) would then be true at some time j iff there is a set of spatiotemporal points h such that h is the extension of u (at some point of reference), and h is in the set of running things at j. There seem to be two difficulties here. First, unless we further constrain the realization relation R, y^s could be any old stage of Mark, including a past or a future one. This would obviously mess up completely the tense system as is usually analyzed. If, on the other hand, R is constrained in such a way that the value of y can only be Mark's manifestation at the time of evaluation, then R becomes indistinguishable from Montague's 'V' operator, as is also pointed out by de Mey. However, and this is the second difficulty, if the value of y (i.e. h) is a set of spatiotemporal points, then (by the preceding argument) it will include the time of evaluation j; so (21) will more or less say that Mark's manifestation at j is in the region of running things at j, i.e. we are repeating twice the information concerning time. In conclusion, if the notion of stage is related to that of time, and if we have time among the coordinates for evaluating sentences, then it is not clear how to avoid redundancies. Talk about stages seems just to introduce a complicated way of saying things we could have expressed more simply.

Carlson, however, dismisses the idea of analyzing objects as individual concepts with the following argument. consider (from Carlson 1977, p. 191):

(22) George and Henriette are sitting here.
(23) George and Henriette are petting dogs.

The context of use should specify the place and time with respect to which both (22) and (23) are evaluated. But (22) entails that George and Henriette are sitting at the same place, while (23) does not entail that they are petting the same dogs. According to Carlson's theory, though, the reduced translation of (23) would look like:

(24) $\forall y^s[R(d,y) \wedge \forall x^s[R(g,x) \wedge \forall z^s[R(h,z) \wedge \underline{pet}'(x,y) \wedge \underline{pet}'(z,y)]]]$
where d is the kind of dogs, g is George and h is Henriette

So (24) seems to say that there is one and the same stage of the dog-kind such that George and Henriette are petting it; and this seems to go against our intuitions. But if stages of, say, the kind of dogs are sets of spatiotemporal points constituting dog-manifestations at the time and place of utterance, they of course need not be spatiotemporally continuous. Stages of individuals, like kinds, might well be scattered entities. Thus, if George and Henriette are protagonists of a petting episode of a stage of dogs, it does not follow that they are petting the very same individual dogs.

In Carlson's theory, however, if (24) is true, then George and Henriette must be petting the very same dogs; as a matter of fact, they must be petting the very same dog. This follows from meaning postulates (8) and (11). We have here further evidence that the notion of stage as implicitly characterized by Carlson's meaning postulates is indeed inadequate. The plurality of bare plurals simply gets lost; (24) is true in any model where George and Henriette are petting one dog (cf. once more de Mey 1980).

The claim has been made that stages are crucially involved in distinguishing between verbs and nouns and between statives and non statives in general. So, they aim at an essential role in a theory of aspect. But to see whether a notion like that of stage can really help in building a theory of aspect, we have to provide a tighter characterization of it. We will try to do so in section 4 after having provided some more apparatus for the purpose.

2.3 Object- and stage-level VPs. Being optimistic about the preceding difficulties, let's assume that Carlson is right in claiming that the analysis of certain linguistic facts requires us to assign a different semantic structure to different families of predicates. This raises the general question about how to implement such distinctions in a grammar.

Three ways of proceeding come to mind: one based on syntactic subcategories (or syntactic features), one based on semantic sorts, and the third based on meaning postulates. We cannot consider them here in any detail.

In what follows, I will discuss in some depth how Carlson implements the distinction in question in his grammar. In particular, I will have in mind the second fragment presented in Carlson 1977; I will aim at an intuitive characterization of its main features, skipping over technicalities as much as possible.

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Carlson's grammar is based on a multisorted version of IL. The type of individuals e is partitioned, as we have already seen, into four subtypes: e^s, e^k, e^o, e^i; a recursive definition of the set SType of the subtypes corresponding to each of the basic sort is then given. For any subtype, say $\langle e^s,t\rangle$, $D_{\langle e^s,t\rangle}$ will be the set of corresponding denotations. In particular $D_{\langle e^s,t\rangle}$ will contain characteristic functions defined just for stages and undefined for other sorts of individuals. This introduces truth-value gaps in IL.

As we have also seen, Carlson assumes that there are VPs of two basic sorts: $\langle e^s,t\rangle$ and $\langle e^o,t\rangle$. All basic intransitive verbs are taken to be of type $\langle e^s,t\rangle$. In order to assign in general a subtype to each lexical item, a function c in $\underline{\text{SType}}^{\bigcup_{a \in \underline{\text{Cat}}} B_a}$ is employed; so, for instance c(run) = $\langle e^s,t\rangle$, c(man) = $\langle e^o,t\rangle$, etc. Carlson also follows the standard practice in MG of analyzing NPs as sets of properties of objects; so John will be translated as $\lambda P\check{}P(j)$, where the subtype of j is e^o. It then follows that if John' is applied to run' then resulting reduced formula (namely run'(j)) will be truth-valueless, and thus semantically deviant. run' can be properly applied to j only if it is raised to an object-level predicate by the operator Gn', yielding Gn'(^run')(j), which represents the generic reading of John runs.[9] This approach, therefore, tends to multiply syntactic ambiguities and to use the semantics to filter out undesirable reading of sentences. In fact a simple sentence like John runs is ambiguous in infinitely many ways in Carlson's grammar,[10] and it can have formulas of the form Gn'(Gn'...^Gn'(run')...)(j) as its translation.[11] All of these formulas, except the ones we want, will come out sortally deviant. I find this an odd use of semantic sorts. A theory of sortal correctness is usually invoked to handle violations of selectional restrictions and related phenomena. Here, however, it is being used to rule out a case of syntactic over-generation that doesn't yield any deviant sentence, but attributes wrong readings. In other words, the syntax assigns to each well-formed sentence a lot of misfit meanings, which then commit suicide because of lack of truth-values. The consequences that this technique has in general on linguistic metatheory are unknown to me. Below, I will sketch an alternative to this approach.

Carlson distinguishes three classes of transitive verbs. Non stative verbs, like hit and pet, select the existential reading of bare plurals (i.e. John pets unicorns means roughly that John pets some unicorns). Carlson proposes to capture this by analyzing verbs like hit as involving stages of the grammatical object they take, i.e. as being ultimately relations between stages of things. However, given that NPs denote sets of properties of objects, this cannot be accomplished directly. The type of this kind of transitive verb bas to be $\langle\langle s\langle\langle s,\langle e^i,t\rangle\rangle,t\rangle\rangle, \langle\langle e^s,t\rangle\rangle$ so that they can take things of NP-type as arguments. What Carlson does is to define each non-stative verb α' in terms of a constant of IL α^+ of type $\langle e^s,\langle e^s,t\rangle\rangle$. So, for instance, hit' is defined as follows:

(25) $\underline{\text{hit}}' =_{df} \lambda P\lambda z^s\check{}P(\hat{}\lambda x^i\bigvee y^s[R(x,y) \wedge \underline{\text{hit}}^+(z,y)])$

In this way an existential quantification over stages is packed in the meaning of each non-stative transitive verb. The reduced translation of, say, John is petting unicorns will be:

(26) $\forall y^s[R(j,y) \wedge \forall z^s[R(u,z) \wedge \underline{pet}^+(y,z)]]$
Where j is John and u is the kind of unicorns

This approach requires for each verb of the class we are considering an opposite translation rule involving a constant of IL of type $\langle e^s, \langle e^s, t\rangle\rangle$.

Stative verbs appear to select the universal reading of bare plurals in object position (i.e. John fears unicorns means roughly that John fears all of them). A way of handling this, according to Carlson, would be to treat statives as involving ultimately relations between objects. Statives are thus treated in much the same way as non-statives, except that the former involve relations of type $\langle e^i, \langle e^o, t\rangle\rangle$. Here is an example:

(27) $\underline{fear}' =_{df} \lambda P \lambda x^o \vee P(\hat{}\lambda y^i\ \underline{fear}^+(x,y))$

The third class of VPs Carlson individuates are intensional verbs like seek. These are claimed to select the existential reading of bare plurals in object position. If we treated them as we treated other non statives, we would regard them as involving relations among stages. There is a problem here, however. The way the bipartition between stage- and object-level VPs is obtained in Carlson's theory automatically extensionalizes transitive verbs. What this means is that intensional verbs like seek would have to be lexically decomposed, and Montague's treatment bas to be given up. Now, it is very likely that Montague's treatment is not the ultimate solution to the obstacles that intensionality posits on the way to Truth. Yet in Carlson's theory, the abandoning of it is not argued for in any principled way, i.e. it is a mere accident. Moreover, it seems simply wrong to me to analyze verbs like seek or look for as involving stages of the object. If I am seeking Mary, I am not seeking a temporally bound manifestation of Mary. There are no stages of Mary that are involved in my seeking activity. Mary in her entirety is the object (in our "technical" sense) I am seeking. On tbe other hand, it seems to me that seek does select the existential reading of bare plurals in object position (i.e. John is seeking unicorns means that John is seeking any old unicorn, which is the usual paraphrase for "John is seeking a unicorn)". How is this possible given the framework we are assuming? The point is that being a relation between stages is sure enough a sufficient condition for selecting the existential reading of bare plurals, but not a necessary condition. Consider the following example:

(28) John is looking for dogs

(29) $\forall y^s[R(j,y) \wedge \underline{look\text{-}for}'(y,d)]$
where j is John and d is the kind of dogs

Let's assume that (29) is the reduced translation of (28). What (29) says i that John is involved in a dog-seeking activity. The nature of this activit is such that John cannot be really looking for all dogs, but just for som (unspecified) dog. This can be in fact guaranteed by meaning postulate, if w want such a guarantee to be part of the grammar of English. Here is how suc a meaning postulate would look in Carlson's own formalism.

(30) $\underline{\text{seek}}'(x^s,y^k) \leftrightarrow \underline{\text{seek}}'(x^s,\hat{}\lambda P\bigvee z^o[R'(y^k,z^o) \wedge \check{}P(z)])$

(30) says that x is seeking a certain kind of thing iff that x is seeking ar object of that kind. Given the intensionality of seek, it does not follow from (30) that there are specific objects that x is seeking. Tbis gives us back a Montaguish treatment of intensionality, and is the route we will follow below.

What we have said so far should be sufficient to give an idea of the difficulties that Carlson's way of implementing a bipartition of predicates in the grammar of English meets. To sum them up, we have (a) an unjustified multiplication of syntactic ambiguities, (b) a severe complication of the translation mapping that involves the function c (cf. earlier this section) plus an individual stipulation of the translation for each verb, and (c) the abandonment of Montague's treatment of intensional verbs. The alternative we will consider below is based on meaning postulates and avoids all such difficulties.

I will not discuss the operators Gn' and Gn which, I think, constitute the most problematic aspect of Carlson's theory. To show what sort of difficulties they run into would require a separate work tackling more directly problems of verbal aspect. Thus, I will provisionally adopt them as they are without any further discussion.

This concludes our criticisms of Carlson's proposals about bare plurals. We can now proceed to develop an alternative to Carlson's theory that tries to maintain its good features while avoiding its problematic ones. In order to be able to do this, however, we have to introduce some novelties in our semantics.

3. AN OUTLINE OF A THEORY OF NOMINALIZATIONS.

Several categories of expressions in natural language (common nouns, verbs, adjectives, etc.) are usually analyzed as denoting properties. Thus, semantics of natural languages must be based on some theory that tells us what sorts of things properties are and how they are predicated or attributed to individuals. Such a theory, for example, should specify what properties there may be, whether there is a property that holds of everything, what properties are definable terms of properties previously available, etc. The theory of properties and replication that Montague built into his semantics is based on

the theory of simple types. Such a theory seems to work well enough for natural languages, except for phenomena involving nominalization. In other words, if we use properties like those denoted by, say, to be beautiful or to be odd to speak about things like me, you, or my dog Fido, everything works out fine. If, however, we use them to speak about other properties (including, maybe, cases of self-applying properties as in to be beautiful is beautiful) we confront an anomaly. Consider the following example:

(31) John is odd.
(32) to be drunk at 8:00 a.m. is odd

Type theory requires that to be odd is to be associated with property of a different type in (31) and (32), since in (31) it is attributed to an individual, while in (32) to a property. To implement such a requirement it would be necessary to complicate the grammar, given the functional dependency between syntactic category and semantic types usually assumed in MG. So type theory reveals its unnaturalness as a theory of properties and predication for natural languages.[12].

Nino Cocchiarella has developed a family of systems for the logical analysis of nominalization. Such systems can be considered (type-free) axiomatic characterizations of the notion of property. Informally, they can be described as non-standard second-order logics that allow for predicate expressions to occur in argument position. So, to give an example, in Cocchiarella's systems, formulas like R(Q,x) or P(P) are well-formed. Usually, in second-order logic, properties are specified through a comprehension principle, i.e. an axiom of the form:

(CP) $\forall R \exists x_1, \ldots, \exists x_n [R(x_1, \ldots, x_n) \leftrightarrow \phi]$

If we allow, however, for predicative expressions to occur in argument position, it is necessary to restrict (CP) in order to somehow avoid Russell's paradox. Different ways of restricting (CP) yield different logics for nominalization. The one that will be of interest to us is based on the notion of stratum. We say that a wff is a homogeneously stratified (or h-stratified) iff there is a function f that maps each symbol of ϕ into a positive integer in such a way that for each atomic subformula $\pi(\alpha_1, \ldots, \alpha_n)$ of ϕ, $f(\alpha_i) = f(\alpha_j$ (where $1 \leq i, j \leq n$) and $f(\pi) = f(\alpha_i)+1$. It is possible then to adopt a version of (CP) where we require it to be h-stratified. In this way, the open wffs through which properties can be specified cannot have the same variables occurring in both predicative and argument position. So, for instance, a wff of the form $\neg P(P)$ that might be employed to reproduce Russell's paradox is not h-stratified; thus a formula like $\forall H \exists x [P(x) \leftrightarrow \forall Q[Q = x \wedge \neg Q(Q)]]$ is not an instance of an h-stratified version of (CP). In other words, we cannot introduce Russell's property using an h-stratefied comprehension principle. This is of course very approximate.

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Within the limits of the present paper it is impossible, however, to go into further details. A logic for nominalization based on an h-stratified version of (CP) is developed in Cocchiarella 1979, and is called HST*.

Let's spend a few words to try to give a rough idea of the semantics of formal systems like HST* with nominalized predicates. There are, essentially, two ways to go. On the one hand, we can take the notion of property as a primitive. Restricting our attention to one-place properties, we might model them in terms of a set P; then if U is the set of individuals, predication can be represented as a relation H in PXU; intuitively H(p,u) holds just in case u is in the extension of p. We can moreover assume that $P \subseteq U$, so that properties can be values of the individual variables of our language. This amounts to sorting out the domain of individuals into two disjoint sets: predicable and unpredicable individuals. What the predication relation does is to associate with each predicable individual an extension. Using U and H we can build models for theories of properties like HST*. Intuitively, a formula of the form P(x) will be true in a model μ iff $H(\|P\|_\mu, \|x\|\mu)$ where H is the predication relation specified by μ and $\|\alpha\|_\mu$ is the value of α in μ.

Another possibility is the following. We can model properties as, say, sets of individuals, and represent predication as set-membership, which is the route most commonly followed in modeling first-order theories. We can introduce, then, a function f that maps properties into individuals. Such a function can be viewed as providing, in intuitive terms, a "individual correlate" for each property. Nominalized predicative expressions (i.e. predicative expressions occurring in argument position) will denote not properties but property-correlates. So properties <u>per se</u> (as values of predicative expressions in predicate position) are not represented as having an individual nature (i.e. cannot be referred to by, say, names). They are systematically related to individuals, though, and these property-correlates are what nominalized predicates refer to. This view of nominalization is related to Frege's distinction between "concepts" and "objects". So. Cocchiarella calls a semantics based on a correlation function f as just described "Fregean semantics".

On the first approach we were representing properties as unspecified entities and using a predication relation to associate them with sets of objects as their extensions. On the second approach we model properties directly as sets of objects and map these sets to unspecified property-correlates. These intuitions can be made fully explicit, in the sense that along the lines just sketched a model theoretical characterization of various logics for nominalized predicates is possible (for a survey of the main results cf. Simms 1980). If we implement HST* with (a modalized version of) an axiom of extensionality for properties, then the two approaches outlined above out to be equivalent. However, HST* is intended to offer an <u>intensional</u> theory of properties (i.e. in pure HST*, necessarily equi-extensional properties need not be identical). For the present purposes, though, we will stick to the traditional view of identifying properties with functions from possible worlds

to extensions. It should be kept in mind that such a view is not forced upon us by HST* per se.

On the basis of Cocchiarella's work, I have tried to develop a version of IL, called IL*, which allows for a treatment of nominalization. I am going to present now a brief and approximate description of IL*; a fully explicit description of it can be found in Chierchia 1982a. In intuitive terms, IL* differs from IL in two respects. First, it allows for expressions of any type to occur as arguments of a function. Second, it has a very simplified, one might actually say trivial, system of types. In IL*, there are three types of things: properties-in-extension, properties-in-intension and individuals. Propositions are regarded as o-place properties-in-intension. More specifically, we assume that for each natural number n, we have denumerably many variables $P^n_1,\ldots,P^n_m,\ldots$, and constants $C^n_1,\ldots,C^n_m,\ldots$ of type n. These will take as values properties-in-extension of n places; 0 will be the type of well-formed formulas, which will have, as usual, truth-values as extensions. We will have then, for each natural number n, denumerably many variables $P^{i,n}_1,\ldots,P^{i,n}_m,\ldots$ and constants $C^{i,n}_1,\ldots,C^{i,n}_m,\ldots$ of type <s,n>. These will range over n-place properties-in-intension. Additionally, we will have denumerably many individual variables $x_1,\ldots,x_n,\ldots$ of type e. Properties-in-extension will be modeled as in IL, i.e. if U is the domain of individuals, then each property-in-extension of type n will be a member of E^e_n, where E^e_n = $\{0,1\}^{\overbrace{U\times\ldots\times U}^{\text{(n-times)}}}$ Properties-in-intension will also be modeled as in IL, i.e. as functions from points of reference to properties-in-extension; eacb property-in-intension of type <s,n> will be a member of E^e_n, where W is the set of points of reference. In Montague's IL (and in Chierchia 1981) W is taken to be I X J, wbere I is the set of possible worlds and J is a set of times. For the purposes of the present paper we will assume that W is IXJXD, where I and J are as above, and D is a set of places. The logical symbols of IL are $\neg$ (negation), $\rightarrow$ (material implication), $\wedge$ (universal quantifier), H (past tense operator), W (future tense operator, $\hat{}$ (Montague's "up" operator, taking from properties-in-extension to properties-in-intension). $\check{}$ (Montague's "down" operator, taking from properties-in-intension to properties-in-extension), (taking a formula and n variables to give a predicative expression of type n). Other logical operators (including '=' and '$\Box$') can be defined as usual. The rule of functional application (through which predication is analyzed) has the following form in IL*:

(33) If β is an expression of type n and α is of <u>any</u> type, then $\beta(\alpha)$ is an expression of type n-1.

So we allow for expressions of any type to occur in argument position. To give an example, $P^1_3(C^{i,2}_1)$ is a wff (i.e. a well formed expression of type 0), $P^{i,2}_1(P^1_3)$ is a well formed expression of type 1 (i.e. a 1-place predicate), etc.

For IL*, a Fregean semantics is assumed, i.e. predicative expressions in argument position denote correlates provided by a function f that embeds properties into the domain of individuals. The model theoretic frames upon which the semantics of IL* is based will have the following form: $\langle U, \langle E_n \rangle_n, I, D, J, \leq, f \rangle$, where (i) I, J. D are disjoint non-empty sets (worlds, times, and place respectively) and $\leq$ is a partial order on J; (ii) for each n, $E_n = E_n^e \sqcup E_n^i$, where $E_n^e = \{0,1\}^{U^{\cdot^{\cdot^{U}}}}$ (n-times) and $E_n^i = E_n^{eIXJXD}$; (iii) f is function from $U \sqcup \bigcup_{n\in\omega} E_n$ into U such that for each $u \in U$, $f(u) = u$. Once the constants of IL* are given a value through an interpretation function F with respect to a Fregean frame $\mathcal{A}$, it is possible to define recursively a function Ext, such that for any value assignment to the variables g, any world i, time j, and place d, and any well formed expression of IL* α, $Ext_{\mathcal{A},i,j,d,g}(\alpha)$ is the extension of α with respect to $\mathcal{A}$ and g at world i, time j and place d. We will not give the details of such a definition here. On tbe basis of Ext it is possible to define in the obvious way a notion of truth and validity of IL*. In the definition of validity for IL* we will restrict ourself to <u>stratified</u> Fregean frames. First we say that a Fregean frame is stratified iff every instance of (a modalized version of) a stratified comprehension principle is true in it. Then we can say that a wff ϕ of IL* is IL*-valid iff it is true in every stratified Fregean frame. In this way we incorporate Cocchiarella's version of the stratification technique into our system. In particular, it turns out that the theorems of HST* are all IL*-valid.

All this is certainly too sketchy to be fully convincing. I hope it will be sufficient to show, however, that a system like IL* constitutes a conceptually simple and interesting framework for the analysis of nominalization in natural language.

4. A MODIFIED THEORY OF ENGLISH BARE PLURALS.

4.1 <u>An ontology for English</u>. The hypothesis I wish to consider here is based on the idea that stages have a mereological nature but, in a sense yet to be made precise, do not directly involve time. They should be pieces of stuff, things somehow less structured than the inhabitants of our common sense world. I think we could regard them simply as portions or quantities of matter. In this way, the notion of stage will not be introduced as a new primitive but will exploit a machinery that has been argued (e.g. ter Meulen 1981) to be independently needed for the analysis of mass nouns. By inhabitants of our common sense world, I mean chairs, bottles, people, etc., which I will call "things" in scare quotes. Carlson's theory claims essentially that stages play a crucial role in the individuation of events and processes while "things" (i.e. Carlson's objects) are involved in states. If we assume that reference to stages is crucially involved in a particular class of VPs then certain properties of the English aspectual system (including the conditions

it imposes on different readings of bare plurals, the differentiated behavior of progressive forms, etc.) could follow in a simple matter. This is what I would like to pursue a little further.

The distinction between stages and "things" will also depend on the different sets of criteria required to identify them. Identifying something that floats in the air in front of me requires operations that are very different from those required by the identification of something that has the property of being a good armchair. It's tempting to say that events do not require that the individuals involved be identified through sortal concepts, while states do. The notion of sort is certainly a problematic and complex one, and the task of providing an analysis for it goes far beyond the limits of the present paper. I tend to regard sorts as sets of classificatory principles elaborated by humans in the course of their interaction with the world. Some of these classificatory principles (like, e.g., natural kinds) might correspond to real causal structures existing in the world, while others (such as, artifacts) might not.[13] In order to see more clearly what the role of sortal concepts in our grammar ought to he, consider the following examples:

(34) it is floating in the air
(35) it is a yellow armchair

The it in (34) could refer to something to which no sortal concept applies, like, say, the heterogeneous matter raised by the fight between a dog and a cat. On the other hand in (35) we are speaking about something clearly identifiable among the inhabitants of our everyday world. That might he exactly what distinguishes states from events and processes. This is a rough first approximation to a complicated topic, but it looks to me a plausible starting point. What we need now is some model-theoretic machinery against which these intuitions can be tested.

For the analysis of stages (i.e. portions of matter) all we need to assume is that among our individuals there are quantities or portions of matter. "Things" can then he represented as individual concepts, i.e. functions from worlds, times, and places to quantities of matter. Episodic properties will be modeled as sets of portions of matter, while characterizing properties will be modeled as sets of individual concepts of the type just described.

Let A be the set of quantities or portions of matter. One can think of A either as the power set of some set of atoms or, more neutrally, as a partially ordered set with a complete join semilattice structure on it[14]. Let also QM (for quality of matter) be a 1-place predicative constant of IL*, and let F be the interpretation function such that for any constant of IL*, and any point of reference, F gives the extension of that constant at that point of reference. We will simply assume that for any world i, time j, and place d, F(QM', i,j,d) = A. This is all we need for talking about stages.

In IL* the "up" operator '^' is defined just for predicative expressions an not for individual terms, so we don't have any device to refer directly t individual concepts. We can represent them closely enough, though, as on place properties that at each point of reference hold of just a singl individual, in the way suggested in Montague's "Pragmatics ad Intensiona Logic" (see Montague 1974). Within the framework of IL*, individual concept can be defined as follows:

(36) $\text{InCon}(x) \leftrightarrow_{df} \bigvee P^i[P^i = x \wedge \Box \bigvee z \bigwedge y[\, P^i(y) \leftrightarrow z = y]]$

It is possible then to isolate the individual concepts that at each point of reference pick out stages (i.e. portions of matter); they will be those satisfying the following formula:

(37) $\Box \bigvee z[\underline{\text{QM}}(z) \wedge \bigwedge y[\hat{}P(y) \leftrightarrow z = y]]$

Let's call m-individual concepts (in symbols InCon^m) those that satisfy (37). I propose to represent the inhabitants of our common sense world as m-individual concepts, i.e. functions from points of reference to portions of matter.[15] Of course, not any old function from points of reference to portions of matter will be a genuine "thing". We hit here one of the most debated problems in modal logic: not any world-line is a good one, not any individual concept represents (or corresponds to) a genuine individual (in the pretheoretical sense of the word). The individual concept that picks out all of John's manifestations is a good one; the one that picks out the manifestations of whoever happens to be the president of the United States is not a good one, doesn't correspond to a genuine "thing". I will leave it open here precisely how genuine "things" are to be singled out; one could resort to a Lewis-like counterpart relation or to some other set of criteria of spatiotemporal continuity and causal connection. For now, we can simply take thing' (abbreviated as th) to be a 1-place predicative constant of IL* and require that "things" be m-individual concepts:

(38) $\bigwedge x \Box[\underline{\text{th}}(x) \rightarrow \text{InCon}^m(x)]$

We can now easily make sure that characterizing properties (e.g. CNs) are analyzed as sets of "things", while episodic-properties are analyzed as sets of stages, by making use of the following axiom schemata:

(39) $\bigwedge x \Box[\delta(x) \rightarrow \underline{\text{th}}(x)]$ where δ is a common count (concrete) noun or stative VP

(40) $\bigwedge x \Box[\beta(x) \rightarrow \underline{\text{QM}}(x)]$ where β is a non-stative VP

This gives us a precise characterization of stages and "things".

Kinds will be analyzed as nominalized predicates. Of course a predicate yields a kind only if it has a sortal nature and/or encodes regular patterns of behavior of the objects that fall within its extension. So, for instance, the property of being a relative of mine does not constitute a kind. In fact, as Carlson accurately notes, bare plural NPs like relatives of mine and people in the next room systematically fail all the tests for being kind-level NPs, and behave pretty much as (existentially) quantified NPs. I think that one can safely assume that all basic CNs of an adult vocabulary (except, maybe, very special CNs like thing) are projected as kinds when nominalized. This gives us a set of "basic" kinds, representing the classificatory set-up encoded in a grammar. This set might be language particular, and even subject to changes within the same speaker in correspondence to the various stages of his/her ontogenetical development. In addition, from a logical point of view, the set of basic kinds is clearly not closed with respect to the standard logical operations: the union of two kinds might not be a kind itself.[16] For our purposes, we will assume kind' (abbreviated as kn) to be a 1-place constant of IL*; of course all kinds will be 1-place properties, but what counts as a kind will vary according to the particular model we will be assuming. In general, however, all basic common nouns will be associated with kinds.

Bare plurals will be analyzed, following Carlson, as names or kinds. They are going to be introduced in the grammar by the following pairs of rules:

S100. If $\alpha \in P_{CN}$ and α is plural then $F_{100}(\alpha) \in P_T$, where F_{100} is the identity mapping.

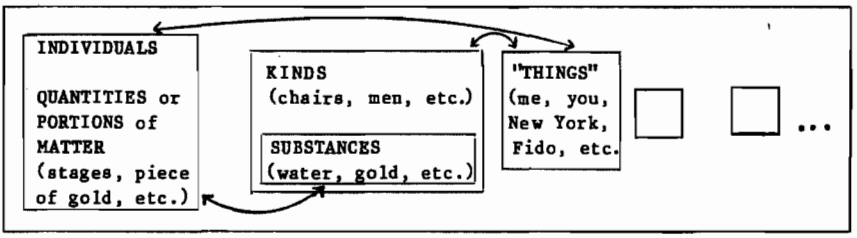
T100. If $\alpha \in P_{CN}$, then $F_{100}(\alpha)$ translates as $\lambda P^{i,s} P^i(\hat{}\alpha')$.

So, for instance, the translation of the NP dogs in, say, dogs are numerous, will be $\lambda P^{i,s} P^i(\hat{}dog')$, and the reduced translation of the entire sentence will be numerous'($\hat{}$dog'), which says simply that the kind of dogs has the property of being a numerous kind (cf. 4.3 below for more details). What S100 and T100 essentially do is to transform a predicate expression into a name. This should make clear in which sense the formation of bare plurals can be viewed as a particular case of nominalization. Within the framework of IL*, category switching rules like S100 are completely straightforward and do not require any further readjustment of the system of syntactic categories. To speak about kinds we can use the same stock of predicates we use to speak about other objects, a step that in IL was prevented by the presence of the hierarchy of types.

The sorts of objects we have considered so far do not exhaust what we can find in our domain of individuals. In particular, we will talk about substances, i.e. things like gold, water, etc. In the next section we will see how they are related to quantities of matter. Besides quantities of matter, "things",

kinds, and substances, there will be many other sorts of individuals: events, groups of things, freedom, brotherhood and equality, etc. But for the time being we will limit our attention just to the former.

The ontology for English we have so far is summarized in the following diagram:



The arrows in the diagram indicate various ways in which the boxes are related; they don't have a uniform interpretation. What they represent depends on how the objects in the boxes are defined. For instance, we have defined "things" as individual concepts that have portions of matter as their values, and this determines how to interpret the bidirectional arrow connecting the box portions of matter with that of "things", and so on. Thus, our domain of individuals is articulated in a complex network of dependencies. How complex the ontology will have to be is in part an empirical question: it depends on what has grammatical relevance and what doesn't. Notice that by getting rid of types we flatten out the domain of individuals. In IL* everything (literally everything, the domain of individuals itself, cf. Chierchia 1981) can be the value of an individual variable. But this of course doesn't mean that the domain of individuals has no structure; indeed it has a very complex one.

Let's go back to bare plurals. What we want to do at this point is to provide a precise model-theoretic analysis of Carlson's realization relation. In order to do so, we need some further machinery. First let's adopt the following notational convention:

(41) $x \Delta y =_{df} \bigvee P^i[P^i = y \wedge \check{}P^i(x)]$

"$x \Delta y$" has to be read as "x is in the extension of y". Notice that the following is a valid wff of IL*:

(42) $x \Delta P^i \leftrightarrow \check{}P^i(x)$

In the system we are going to propose we will define Carlson's realization relation in terms of the notion of mereological sum, which we will write officially as S* and unofficially as +. We will take S* to be a 3-place

relation of IL* such that for any x, y and z, S*(x)(y)(z) holds iff x and y are portions of matter and z is their sum. It would he possible to characterize S* in terms of some version of the axioms for mereological sum. In the case at hand, however it is simpler to provide directly the semantics for S*, which can be done as follows:

(43) For any time i, world j and place d, and for any u,u′, u′′ ∈ U, $F(S^*)(\langle i,j,d\rangle)(u)(u')(u'') = 1$ iff u,u′,u′′ ∈ A and u′′ = u ⊔ u′.

Let′s assume, moreover, the following notational convention:

(44) $x + y = \iota z\, S^*(x)(y)(z)$

Given +, we can easily define a <u>part of</u> relation, in the following terms:

(45) part of′ $=_{df} \lambda x \lambda y[x+y = y]$

We can now define stepwise first what it means for a stage (i.e. a portion of matter) to realize a "thing" (and we will call this form of realization Re_1), then what it means for a stage to realize a kind (and we will call this form of realization Re_2); finally, we will take Carlson′s realization relation R to be just the union of the two relations so defined (and we will call it Re). Formally:

(46) $Re_1 = \lambda x \lambda y[th(x) \wedge y \Delta x]$

Given the way "things" are, Re_1 turns out to be a function (for any "thing" x there is a unique portion of matter that constitutes its value at any given point of reference). So we can write:

(47) $\forall x = \iota y\, Re_1(x)(y)$

′∀′ is the restriction of Montague′s ′∪′ operator, to a particular sort of individual concept.

Re_2 will be defined as follows:

(48) $Re_2 = \lambda x \lambda y[kn(x) \wedge \forall z \forall w[z \neq w \wedge z \Delta x \wedge w \Delta x \wedge$ part of $(\forall z + \forall w)(y)]]$

So a stage $realizes_2$ a kind iff it is the fusion of some $realization_1$ of some (at least two, for the plurality presupposition of bare plurals) instances of the kind. Finally, we will have:

(49) $Re = \lambda x \lambda y[Re_1(x)(y) \vee Re_2(x)(y)]$

Given the present definition of the realization relation, all of Carlson′s axioms, (except for (12)) will have to be abandoned. But we already argue that they provide an inadequate characterization of the notion of stage. On

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the other hand, the approach presented here provides us with a conceptually sharp definition of the notion of stage and of the realization relation R, using an apparatus that seems to be independently needed for dealing with mass nouns. We will see in section 4.3 how the notion introduced here can do some real work for us in describing the grammar of English bare plurals.

4.2 A note on mass nouns. In what follows, I would like to sketch how our framework could be extended to accommodate a theory of mass nouns. Consider the following examples:

(50) the ring is gold
(51) gold is an element

It is possible to argue, following essentially ter Meulen 1981, that gold in (50) is a predicate expression (syntactically a CN) having a set of quantities as its extension, while in (51) is a name of the substance gold (syntactically an NP), where substances can be analyzed as the intension of the corresponding CN (i.e. as functions from points of reference to sets of quantities of gold). Thus, predicative masa nouns can be taken to have as substance their intension nominal mass nouns refer to substances like proper names to their bearer. Therefore, within the present approach it is very natural to regard mass NPs as nominalizations of mass CNs.

Consider now the following example:

(52) a. this stuff is gold
b. this ring is gold
c. this substance is gold

The subject of (52a) refers to some quantity of matter, to which the property of being gold is being attributed. In (52c), however, the very same property is attributed to a "thing", namely a certain ring. What (52b) seems to say, intuitively, is that the ring in question is of gold. Finally, in (52c), the property of being gold is attributed to some substance. Notice that (52c) doean't have to be an identity statement. The substance referred to might be some subspecies of gold (such as, say, white gold). so, the VP is gold appears to be quite liberal with respect to the kind of subjects it can take. We might attribute this ambiguity to the copula itself. One of the syntactic functions of the verb to be is that of mapping a set of non-verbal categories (such as adjectives, common nouns, prepositional phrases) into VPs. How the verb to be contributes to the semantics of the entire VP is a complex and open question. What we will do here is to try to maintain one of the standard hypotheses about the verb to be, namely that it is semantically empty. It is unlikely that this hypothesis can resist a more detailed analysis of tense and aspect, but such an analysis goes far beyond the limits of the present paper. If we take to be to be semantically empty (i.e. the identity function, or something analogous), then the variety of readings that the VP to be gold can have in (52a-c) is to be attributed to the CN itself. We could proceed as

follows. It seems plausible to assume that in some primary sense, gold is a predicate that applies to quantities of stuff (as exemplified in (52a)). So, we might have a predicate of IL*, say $gold_1$, that can be truly attributed only to quantities.

(53) $\bigwedge x \Box [gold_1(x) \rightarrow QM(x)]$

Then it is easy to construct a derivative sense in which the CN gold is attributed to "things" that are made of gold. We might represent this reading in terms of a predicate of IL*, call it $gold_2$, defined as follows:

(54) $gold_2 =_{df} \lambda x[gold_1(^{\vee} x)]$

Recall that "things" are individual concepts that have portions of stuff as their values. So, $gold_2$ would denote at each point of reference the set of "things" that have quantities of $gold_1$ as their values.

Finally, it is possible to attribute the CN gold to some of its sub-substances (such as white gold). In this respect, it is worthwhile emphasizing once more that the notion of substance we are employing is not that of "natural" kind, though is related to it. The grammar of English simply does not make such a distinction. What the grammatical notion of kind and substance have in common with natural kinds of substances is that they both are taken to constitute patterns of regularity in the behavior of objects. But the criteria identifying such regularities are very different. For natural kinds and substances, they are provided by nature (whatever that may mean); for grammatical kinds and substances, they may be determined by a heterogeneous set of linguistic dispositions and conventions (including "natural" dispositions). At any rate, (52c) can be represented by positing a further constant of IL*, $gold_3$, defined as follows:

(55) $gold_3 =_{df} \lambda x \bigwedge y[y \Delta x \rightarrow gold_1(y)]$

$gold_3$ would represent the meaning of the CN gold in sentences like (52c). So we can take our CN gold to be ambiguous between the readings represented by $gold_1$, $gold_2$ and $gold_3$. We might, therefore, represent the meaning of the CN gold as follows:

(56) $gold' =_{df} \lambda x[gold_1(x) \vee gold_2(x) \vee gold_3(x)]$

However, we can achieve the same effects of this definition by constraining the meaning of the CN gold in terms of a set of meaning postulates. Recall that our realization relation Re is a relation between entities and their stages. In particular, it holds between a "thing" and the stuff that realizes it and between a kind and the fusion of some members of that kind. Now, substances can be regarded as kinds whose members are not "things" but quantities. As a matter of fact, this view is forced upon us, if we regard nominal mass nouns (as the one in (51)) as nominalized CNs, as we did for

plural CNs. Therefore, for something to be a stage of a kind which is a substance will simply be to be a quantity of that substance. Our realization relation Re can be straightforwardly extended to cover such a case by extending Re_2 (48) as follows:

(57) $Re_2 =_{df} \lambda y \lambda x[kn(y) \wedge \forall z \forall w[z \neq w \wedge z \Delta y \wedge w \Delta y \wedge$
$\hat{} [part\ of'(\forall z + \forall w)(x)] \vee [part\ of'(z+w)(x)]]]$

We can now characterize the meaning of mass nouns like gold in terms of the following set of meaning postulates:

(58) a. $\wedge x \Box[gold'(x) \rightarrow [QM(x) \vee \wedge y[Re(x)(y) \rightarrow gold'(y)]]$
b. $\wedge y \wedge x \Box[[Re(x)(y) \wedge gold'(y)] \rightarrow gold'(x)]$
c. $\wedge y \wedge x \Box[[gold'(x) \wedge gold'(y) \wedge QM(x+y)] \rightarrow gold'(x+y)]$

(58a-c) achieve the same effects of (53)-(55) without having to posit "abstract" notions such as $gold_n$. In particular, (58c) imposes a join lattice structure on the quantities that are in the extension of mass CNs. (58a-c) jointly are taken to be an abstract representation of the semantic structure of mass nouns. All we need to do, then, is to extend to mass nouns our nominalization rule.

(59) S100'. If $\alpha \in P_{CN}$ and α is mass or α is plural, then $F_{100}(\alpha) \in P_T$, where F_{100} is the identity mapping.

So, the formation of bare plural and mass NPs is analyzed as different instances of the same grammatical process. This seems to offer a unified and maximally simple account of such nominal structures that embodies a number of interesting claims. First, given (59), we ought to expect mass and plural NPs to pattern alike with respect to scope and anaphora. In Chierchia 1982b, I have tried to show that all the relevant properties that characterize bare plurals also apply to mass nominals. Second, sentences like (52a-c) receive a uniform semantic representation that matches their uniform syntactic structure. To exemplify, consider the sentence the ring is gold. Its semantic representation will be:

(60) $\forall y \wedge x[[ring'(x) \leftrightarrow x = y] \wedge gold'(y)]$

In virtue of (58a-c), this will be true iff x is a "thing" constituted of gold. Moreover, if the ring in question has the property of, say, having been made by a famous jeweler, the quantity of gold that makes it up obviously will not have such property. In sentences like (51), on the other hand, the CN gold is nominalized by our rule (59). So its translation will be:

(61) $\lambda P^{i \vee} P^i(\hat{} gold')(\hat{} element') <=> element'(\hat{} gold')$

(61) says of the substance gold that it is an element. Consider now a sentence like white gold is gold (which is analogous to (52c)). I take white to be an intersective adjective. So, the meaning of the CN white gold will be represented as $\lambda x[white'(x) \wedge gold'(x)]$ (see on this Chierchia 1982a). This CN can then undergo our nominalization rule (59), becoming an NP whose meaning will be $\lambda P^{i,s} P^{1}(\hat{}\lambda x[white'(x) \wedge gold'(x)])$. So the reduced translation of the sentence in question will be:

(62) $gold'(\hat{}\lambda x[white'(x) \wedge gold'(x)])$

By (58a-b) this is equivalent to

(63) $\bigwedge y[Re(\hat{}\lambda x[white'(x) \wedge gold'(x)])(y) \rightarrow gold'(y)]$

(73) says roughly that all the quantities of white gold are quantities of gold. Now by the definition of Re (49), (63) is IL*-equivalent to

(64) $\bigwedge y[\lambda x[white'(x) \wedge gold'(x)](y) \rightarrow gold'(y)]$

Of course, (64) is IL*-valid, and thus white gold is gold is logically true. So, our semantics seems to attribute the intuitively correct meaning to this sentence, and captures our intuitions about a relevant set of entailments involving mass nouns.

Moreover, given the present approach, we expect to be able to explain the behavior of mass nouns in terms of the same apparatus developed in connection with bare plurals. To make an example, let's consider the interaction of mass nouns with tense and aspect. The progressive will select, in general, the existential reading of mass nominals, while the generic present tense will select the universal one, as expected:

(65) a. polluted water is dripping on the floor
b. polluted water upsets John

In (65a), polluted water has an existential import, while in (65b) it has a universal one. This pair of sentences will be treated just like analogous sentences with bare plurals. Their reduced translstion will, thus, be:

(66) a. $\bigvee y[Re(\hat{}\lambda x[polluted'(x) \wedge water'(x)])(y) \wedge drip\text{-}on\text{-}the\text{-}floor'(y)]$
b. $Gn(\hat{}upset')(j)(\hat{}\lambda x[polluted'(x) \wedge water'(x)])$

In (75b) the property of upsetting John is attributed to the substance polluted water as a whole. (66a), on the other hand, says that an instance or stage or the substance in question is dripping on the floor. Stages are, however, quantities of matter; so, what (66a) in effect says is that some quantities of polluted water are dripping on the floor, which seems to be the right meaning for (65a). Analogous accounts will go through for the other characteristics that mass nouns have in common with bare plurals, such as, for

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instance, the lack of wide scope reading for gold in John is looking for gold (see next section). No specific stipulations are needed.

This is of course very sketchy and preliminary. However, it should suffice to show that to incorporate a treatment of mass nouns in an analysis of bare plurals like the one presented here not only appears to be straightforward, but also enlightening. The present approach seems able to capture in a principled way various of the crucial generalizations concerning syntactic and semantic properties that these structures appear to share.

4.3 Meaning postulates for English bare plurals. We are now about to collect the harvest of our ontological sowing. We will present a set of meaning postulates that allow us to achieve all the essential results of Carlson's theory, while avoiding its problematic aspects. A PTQ-like fragment of English that implements a slight revision of the theory presented here can be found in Chierchia 1982a. In that fragment, the language used for the translation is IL*. The basic set up of the translation is the same as PTQ; for example, NPs are translated as λ-expressions denoting sets of properties, i.e. John' = $\lambda P^{\vee}P(j)$, a man' = $\lambda P \bigvee x[man'(x) \wedge {}^{\vee}P(x)]$, etc. The peculiarity of IL* ((namely its being a type-free language) will allow us, however, a freedom whose advantages will become clear in a moment.

We have already presented meaning postulates (39) and (40) that discriminate characterizing properties (in particular, common (count, concrete), nouns, and, maybe adjectives of the class of intelligent) from non-state-properties (in particular, all basic intransitive verbs together with, maybe, prepositional phrases and adjectives like awake). An analogous pair of meaning postulates will be necessary to distinguish stative from non-stative transitive verbs:

(67) $\Box\delta(x)(y) \rightarrow$ st(y) where δ is hit', seek', wash', etc.
(70) $\Box\delta(x)(y) \rightarrow$ th(y) where δ is love', hate', know', etc.

In order to go further we have to display how extensional verbs are going to be treated in the present framework, which will give us the opportunity show some features of systems like IL* (i.e. type-free). "Being a quantifier" has to be regarded as a semantic, model-theoretical notion (cf. Barwise and Cooper, 1981). That is to say, such a property selects certain objects in the model: something is a quantifier iff (roughly speaking) it is a set of properties. Now, such a notion can be formally defined in IL*, as follows:

(69) $Qn(x) \leftrightarrow [property'(x) \wedge \bigwedge y[y \Delta x \rightarrow property'(y)]]$

where property' is defined in the obvious manner:

(70) property' $=_{df} \lambda x \bigvee P^{i}[P^{i} = x]$

The definition of Qn might be insufficient as general definition of the notion of quantifier, but for our purposes it will do.[17] We will use the notion of "being a quantifier" in our extensionalizing axiom for transitive verbs:

(71) $\Box[[\alpha'(x)(y) \wedge Qn(x)] \leftrightarrow \lambda z[\neg Qn(z) \wedge \alpha'(z)(y)]\Delta x]$
where α is any extensional verb

Let's see how this works. consider:

(72) John loves a woman.

The reduced translation of (72) before the application of (71) will be:

(73) $\underline{love}'(\hat{}\lambda P^i \forall y[\underline{woman}'(y) \wedge \check{}P^i(y)])(j)$

Let $\beta = \hat{}\lambda P^i \forall y[\underline{woman}'(y) \wedge \check{}P^i(y)]$; since β clearly satisfies the definition of Qn, $Qn(\beta)$ is true. Thus we can use (71) to infer from (73):

(74) $\lambda z[\neg Qn(z) \wedge \underline{love}'(z)(j)]\Delta\hat{}\lambda P^i \forall y[\underline{woman}'(y) \wedge \check{}P^i(y)]$

by definition of Δ, (74) is equivalent to:

(75) $\check{}\hat{}\lambda P^i \forall y[\underline{woman}'(y) \wedge \check{}P^i(y)](\hat{}\lambda z[\neg Qn(z) \wedge \underline{love}'(z)(j)])$

From (75), by the usual steps of λ-conversion and down-up cancellation, we obtain:

(76) $\forall y[\underline{woman}'(y) \wedge \underline{love}'(y)(j) \wedge \neg Qn(y)]$

It is commonly assumed that humans are not quantifiers. We, may be somewhat over killing, in having actually built this requirement in our meaning postulate (75). Thus, (76) is logically equivalent to:

(77) $\forall y[\underline{woman}'(y) \wedge \underline{love}'(y)(j)]$

This way of handling extensional verbs, while being quite similar to Montague's original one, seems to be more natural in the following respect. In PTQ the interpretation of any transitive verb involves two completely different functions, represented by $\underline{love}'$ and $\underline{love}_*$ respectively. In IL*, on the other hand, we have a unique function, namely $\underline{love}'$; and we simply require (through (71)) that whenever $\underline{love}'$ is applied to a quantifier, say $\underline{a\ man}'$ it will yield the property that x has just in case for some man y, x loves y.

We can now write a meaning postulate requiring that verbs like hit involve stages of their grammatical object, which will give us the desired existential reading of bare plurals in object position:

(78) $\Box[[\delta(x)(y) \wedge \underline{th}(x)] \leftrightarrow \forall z[\underline{Re}(x)(z) \wedge \delta(z)(y)]]$
where is $\underline{hit}'$, $\underline{pet}'$, $\underline{chase}'$, etc.

In a moment we will give some examples of the interaction between (78) and (71). First we have to show what the rule that combines verbs with their subjects might look like:[18]

S10.′ If $\beta \in P_{IV}$ then $F_7(\beta) \in P_{IV}$, where $F_7(\beta)$ is the present progressive of β.
T10.′ If $\beta \in P_{IV}$ then $F_7(\beta)$ translates as $\lambda x \forall y[\underline{Re}(x)(y) \wedge \beta'(x)]$
S11.′ If $\beta \in P_{IV}$ and $\alpha \in P_T$ then $F_8(\alpha,\beta) \in P_t$, where $F_8(\alpha,\beta) = \alpha\beta'$; and β' is the third person (plural or singular according to α) of the simple present of the main verb in β.
T11.′ If $\alpha \in P_T$ and $\beta \in P_{IV}$, then:
(i) if β' is a characterizing property, then $F_8(\alpha,\beta)$ translates as $\alpha'(\hat{}\beta')$, otherwise
(ii) $F_8(\alpha,\beta)$ translates as $\alpha'(\hat{}Gn(\hat{}\beta'))$.

At first sight these rules might look more awkward than they in fact are. S10 should be the rule for the present progressive. Semantically, such a rule takes a process or event and maps it into a characterizing property (namely, the property of being an x such that a stage of x is βing). Notice that the present semantics will make logically false, thus deviant, a sentence like John is knowing Mary, since to know Mary is already a characterizing property. S11 is meant to exemplify the rule for the habitual simple present. Its semantics make use of the notion of "being a characterizing-property". This could possibly be regarded as a semantic feature (on a par with things like "being downward entailing" or "being monotone"). Of course, both rules are purely illustrative and shouldn't be taken too seriously. They are meant only to show that the present treatment of bare plurals is compatible with recent work on the syntax and semantics of English aspectual systems, including Gazdar, Pullum, and Sag, 1981, and Bach, 1980b, and should eventually be recast in some such framework.

Here is an example of how the system presented so far works when we get bare plurals in the object position of non-stative verbs:[19]

(79) John is raking leaves, t => $\lambda P^{i\vee}P^i(j)(\hat{}\lambda x \forall y[Re(x)(y) \rightarrow \underline{rake}'(\hat{}\lambda P^{i\vee}P^i(\hat{}\underline{leaf}'))(y)])$

John,T => $\lambda P^{i\vee}P^i(j)$ be raking leaves, IV => $\lambda x \forall y[Re(x)(y) \rightarrow \underline{rake}'(\hat{}\lambda P^{i\vee}P^i(\hat{}\underline{leaf}'))(y)]$

rake leaves,IV => $\underline{rake}'(\hat{}\lambda P^{i\vee}P^i(\hat{}\underline{leaf}'))$

rake,TV => $\underline{rake}'$ leaves,T => $\lambda P^{i\vee}P^i(\hat{}\underline{leaf}')$

leaves,CN => $\underline{leaf}'$

leaf,CN => $\underline{leaf}'$

(80) reduction of the translation of (79)

(i) $\lambda P^{i}\check{}P^{i}(j)(\hat{}\lambda x \forall y[Re(x)(y) \wedge \underline{rake}'(\hat{}\lambda P^{i}\check{}P^{i}(\hat{}\underline{leaf}'))(y)])$

(ii) $\forall y[Re(j)(y) \wedge \underline{rake}'(\hat{}\lambda P^{i}\check{}P^{i}(\hat{}\underline{leaf}'))(y)])$
by two steps of λ-conversion and down-up cancellation

(iii) $\forall y[Re(j)(y) \wedge \lambda P^{i}\check{}P^{i}(\hat{}\underline{leaf}')(\hat{}\ z[\neg Qn(z) \wedge \underline{rake}'(z)(y)])]$
by (71) and def. of Qn

(iv) $\forall y[Re(j)(y) \wedge \underline{rake}'(\hat{}\underline{leaf}')(y) \wedge \neg Qn(\hat{}\underline{leaf})]$
by two steps of λ-conversion and down-up cancellation

(v) $\forall y[Re(j)(y) \wedge \underline{rake}'(\hat{}\underline{leaf}')(y)]$ by tautologous transformation

(vi) $\forall y[Re(j)(y) \wedge \forall z[Re(\hat{}\underline{leaf}')(z) \wedge \underline{rake}'(z)(y)]]$ by (78).

What (vi) says is that the manifestation of John at the point of evaluation is involved in an activity of leaves-raking, i.e. that John is raking some leaves. This is precisely what we wanted. Consider now the following sentence:

(81) John is seeking unicorns.

The translation of (81), after straightforward simplifications, will be:

(82) $\forall y[Re(j)(y) \wedge \underline{seek}'(\hat{}\lambda P^{i}\check{}P^{i}(\hat{}\underline{unicorn}')(y)]$

In the system developed in Chierchia 1981, something analogous to Montague's substar notation reduces (82) to:

(83) $\forall y[Re(j)(y) \wedge \underline{seek}'(\hat{}\underline{unicorn}'(y)]$

The existential import of (83) with respect to the object of <u>seek</u> can be obtained, as we have already seen, in terms of a meaning postulate, which we can state in the framework of IL* as follows:

(84) $\Box[[\underline{seek}'(x)(y) \wedge \underline{kn}(x)] \leftrightarrow [\underline{seek}'(\hat{}\lambda P^{i}\forall z[z \Delta x \wedge \check{}P^{i}(z)])(y)]]$

So, in virtue of (84), (83) will be equivalent to:

(85) $\forall y[Re(j)(y) \wedge \underline{seek}'(\lambda P^{i}\forall y[\underline{unicorn}'(y) \wedge \check{}P^{i}(y)](y)]$

(85) will also be the translation of "John is seeking a unicorn", which will capture its relatedness of (81).

This shows that the present theory of bare plurals doesn't force us to a semantic analogue of a lexical-decomposition analysis of intensional verbs,

like the one Carlson proposes (cf. Carlson 1977, pp. 166 ff.). No problem arises here with respect to intensionality.

Notice also that the other problems pointed out in sec. 2 disappear. Stages are regarded as portions of matter. Thus, no complications with respect to the standard treatment of tenses arise. The plurality presupposition of bare plurals is built in the definition of Re, so the counterintuitive results discussed with respect to (22)-(23) are avoided. Finally the bipartition of English VPs into stage- and object-level predicates is obtained via a set of meaning postulates. This avoids the odd use of semantic sorts and the complications in the translation mapping present in Carlson's approach. In our theory all the burden is put on the semantics; furthermore we can accomplish this by exploiting a mechanism (i.e. meaning postulates) that is needed anyhow in MG. The meaning postulates presented here can be regarded as a fragment of a theory of English aspectual system. Their status is analogous to that of the meaning postulates proposed by Dowty (1976) for dealing with causativity. Finally, all the notions introduced by Carlson are reanalyzed in terms of a different model theoretic approach. In particular, the formation of bare plurals turns out to be an instance of a much more general process of nominalization. Regarding bare plurals as nominalized CNs allows us, among other things, to shed some light on their relation with mass nouns. In this respect the framework developed here seems able to offer a lot of potentialities for a unified account of bare plurals and mass nouns. It remains to be seen to what extent the hypothesis entertained here will turn out to be fruitful or at least compatible with a fuller treatment of tense, aspect, and plurality. The present approach might be viewed as offering some fairly clear adequateness criteria for any such general theory.

FOOTNOTES

[1]Carlson 1977, 1979.

[2]Cf. Bach 1979, 1980a

[3]I am assuming here Bennett's (1976) modification of Montague's original assignment of types to syntactic categories.

[4]CN is the category of common nouns in Montague 1973 (PTQ). In the text, I will use NP to refer to PTQ's category T, S to refer to PTQ's category t, and VP to refer to PTQ's categories IV and TV.

[5]There is a vast literature on the distinction between events, processes, and states. For a good presentation of the main issues involved, cf. Dowty, 1979, Ch. 2.

[6]Cf. Carlson 1980.

[7]Carlson 1977, pp. 194 ff points out, however, that there is a set of bare plurals that pattern like quantified NPs.

[8]I am adopting here the familiar notation of PTQ: primed expressions denote their translations in IL.

[9]For the reportive reading of John runs, Carlson has a special rule that maps VPs into VPs; such a rule would leave syntactially unmodified run, and would change run′ to $\lambda x \bigvee y[Re(x)(y) \wedge run'(y)]$, so that it can be combined with John.

[10]Not in the trivial sense of being generated by quantifying in John into he_n runs for different ns.

[11]This is obtained by alternating Carlson's version of the dervied VP rule with the rules that introduce Gn and Gn′.

[12]For a more thorough analysis of the evils of type theory as a theory of predication for natural languages, cf. Chierchia 1982a.

[13]For a stimulating formal analysis of the notion of sort and its role in identifying things, cf. Cocchiarella 1976.

[14]More precisely, a function from points of reference to singletons containing just one stage (i.e. one portion of matter).

[15]Such an approach has been proposed by G. Link at the Konstanz conference on formal semantics, 1981.

[16]So, for instance, the property of being a fork or a man does not yield a kind. This might be the reason why forks or men are widespread is odd.

[17]Notice, en passant, that properties of quantifiers like being "monotone" or "being persistent", etc. can also be directly defined in IL*.

[18]The numbers of the rules are the same of the fragment in Chierchia 1982a. The prime sign indicates that the rules presented here constitute a slight revision of the ones presented there.

[19]More examples can be found in Chierchia 1982a.

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