

PLURALITY OF MASS NOUNS AND THE NOTION OF
"SEMANTIC PARAMETER"

1. INTRODUCTION

The main thesis I would like to develop and defend in this paper is that mass nouns come out of the lexicon with plurality already built in and that that is the (only) way in which they differ from count nouns. On the basis of this hypothesis (let us dub it the Inherent Plurality Hypothesis), I will offer a new account of the distribution of mass and count quantifiers, one that takes into consideration possible crosslinguistic variations in such distribution. I will also address, in a preliminary and somewhat speculative way, the issue of languages (such as Chinese) that are said not to have count nouns. One conclusion that we will reach is that there is some limited variation in the way in which the syntactic structure of NPs is mapped onto its denotation across different languages. If crosslinguistic variation is to be accounted for in terms of parametric differences, then the mass/count distinction seems to provide evidence for a semantic parameter. In the rest of this introduction, I will first try to give in a highly informal way an idea of the main thesis to be defended. Then I will briefly review the main data to be accounted for. Looking ahead to the overall organization of the paper, in section 2 I give some background assumptions on the nature of plurality. In section 3 I will present in detail the Inherent Plurality Hypothesis and show how it accounts for the data presented below. In section 4, I will consider further empirical consequences of the Inherent Plurality Hypothesis and see how it compares to a sample of other current influential approaches. Finally, in section 5, I will tackle the issue of languages allegedly without count nouns.

1.1. *The idea in informal terms*

It is generally held that the denotation of a mass noun is in some sense qualitatively different from that of a count noun, even in the case of near synonyms like *coins* vs. *change* or *curtains* vs. *drapery*.¹ Here is a pretty typical view of

this matter. A singular count noun is usually taken to denote a class of objects and its plural counterpart a class of groups or sets of such objects; so, while a singular count noun has singular individuals in its extension (e.g. "coin" is true of single coins), a plural one has plural individuals or groups in its extension (e.g. "coins" is true of pluralities of coins). A mass noun is instead generally interpreted either as a mereological whole of some kind; or else its extension is drawn from a domain of substances whose minimal components are somehow more elusive than ordinary individuals. For example, the denotation of "change" can be taken to be some kind of substance whose minimal parts don't have the same identification criteria as coins. On this view, the minimal parts of mass noun extensions are surrounded by mystery and this is why we cannot count them. I propose instead that the extension of mass nouns (like *change*) is essentially the same as that of plurals (like *coins*). A mass noun simply denotes a set of ordinary individuals *plus* all the pluralities of such individuals. For example, "change" denotes, roughly, single coins and all the possible sets or pluralities of coins. This view is an "atomistic" one: we are committed to claiming that for each mass noun there are minimal objects of that kind, just like for count nouns, even if the size of these minimal parts may be vague. The main difference between count and mass nouns thus comes to the following: while count nouns single out in the lexicon the relevant atoms or minimal parts (by making them the exclusive components of their extension), mass nouns do not. The fact that the denotation of count nouns may be directly counted will be argued to follow in a natural way from this difference. This view is based upon the following arguably natural intuition. Common nouns in general refer to qualitatively homogeneous aspects of the world and there are two ways of doing so. Either we let a noun denote the minimal representatives of a kind or substance (and we get count nouns). Or we let it denote all the homogeneous parts of that kind or substance (and we get mass nouns).

Since early work on plurals and mass nouns (e.g. Bennett 1974), through much recent influential research (e.g. Link 1983, Landman 1991, ch. 7) there is an acute awareness of the strong similarity between plurals and mass nouns.² However, just about every theory I am familiar with tries to account for these similarities in an indirect way, by setting up some kind of isomorphism between plural count denotations and mass ones. Virtually no theory explores what after all one might reasonably regard as the null hypothesis, namely that mass nouns are just inherently plural. One noticeable exception to this dominant trend is constituted by the work of Gillon (1992), to whose spirit the present paper is very close. However, Gillon does not discuss the different distribution of quantifiers with mass and count nouns. And yet, it is important to do so in some detail, if one wants to maintain that plurals and mass nouns are essentially the same. For any distributional difference between them constitutes a potential counterexample to such claim. For the same reasons, differences in how the distinction manifests itself crosslinguistically also ought to be addressed.

1.2. Review of the main data

As the mass/count phenomenology is well documented in the literature, it can be reviewed in a fairly schematic way. One can easily individuate at least ten main empirical properties that jointly characterize the different behavior of mass and count nouns. These properties appear to be tendentially universal, i.e. they show up whenever such a contrast can be detected. The first, and in a sense most basic, such property has to do with plural morphology. While count nouns are perfectly natural in the plural, mass nouns are not:

- (1) Property 1: availability of plural morphology.
 - a. There are shoes in this store.
 - a'. *There are footwears in this store.
 - b. There are drops of blood on the wall.
 - b'. *There are bloods on the wall.
 - c. There are hidden virtues in each man.
 - c'. *There are hidden honesties in each man.

As usual, asterisks here and throughout should not be taken to signal an "absolute" ungrammaticality but an awkwardness that sometimes can be overcome by superimposing on mass nouns some kind of non-standard interpretation (cf. properties 9–10 below).

The second canonical property that sets mass nouns apart concerns the impossibility of occurring with numeral determiners:

- (2) Property 2: distribution of numeral determiners
 - a. Three drops, four pieces of furniture, two virtues
 - b. *Three bloods, four furnitures, two honesties
 - c. The boys from Milan are three.
 - d. The blood found on the floor is three drops.
 - e. *The blood found on the floor is three.

Though obviously related to Property 1, Property 2 is distinct from it. In case of numerals in prenominal position, the ungrammaticality of phrases like (2b) can be attributed to the fact that numerals require plural morphology on the accompanying noun, which is something we know from (1) to be incompatible with mass nouns. However, agreement is not strictly necessary when numerals occur in predicate position (contrast (2c) with (2d)) and yet numerals in predicate position remain incompatible with mass nouns (as (2d) illustrates). Facts such as these are at the basis of the familiar generalization that the denotation of mass nouns can be measured but cannot be directly counted. This brings us to the next property. In order to "count" using mass nouns we must resort to classifiers or measure phrases. By classifier phrases, I mean relational nouns such as the ones in (3a), while measure phrases are exemplified in (3b)

- (3) Property 3: Obligatoriness of classifier and measure phrases for combining with numerals.
 - a. three grains of rice; two piles of wood, two stacks of hay

- b. two kilos of rice; a gallon of milk

The next group of properties has to do with the interaction of the determiner system with the mass/count distinction. The main facts are summarized in (4)–(7):

- (4) Property 4: some determiners occur only with count nouns.
singular determiners: every, each, a
plural determiners: several, few, a few, many, both
- (5) Property (5): some determiners occur only with mass nouns.
little, much
- (6) Property (6): some determiners occur only with plurals and mass nouns.³
a lot of, all, plenty of, more, most
- (7) Property (7): some determiners are unrestricted.
the, some, any, no

It is evident from this raw list that the mass/count distinction pervades the determiner system.

The final group of properties concerns the relation between nouns and their denotata. As is well known, fluids tend to be denoted by mass nouns (e.g. water, air, lava, etc.) and solid “medium size” objects by count nouns. But there are plenty of exceptions in both directions (gases, puddles, clouds etc. on the one hand, furniture, clothing, etc. on the other). In fact, the same slice of reality can be classified as either count or as mass, as attested by the existence of near synonyms like those in (8):

- (8) Property 8: independence of the distinction from the structure of matter
 - a. shoes vs. footwear
 - b. clothes vs. clothing
 - c. coins vs. change
 - d. carpets vs. carpeting

Although synonymy is never perfect — it is well known how much languages loathe it (cf. Markman 1989) — the closeness in meaning of pairs such as these shows that what is in a clear sense one and the same item can be viewed in either way. This can be made even more vividly clear by the observation that nouns that belong to one class in a language have literal (non periphrastic) translations that belong to the other class in a different language. Thus, for example, the English word *hair*, which is mass, translates into Italian as the count word *capello*/i, while the count Italian word *mobile*/i translates into English as the mass one *furniture*, and so on. Related to this is the phenomenon that a noun with a predominantly mass meaning can be reinterpreted as count and viceversa. The following examples illustrate how this may typically happen.

- (9) Property 9: a (predominantly) count noun can be made mass

Example: there is rabbit in this stew $\Rightarrow$ there is rabbit meat in this stew.

- (10) Property 10: a (predominantly) mass noun can be made count.
Example: In this lab we store three bloods $\Rightarrow$ In this lab we store three blood types.

Thus, in conclusion, while the mass count/distinction is not altogether indifferent to how things are inherently structured, it appears to be independent of it, which is what makes such a distinction a strictly grammatical one.

Properties 1–10 do not exhaust the way in which the mass vs. count distinction manifests itself in language. There is more to it. For example, there are a distinctive set of scopal and anaphoric properties that mass nouns share in English with so called bare plurals.⁴ However, these properties, while important and interesting, are subject to significant crosslinguistic variations, even among closely related languages.⁵ In contrast, as already pointed out, the properties outlined above appear to be considerably stable, if not universal, modulo some lexical variation whereby a word that belongs to one class in a language can belong to the other in another language. In the attempt to arrive at the individuation of what is essential to the distinction, it appears thus reasonable to focus in first approximation on tendentially universal properties and try to understand the principles that underlie such properties. Subsequently, we will give some indication on how the crosslinguistically more variable properties of the distinction might be addressed. In the spirit of Link (1983) and much related work, I will argue that the mass/count distinction has a semantic basis. What I mean by this is that the morphosyntactic phenomena in (1)–(10) can be properly explained only in terms of how the denotation of mass nouns differs from that of count nouns.

2. PLURALS

As the hypothesis to be explored is that mass nouns are lexical plurals, my assumptions about the singular vs. plural contrast should be laid out. I will try to make them as theory neutral as possible, not an easy task in such a complex and controversial topic. I will first discuss the interpretation of singular and plural common nouns, then that of collective nouns (like *bunch*, *pile*, *group*, etc.), and finally, the interpretation of plural definite NP's (like *those boys* or *John and Bill*). As we will see shortly, all this will involve making certain assumptions concerning the structure of the quantificational domain. As far as notation goes, I will adopt a higher order intensional logic with variables over worlds, like Gallin's (1975) TY2. The truth-conditions of a simple sentence like *John is blond* will be represented as follows:

- (11) $\text{blond}_w(j)$

where j is a singular term, *blond* is a function from worlds into a function from individuals into truth values, and boldface w is a (distinguished) variable mapped onto the actual world, which will be omitted when irrelevant. I will

assume that the representation language contains standard set theoretic notation like $\{a, b, c\}$, $\{x: \phi\}$ and $u \in X$, interpreted in the obvious way. Set denoting expressions like $\{a, b, c\}$ are regarded as singular terms (i.e. using Montague's notation for type theory, they will be of type e).

2.1. Singular and plural common nouns

The basic idea, common to most work on this topic, is that our domain of discourse has the following shape (cf. Link (1983, Landman (1989)):

$$(12) \quad \begin{array}{ccccccc} & & & & & & \{a, b, c, d, \dots\} \\ & & & & & & \{a, b, c\} \quad \{a, b, d\} \quad \{b, c, d\} \quad \{a, c, d\} \dots \\ & & & & & & \{a, b\} \quad \{a, c\} \quad \{a, d\} \quad \{b, c\} \quad \{b, d\} \quad \{c, d\} \dots \\ & & & & & & a \quad b \quad c \quad d \quad \dots = \text{At} \end{array}$$

The individuals at the bottom in (12) are the singularities: Bill, Fred, John They constitute the reference of singular definite NPs like "that man". The sets in (12) represent the pluralities and constitute the denotation of plural definite NPs like "those men". For example, if a is the man to my left, and b the man to my right, the set $\{a, b\}$ is the plurality constituted by a and b . The structure in (12) is ordered by what we may call the relation of being a "component of". Take for example the set formed by the individuals a, b and d , viz. $\{a, b, d\}$. The set $\{a, b\}$ is a component (i.e. a subset) of $\{a, b, d\}$; the individual a (or b , or d) is also a component (i.e. a member) of $\{a, b, d\}$. I will indicate the component relation as " $\leq$ " and will write formulae like:

$$(13) \quad \text{a. } b \leq \{a, b, d\} \quad \text{b. } \{a, b\} \leq \{a, b, d\}$$

The spatial arrangement in (12) is meant to partially represent this ordering. If A is a component of B , then A is below B in (12). The singularities are the smallest elements in (12); they do not have components (i.e. members). Or rather each singularity a has only itself as component (i.e. if a is a singularity, $b \leq a$ only if $b = a$). For this reason, they play the role of "atoms" (At) in the structure in (12), even though from a material standpoint, they may well have parts. For example, both a chest of drawers and its drawers taken individually count as atoms, even though the second may be regarded as part of the first.

In terms of $\leq$, we can then define an operation of sum (or union, or also join) which we denote as " $\mathbf{U}$ " (i.e. a boldface set theoretic union sign). Given any two elements A, B of the structure in (12), $A \mathbf{U} B$ will be the smallest element of the structure of which both A and B are components. For example:

$$(14) \quad \begin{array}{l} \text{a. } a \mathbf{U} b = \{a, b\} \\ \text{b. } \{a, b\} \mathbf{U} \{c, d\} = \{a, b, c, d\} \\ \text{c. } a \mathbf{U} \{b, c\} = \{a, b, c\} \end{array}$$

In the case of two individuals a, b , their union corresponds to set formation; in the case of two groups it corresponds to standard set-theoretic union.

In terms of $\mathbf{U}$, we can define a "supremum" operator. For any subset X of U , we can pick an element $\mathbf{U}X$ in U which is the sum of all the elements of X . This is simply a generalization to subsets of U of the sum operator.

(15) a. Examples:

$$\begin{array}{l} \mathbf{U} \{a, \{a, b\}\} = \{a, b\} \\ \mathbf{U} \{\{a, b\}, c\} = \{a, b, c\} \\ \mathbf{U} \{a, b\} = \{a, b\} \end{array}$$

$$\text{b. For any } X \subseteq U, \mathbf{U}X = \{u \in \text{At} : \text{For some } u' \in X, u = u' \text{ or } u \in u'\}^6$$

In a sense, via the supremum operator each set of members of U comes to have a representative within U . Next, we can define an operator that selects the greatest element of a set (if that set has one):

(16) a. Examples:

$$\begin{array}{l} i(\{a, \{a, b\}\}) = \{a, b\} \\ i(\{\{a, b\}, c\}) = \text{undefined} \end{array}$$

$$\text{b. For any } X \subseteq U, iX = \mathbf{U}X, \text{ if } \mathbf{U}X \in X; \text{ else undefined.}^7$$

Finally, following Link we say that for any $X \subseteq U$, $*X$ is the closure of X under $\mathbf{U}$, i.e. the set of all sums of elements of X : $*X = \{\mathbf{U}Y : Y \subseteq X\}$.

From a formal point of view, our domain U constitutes a complete, free join semilattice, generated by a set of atoms At. I find the structure in (12) intuitively plausible; but readers should feel free to replace it with their favourite algebraic structure.

Predicates (e.g. common nouns and verbs) will be true or false of members of U at a world. An n -place predicate is thus of type $\langle w, \langle e_1, \dots, \langle e_n, t \rangle \dots \rangle \rangle$. By extension of a predicate, I will refer to the set of entities for which the predicate takes value 1 (in the actual world). A singular count noun will have as its extension a set of singularities. So for example if a, b and c are all the tables in a world w , then the extension of the noun *table* in w (in symbols $|table_w|$) will be:

$$(17) \quad |table_w| = \{u : table_w(u) = 1\} = \{a, b, c\}$$

The plural form of *table* (viz. *tables*) will be true of all the pluralities of tables. Thus in the world w of example (17) we will have:

$$(18) \quad |tables_w| = \{\{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\}$$

Consider now sentence (19a) and assume that the indexical *those* in it refers to table a and to table c . Sentence (19a) will thus be interpreted as shown in (19b), which is in turn equivalent to (19c).

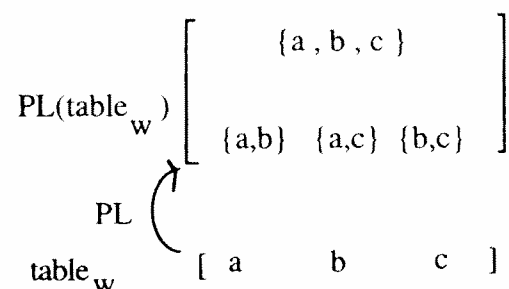
$$(19) \quad \begin{array}{l} \text{a. Those are tables} \\ \text{b. } tables_w(\{a, c\}) \\ \text{c. } \{a, c\} \in \{\{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}\} \end{array}$$

It follows from this that the plural morpheme must map a set of atoms into the set of pluralities constituted by those atoms. It is pretty clear how such a morpheme is to be interpreted:

(20) For any $A \subseteq U$, $PL(A) = *A - A^8$

All this can be summarized by means of the following schema:

(21)



A count noun individuates singularities. Pluralization is a way of talking about the corresponding sets or pluralities. The denotation of *table* and the denotation of *tables* taken jointly constitute a sublattice of the domain (i.e. something that has the same structure as the whole domain).

The account of plurality just sketched has been proposed by various authors (e.g. Hoeksema 1983) and criticized by others (e.g. Schwarzschild 1991) on grounds that it gives the wrong results for determiners like *no*. The standard analysis of *no* as a generalized quantifier maintains that $no(X)(Y)$ holds just in case X has an empty intersection with Y . It follows then that under the analysis of plurality just sketched, a sentence like *no men lifted the piano* only requires that no plurality of men did, but it leaves open the possibility that single men did. Hence, sentences like *no men lifted the piano but John did* ought to be consistent; yet they appear to be contradictory. This is a problem. Notice however, that a similar problem arises with singulars. A sentence like *no man lifted the piano* only requires that no singular man did, but it leaves open the possibility that a plurality of men did some lifting. Hence it ought to be possible (i.e. non contradictory) to say something like *no man lifted the piano but John and Bill did*.⁹ Yet this sentence too appears to be contradictory. These considerations suggest that the problem lies in the analysis of *no* and not in the analysis of plurality adopted here. In section 3 I will give a semantics for *no* that does not suffer from this drawback, consistent with the present approach to plurals.

Another potential problem for the analysis just sketched was pointed out to me by Y. Winter and has to do with examples like *John or Bill and George are thieves*. If the denotation of "thieves" excludes singularities, such a sentence ought to be false if it turns out that John is the only thief, contrary to facts. A possible line of reply is that the proposal I am adopting applies primarily to nouns in argument position and is motivated by the fact that NPs like *the thieves* cannot possibly refer to just one thief. However, for nouns in predicate

position, things might well be different. The denotation of a predicative NP is presumably obtained via a type shifting (see, e.g. Partee 1987) and this can happen in ways that do not exclude singularities. I'll assume that this line of reply to Winter's observation is on the right track.

A nice consequence of the approach we sketched (pointed out for the first time in Sharvy (1980)) is constituted by the possibility of giving a simple interpretation for the definite article as it applies to singulars and to plurals, namely:

(22) the $P = \iota | P|$

If P is plural, *the P* will denote the largest group in P . Thus for example *the boys* will denote the largest set of boys in the world in question. If P is singular, *the P* will be defined only if P is true of exactly one atom. For otherwise, the denotation of P would be a set of atoms, none of which would be greater than the other in terms of the relevant ordering relation ' $\leq$ '. This explains why a phrase of the form *the P* has a uniqueness presupposition in the singular, while in the plural the presupposition is that there be more than one element.

It should also be noted that count nouns as defined have the following properties. If a plural count noun α is true of a set A , then (i) α is true of all the subsets of A and (ii) the corresponding singular is true of all the atoms in A . In (23) I give an example of these properties:

- (23) a. $PL(table)(\{a, c\}) \rightarrow table(a) \wedge table(c)$
 b. $PL(table)(\{a, b, c\}) \rightarrow PL(table)(\{a, b\}) \wedge PL(table)(\{a, c\}) \wedge PL(table)(\{b, c\})$

This means that count nouns are distributive predicates: they distribute from a plurality to its components. Also the opposite is the case:

- (24) a. $[table(a) \wedge table(c)] \rightarrow PL(table)(\{a, c\})$
 b. $[PL(table)(\{a, b\}) \wedge PL(table)(\{a, c\})] \rightarrow]PL(table)(\{a, b, c\})$

Following the terminology of Schwarzschild's (1991), we might call this property "cumulativity" (not to be confused with the use of this term in Scha 1984). If a count predicate is true of two or more things, it is true of their sum.

Verbs differ from nouns in several respects, of which we might mention at least two. First verbs have an event argument. Since nothing that I will say hinges directly on it, I will largely ignore the event argument of verbs.¹⁰ Second, verbs, unlike count nouns, need not be either distributive or cumulative. Thus, to use a classical example, (25a) can be true, without (25b) being true.

- (25) Absence of distributivity in verbs
 a. John and Bill lifted the piano
 b. John lifted the piano

There is also at least a sense in which (26a,b) can be true without (26c) being true:

- (26) Absence of cumulativity in verbs
- John lifted the piano.
 - Bill lifted the piano.
 - John and Bill lifted the piano (together).

This brings us to the issue of the treatment of so called collective readings, such as the one of sentence (26c). While what I've said so far on the grammar of plurality is relatively uncontroversial, there is more uncertainty on the proper treatment of groups.

2.2. Collective nouns

An important issue relevant for the analysis of collective readings concerns the treatment of those nouns traditionally called "collective", like *committee*, *pile*, *bunch*, *group*, etc. There are a couple of reasonable possibilities. On the one hand, we might regard these nouns as being true of pluralities. For example, if a certain committee is constituted by *a* and *b* in a world *w*, the noun *committee* might have $\{a, b\}$ in its extension in *w*. However, this position has two drawbacks: first some singular nouns would have pluralities as their extensions and the simple picture of plurality given above could not be maintained; second, it seems implausible to regard a collective as just the sum of its members, in the way a plurality is. As an alternative treatment of collective nouns, we might regard committees, bunches, groups, etc. as atomic individuals related in some suitable manner to their members. Schwarzschild (1991) has offered some arguments in favour of this view and we will follow him on this issue, as it allows us to maintain the simple tack on pluralities taken above (cf. also Barker 1992).

Accordingly, our set *At* of atoms is going to be sorted into collectives and ordinary individuals. For any collective, i.e. for any *x* which is a committee, a bunch, a group, etc., let *p(x)* be the plurality that constitutes it, i.e. *p(x)* is the set of individuals that are members, in the appropriate sense, of *x*. We can then straightforwardly extend to collectives the notions introduced for pluralities, e.g., we can say that a collective *x* is a component of a collective *y* iff $p(x) \leq p(y)$.

Of special interest is the semantics of the common noun *group*. What are groups? Something like aggregates or sets or collections, perceived as a singularity or as a unit. What difference is there between sets and groups? Groups, *qua* denotata of a (non-technical) common noun, are part of the naturalistic frame of reference built into language; they cause events to take place and are causally affected by events. Sets are instead abstract things (like numbers and possible worlds) and as such their place in a naturalistic frame of reference is more controversial: they are whatever your favourite theory of abstract things tells you that they are.

Suppose that there you are in a classrooms full of students and you are asked how many groups of students there are. Can you tell? Only if a criterion for

grouping is made clear. For example, the students have to be located in space so as to form distinct visual blocks. Or they have to wear different fraternity uniforms. It seems that the noun *group* contains an indexical element. We might think of its meaning as a function $group_P$ from grouping criteria *P* into actual groups. A grouping criterion *P* is simply a property that objects have to satisfy in order to belong to the group. The value of *P* varies from context to context. The word *group* functions as a classifier (see below) for pluralities: it maps pluralities into atoms (modulo the availability in the context of use of a grouping criterion).¹¹

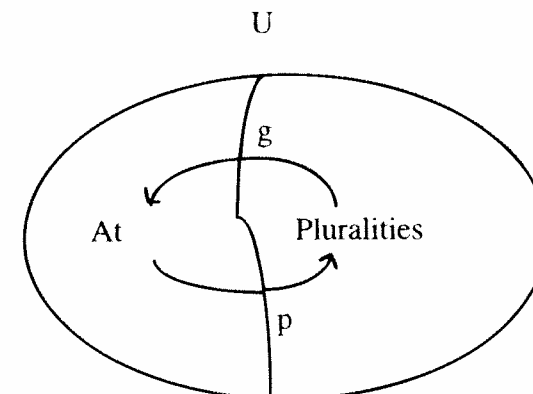
An interesting question now arises. To use the word *group* we need a property. Is there any constraint on what that property can in principle be? Hardly, it would seem. The minute we conceive of a plurality "together", we can think of it as a group. At this point, groups begin to look like sets; except that groups are more "concrete" than sets and must formally play the role of atoms in our domain (groups are singularities, while sets are used to model pluralities).

I can see two ways to go in this connection. The first is to assume that in each context, we are going to have a smallish set of contextually salient groups, that "correspond" to a few pluralities. In other words, for some pluralities *x*, there is going to be a grouping criterion *P* that determines a function g_P , such that $g_P(x)$ is a group. So *g* is a partial, context-dependent function from properties and pluralities into groups. (The word *group* can then be analyzed as the range of such function). The second way to go is more radical. We can assume that for every plurality there is a corresponding group *g(x)*, with the following properties

- (27) a. For any plurality *x*, *g(x)* is the group whose members are the atoms of *x*
 b. For any plurality *x*, $p(g(x)) = x$
 c. For any group *x*, $g(p(x)) = x$

The situation can thus be pictured as follows:

(28)



The English word *group* could then be analyzed as some contextually supplied restriction on the range of g .

$$(29) \text{ group}_P = \text{Range}(g) \cap P$$

This second approach reflects the intuition that any plurality can in principle be viewed as a group, something that we seem to be able to do. But to develop it in this simple form, we must resort some non-standard set theory (like, for example, property theory). In what follows, I will remain neutral on these two ways of treating groups. I will avail myself of a function g that maps pluralities into groups. But I won't take a stand as to whether g is partial and context dependent or whether it is total.¹²

The presence of groups in our domain changes a bit the perspective on pluralities we have adopted. Consider again sentence (25a) repeated here as (30a).

- (30) a. John and Bill lifted the piano.
 b. distributive reading: lift the piano (j) $\wedge$ lift the piano(b)
 c. collective reading: lift the piano ($\{j, b\}$)

Of sentence (30a)'s two prominent readings, the distributive one boils down to (30b) and the collective one, in first approximation, might be plausibly represented as in (30c). We will come back below to how these readings are to be compositionally obtained. The treatment of collective readings as in (30c) is based on two assumptions: (i) the plural definite *John and Bill* denotes the plurality $\{j, b\}$ and (ii) collective readings are obtained by directly applying predicates to pluralities. However, there are reasons for modifying assumption (ii) while sticking to (i). Compare (31a) with (31b):

- (31) a. The group constituted by John and Bill lifted the piano.
 b. lift the piano($g\{j, b\}$)¹³

Presumably, the logical form of (31a) will be something like (31b), where *lift the piano* is predicated of a group (i.e. a particular kind of atom). The question is whether there is any difference in meaning between sentence (30a), *on its collective reading* and sentence (31a), where we explicitly refer to groups. In so far as I know, no difference can be detected. Yet, if we analyze (30a) as (30b), these two sentences wind up having different, non-equivalent logical forms.

What seems to be happening is that existence of singular collective nouns like *group* (i.e. the presence of groups as atoms) creates a kind of redundancy in the system. A plausible way to overcome it might be giving up assumption (ii) above. Since the intended meaning that (30c) seeks to capture is the one whereby John and Bill together, *as a group*, do the lifting and since there are groups in our domain, we can more directly represent the group reading of (30a) as in (32):

$$(32) \lambda y [\text{lift the piano}(g(y))](\{j, b\})$$

Formula (32) reduces of course to (31b). In this way, (30a) and (31a) become equivalent as a matter of logical form, without having to resort to meaning postulates and the like, a desirable result. The philosophy behind this move is that basic natural language predicates directly apply just to either individuals or to groups. They do not directly apply to pluralities. Pluralities are just a way to say something either about the singularities that make them up or about groups constituted by them. One might regard pluralities (whether they are modelled as sets, like here, or whether they are modelled as lattice theoretic sums) as abstract devices that enter into the recursive computation of truth conditions but not into natural causal relations of the sort expressed by basic English verbs. Only atoms (i.e. ordinary individuals and groups) can be regarded as concrete and be the direct bearers of thematic roles.¹⁴

To implement this view, we will assume that any predicate P that holds of atoms (in the case at hand, ordinary individuals or groups) can be turned into a predicate that holds of pluralities in terms of the following type-shifting operation:

$$(33) \text{ a. } [[P]] = \lambda x [P(g(x))]
 \text{ b. } [[\text{lift the piano}]](\{j, b\})$$

The function " $[[\]]$ ", we may assume, applies freely to solve type mismatches whenever they arise. The logical form of the group reading of (30a) thus becomes (33b), which then reduces to (31b).

Thus to summarize, plural common nouns, because of the way they are derived, can be predicated directly of pluralities. Verbs, instead, apply primarily to groups but can be predicated of pluralities via a type shift.

2.3. Plural definites

There is a further important issue that needs to be discussed, also related to the denotation of plural definite NPs. Let me try to illustrate it starting with an example. Consider the following sentence:

- (34) The boys and the girls lifted the piano.

Sentence (34) has a reading according to which the boys as a group and the girls as a group lift the piano separately (without, however, any component of the two groups doing it). How is this reading to be represented? Suppose we are in a world w where the boys are a and b and the girls c and d . The group constituted by the boys and the girl, i.e. $g\{a, b, c, d\}$, did not lift the piano. So, if we assume that *the boys and the girls* denotes $\{a, b, c, d\}$ and we assign to (34) the reading

$$(35) [[\text{lift the piano}]](\{a, b, c, d\})$$

we get something that would be false in the situation described. Hence, formula (35) is inadequate as a representation of the intended reading of (34). The problem is what to replace it with.

There are two main lines that are currently being explored. The first is to modify, by enriching it, the denotation of the relevant NP:

$$(36) \text{ the boys and the girls} = \{\text{the(boys), the(girls)}\} = \{\{a, b\}, \{c, d\}\}$$

This is a set of sets. The predicate *lift the piano* is then analyzed as being true distributively of this set. This means that *lift the piano* winds up being ultimately true of $g\{a, b\}$ and of $g\{c, d\}$ but not of any components of these. Such a line of analysis, which has intuitive plausibility, involves enriching the structure of the domain, since we must somehow countenance predicates being true of sets of sets (see e.g. Landman 1989a).

The second line of inquiry instead assumes that when we say something of a group or plurality, the context typically supplies information that enables us to distribute predicates to its components. Such components can be individuals or subgroups depending on what the context is (see e.g. Gillon 1987, Schwarzschild 1991, 1992 and references therein). Here is one way of working this out. If u is a plurality or a group, let $C(u)$ (for ‘‘cover’’, see Gillon 1987) be the result of dividing u into (possibly overlapping) components.

(37) A cover C is a function from pluralities or groups u into subsets $C(u)$ of u such that:

- i. if u is a plurality, $\cup\{p(u') : u' \in C(u)\} = u$
- ii. if u is a group, $C(u) = C(p(u))^{15}$

When we predicate a verb of a group, the context supplies such a C , with respect to which the attribution of the verb takes place. Going back to the previous example, suppose that *the boys and the girls* denote $\{a, b, c, d\}$ and let $C(\{a, b, c, d\}) = \{g\{a, b\}, g\{c, d\}\}$. Then intended reading of sentence (34), repeated here as (38a) can now be given as in (38b):

- (38) a. The boys and the girls lifted the piano.
- b. $\forall u[u \in C(\{a, b, c, d\}) \rightarrow \text{lift the piano}(u)]$
- c. $\forall u[u \in \{g\{a, b\}, g\{c, d\}\} \rightarrow \text{lift the piano}(u)]$
- d. $\text{lift the piano}(g\{a, b\}) \wedge \text{lift the piano}(g\{c, d\})$

Formula (38b) reduces first to (38c) and then to (38d), which says that a group constituted by the boys and one constituted by the girls lifted the piano. This is just the reading we want. We can abbreviate (38b) as in (39a) and, more generally, modify the typeshifting operation $[[\]]$ by relativizing it to covers, as in (39b):

- (39) a. $[[\text{lift the piano}]]_C(\{a, b, c, d\})$
- b. $[[P]]_C = \lambda y \forall x[x \in C(y) \rightarrow P(x)]$

Distributive readings are obtained via distributive covers, i.e. covers that give as outputs sets of ordinary individuals. Take for instance a distributive predicate like, say, *is Italian* and consider a sentence like:

- (40) a. The boys are Italian
- b. $[[\text{Italian}]]_C(\text{the (boys)})$
- c. $\forall x[x \in C(\text{the(boys)}) \rightarrow \text{Italian}(x)]$

The logical form of (40a) is (40b), which by the definition of $[[\]]$ is equivalent to (40c).

Suppose that the boys are $\{a, b, c\}$. Given the inherent distributivity of *Italian*, the only cover we can choose is the identity map. We thus get:

- (41) $\forall x[x \in \{a, b, c\} \rightarrow \text{Italian}(x)]$

In this second line of approach, we keep the structure of the domain simple. No NP refers to sets of sets. We have, however, a somewhat more elaborate way of attributing a predicate to pluralities, one which relies heavily on the context. Mostly because it simplifies the formulation of my proposal, I will assume this second approach to the denotation of NPs. I will therefore assume that whenever a verb is predicated of a plurality, a variable over covers is contextually supplied.

Here is a summary of our main assumptions:

- (a) The domain of interpretation contains atoms and pluralities.
- (b) Singular definites denote atoms, plural definites denote pluralities.
- (c) Singular count common nouns have sets of atoms as their extension. Plural count common nouns have the **U**-closure of their singular counterparts as extension (minus the atoms).
- (d) Collective nouns, including *group*, have sets of atoms as their extensions. Hence, among the atoms, there are groups.
- (e) Application of verbs to pluralities or groups takes place via pragmatically supplied covers.
- (f) Basic predicates hold of atoms. Application to pluralities is derivative.

Of these assumptions, (a)–(d) are fairly theory-neutral. Most theories of plurals incorporate them in some form. Assumption (e) is controversial. There is a family of approaches that adopts it and the one that I have in mind is that of Schwarzschild (1991, 1996). What I have to say might also be compatible with theories that do not adopt (e). Assumption (f) is also controversial.

3. MASS NOUNS AS PLURALS

What does a mass noun like, say, *furniture* denote? Given that our domain is a complete, atomic, join semilattice it is natural to think of the extension of a

mass noun as a sublattice of the domain. For example, in a world where *a*, *b*, and *c* are all the pieces of furniture that there are, the extension of the noun *furniture* might be represented as follows:

(42)

$$\text{furniture}_w \left[\begin{array}{ccc} & \{a, b, c\} & \\ \{a, b\} & \{a, c\} & \{b, c\} \\ a & b & c \end{array} \right] \begin{array}{l} \text{pieces of furniture}_w \\ \text{piece of furniture}_w \end{array}$$

Let us spell out this idea a bit. Any single piece of furniture (e.g. this table) is furniture and so is any plurality of pieces of furniture (e.g. this table and the four chairs around it). What counts as a piece of furniture is somewhat vague. This means that the minimal instances of “furniture” are only vaguely determined. But no more significantly so than for nouns like *table* or *chair*. There are some objects that clearly qualify as elements of the extension of *furniture* and as minimal ones at that. For example a clear instance of *table* also counts as a clearly atomic or minimal element of the extension of *furniture*, since a leg of that table or one of its drawers do not qualify as furniture. This illustrates how *furniture* is no less “atomic” (i.e. made up of discrete sets of singularities) than *piece of furniture* or, indeed, *table*. There may be nouns such that the minimal parts of their extension are even more vaguely specified, like *water*, *sand* or *rice*. Is half a grain of rice still rice? Maybe yes. And a quarter of a grain? It starts getting difficult to tell. Probably, we would not call a sprinkling of rice powder rice. At any rate, since in subdividing something we always get to an end, there is no principled reason to maintain that mass nouns (even those whose granularity is unclear) do not have an atomic structure. This is indeed what I will assume, in keeping with the view that semantics characterizes a class of models for natural language, one of which, the “intended one”, is reality. And I will also abstract away from vagueness, as it raises issues orthogonal to the mass/count distinction. Traditionally, theories of mass nouns have focussed on terms like *water* or *rice*, whose minimal parts are involved in vagueness. I think that this has contributed to obscuring the relation between mass nouns and plurals and led to the idea that the denotation of mass nouns is somehow qualitatively distinct from that of count ones. Focussing on mass nouns like *furniture*, whose minimal parts are no more vaguely determined than tables and chairs, helps us individuate what the right relationship between mass and plural is: what else can the denotation of *furniture* be, if not all the pieces of furniture (down to the single ones)?

Still, the difference between *furniture* and *piece of furniture* or *table* is semantic in character, but it lies merely in the way the extension is structured. The basic lexical entry *table* is associated, by our hypothesis, with individual atoms and to talk about pluralities of tables we will need a set-forming operator such as PL. The basic lexical entry *furniture* does not single out a set of atoms, but a whole, qualitatively homogeneous sublattice. In this precise sense, a mass noun is inherently plural, it comes out of the lexicon with plurality built in. Or

rather, for a mass noun the difference between plural and singular is quite literally neutralized, for such a noun will apply equally well to both atoms and sets thereof. Another way of saying the same thing is that while atomic texture is foregrounded in a count noun (in that, by definition, its extension singles out a set of atoms), such a structure, though present also in a mass noun, is present in it only implicitly in that the lexical entry is not directly associated with atoms. It is as if language chooses not to care about the atoms or singularities of mass nouns.

Consider now the following sentence:

(43) This table and that chair are furniture.

Suppose that *this table* denotes table *a* and *this chair* chair *b*. The subject NP of (43) will denote the plurality $\{a, b\}$ and the truth-conditions of (43) boil down to (44a) which is equivalent to (44b):

- (44) a. furniture($\{a, b\}$)
b. furniture(*a*) $\wedge$ furniture(*b*)

However, the very same situation can be reported as:

(45) That is furniture.

where what makes (45) true is that we are pointing at table *a* and chair *b*. We could assume that the singular definite NP *that* in (45) denotes the plurality $\{a, b\}$, in which case the logical form of (45) would also be (44). This, however, lets a singular definite denote a plurality, contravening one of the assumptions we have made. There is a “clever” way to maintain such generalization in full form. Presumably, table *a* and chair *b* are being perceived as a unit, i.e. as a group. We know that groups are atoms. So in accordance with its singularity, we can assume *that* in (43) refers to $g\{a, b\}$. However, given that *furniture* is mass and not collective, it does not hold of groups as such. Hence, we cannot apply *furniture* directly to $g\{a, b\}$. Such an application would be vitiated by a sort mismatch. What we want is:

(46) furniture($p(g\{a, b, c\})$)

This is logically equivalent to (44). And we can maintain that the singular definite NP *that* refers to a singularity. The function *p* is in this case used as a type-shift, to mediate between the denotation of *that* and the extension of *furniture*.

This approach extends also, I think plausibly, to abstract mass nouns like “sense” or “honesty”. We have to assume that our domain comprises quanta of sense or of honesty and that abstract mass nouns denote **U**-closed sets thereof. In the case of derived nouns like “honesty”, the quanta or units can perhaps be identified with instantaneous states (states of being honest). In the case of nouns like “sense”, we have to think of units of sense, whatever they might be (functions from worlds into extensions or what have you). At any

rate, assuming abstract entities with a quantic structure is certainly no more problematic than positing atomless abstract ones, as, say, a theory like Link's would have it.

So to summarize so far, a singular count noun denotes a set of atoms or singularities (or, to be pedantic, a characteristic function thereof). A plural count noun denotes a **U**-closed set of pluralities (each containing 2 or more atoms). A mass noun denotes the closure under **U** of a set of atoms. What set of atoms generates the extension of a mass noun can be quite vague (though for mass nouns like *furniture* it isn't substantially more vague than for *table*) and typically varies from context to context.

As far as I know every theory of plurality needs to assume at least as much structure as the one adopted here. Every theory of mass nouns I am familiar with enriches such structure with additional apparatus to deal with the mass/count distinction. The main point of my proposal is that the characterization of mass nouns just given, which exploits no more than what is independently revealed by the singular/plural contrast, suffices to account for all of their properties. In what follows I will indicate, mostly in an informal way, why this is so, going through the ten properties associated with the mass/count distinction which we have discussed in the introduction.

3.1. Plurality and numerals

The reason why mass nouns cannot take plural morphology (Property 1) is obvious: they are already plurals. From a formal point view, if we apply PL to a mass noun, we get the empty set:

(47) For any mass noun denotation A , $PL(A) = \emptyset$.

Proof: $PL(A) = *A - A$. But since A is already **U**-closed, $*A = A$. Hence, $PL(A) = A - A = \emptyset$.

This gives us a formal handle on why pluralizing mass nouns doesn't make sense.

One might object that in this way the denotation of pluralized mass nouns is always well defined, though necessarily empty. Thus, saying something like *these things are furnitures* ought to be analogous to saying something contradictory like *these things are different from themselves*, which it doesn't seem to be. There are however many precedents for taking certain forms of contradictoriness as a sufficient ground for ungrammaticality. And at any rate, it is straightforward to modify the present approach so as to make the impossibility of mass nouns taking plural morphology a presuppositional phenomenon.¹⁶

The next fundamental property (property 2) is the impossibility of combining numerals with mass nouns (which, as we saw, is at least partly independent of the possibility of pluralizing them). Here is the intuition. To count, one needs a suitable level at which the objects to be counted can be individuated. Certain nouns provide us with good counting criteria; others do not. For

example, the noun "table" does; the noun "object" does not. You can count the tables in your room. But if you are asked to count how many objects there are in your room, you are in trouble: there's the book you are reading; that's one object. Then there is the first page of the book you are reading; that's a second object. Then the first word of the first page. And so on. Similarly, as we saw, for nouns like "group". Nouns like "object" or "group" need to be supplemented by an external criterion, to provide a usable counting ground.¹⁷ Mass nouns are just like that. Their denotation resembles a lot that of the noun "group", and for similar reasons; it does not provide us with a useful level at which to count, without the help of an external criterion. In all count nouns, the lexical entry singles out a set of atoms. The atomic granularity of the relevant stuff is thus foregrounded or presupposed. For this reason, most count nouns provide us with a good counting criterion. However, some count nouns individuate their atoms too vaguely for direct counting. Mass nouns are not only often vague as to their atoms but, furthermore, never isolate a set of non-spatiotemporally overlapping entities. Counting the members of the extension of *furniture* would not directly tell us how much furniture there is. That is why numerals do not combine directly with them.

Here is how one might formalize this view. For any subset A of the domain of individuals, we need to check whether it has an atomic texture or not, i.e. whether its denotation individuates a set of singularities or not. This checking can be done by a function SG which applied to any property extension A returns it if A has an atomic granularity and otherwise is undefined. For a set A to have an atomic granularity is to either be a set of atoms or being in the range of PL (i.e. being generated by a set of atoms via PL). Here is the definition:

(48) For any set A :

$$SG(A) \begin{cases} A, \text{ if } A \subseteq At \text{ or if } A = PL(B), \text{ for some } B \subseteq At \\ \text{undefined, otherwise} \end{cases}$$

So in case A is not a set of atoms, nor built up from such a set via PL, $SG(A)$ will be undefined. This means, in particular, that SG will be undefined for the denotation of mass nouns, as they do not single out a set of atoms. Numerals can then be defined as generalized quantifiers in the usual way, the only novelty being the use of SG to get at the proper restriction. SG acts as a domain regulator for numerals:

- (49) a. $n(X)(Y) = \exists u[u \in SG(X) \wedge |u| \geq n \wedge u \in Y]$
 (where for any X , $|X|$ is the cardinality of X)
 b. $n(X)(Y) = |\mathbf{U}(SG(X) \cap Y)| \geq n$

In (49), we find the traditional definition of numerals as generalized quantifiers. For our purposes, (49a) and (49b) are equivalent.¹⁸ The only novelty in (49) is the use of SG on the restriction (i.e. the first argument of the generalized quantifier). This checks, in a sense, whether singularities are foregrounded by

the noun. If they are not, as in the case of mass nouns, then SG applied to it will be undefined and consequently the numerical generalized quantifier will also be.¹⁹ In this way, the possibility of counting something is directly linked to lexical properties of the head noun (i.e. whether it singles out or not a set of singularities), which besides giving the right results, is also intuitively plausible. Compare this with what happens on other approaches, like, e.g. Link (1983). On Link's approach a mass noun, like *furniture* takes its denotation from an atomless domain, while a plural like *pieces of furniture* will denote pluralities built out of single pieces of furniture. The denotation of *furniture* is not known to have atoms in it. The denotation of *coins* is. But *those pieces of furniture* and *that furniture* (uttered pointing at the same) clearly denote the same thing. Claiming that the one is not known to be atomic makes little intuitive sense. It appears to be just a way of arbitrarily marking the countability of the one vs. the non-countability of the other. On the present approach it is clear in what sense we can use *furniture* and *pieces of furniture* to talk about the very same stuff. And it is also clear that we are dealing not with the inherent atomicity of the denotatum, but with something like presupposed or foregrounded atomicity. A substance or kind is presupposed to have an atomic texture just in case what the unmarked, lexical noun denotes is precisely the atomic or minimal parts of that kind or substance.

3.2. Measures and classifiers

Mass nouns can be quantized by means of classifier and measure phrases (property 3). The approach developed here is compatible with several proposals that can be found in the literature on this topic. Starting with classifiers (like *grain*, *stack*, *drop*, and the like), one observes these macroscopic characteristics. First, they are all relational. This is shown by the fact that they are rather odd when used without an of-phrase. And when they are not odd, it is because a relatum is implicitly understood:

- (50) a. ?There were three grains on the floor.
b. ?I saw four stacks.

Second, not every noun figures equally well with every classifier noun:

- (51) a. *Four grains of that water/those men
b. *Three packs of hay/flowers

Third, some classifiers must have plural relata, others singular ones:

- (52) a. Two slices of cake/*cakes
b. One pack of cigarettes/*cigarette

This can be easily accommodated by assuming that classifiers are partial functions from pluralities into sets of atoms constituted by members of the pluralities. Here are a couple of definitions for illustrative purposes:

- (53) For any $u \in U - At$ and any $u' \in At$,
a. $|grain|_w(u)(u') \leftrightarrow u'$ is a rounded, solid body of small dimension made of members of u
b. $|drop|_w(u)(u') \leftrightarrow u'$ is a rounded, cohesive, liquid body of small dimension made of members of u .

In combining a classifier with a noun, one can use the supremum to get at the relevant plurality:

- (54) $drop\ of\ water \Rightarrow drop(\sup water)$

Often the objects associated with classifiers display the behavior of "containers" and are used to refer to their content, via either type-shifting devices, or, possibly, lexical entailments of the relevant predicates:

- (55) a. John smoked two packs of cigarettes.
b. $2\ (PL(pack(\sup cigarettes)), \lambda x(smoke\ (John, C(x))),$ where 'C' maps a "container" into its "content"

Sentence (55b) represents one of the salient interpretations of (55a). Other interpretations arise as typically classifiers double up as measure phrases, which we will discuss shortly. The behaviour of classifiers appears to be fully parallel to that of collective nouns like *bunch* or *group*, which also map pluralities into atoms. They can, therefore, be viewed as a special case of classifiers. An interesting case is that of the classifier *quantity* which applies to both mass nouns (*that is a quantity of water*) and to plurals (*that is a quantity of men*). It seems that every group of something is a quantity of that something and vice-versa: every quantity of something is a group of atoms of that something. *Quantity* and *group*, in other words, seem to be nearly synonyms. They differ merely in that the argument of *group* is presupposed to be plural, while that of *quantity* is not. For the purposes of the present paper, I will ignore this difference and treat them as synonymous.

Measures can be thought of as (partial) functions from (plural or singular) objects into real numbers. Measure phrases are in a way similar to classifier phrases, in that they too are inherently relational and allow us to quantize a certain domain of objects. But they differ from classifier phrases in several respects. For one thing, they combine only with a restricted range of numeral determiners:

- (56) a. ??I bought every/most/no pound of rice from that store.
b. ??Most liters of wine in this tank are polluted.
c. Three liters of wine in this tank were polluted.

Moreover, measure nouns hardly allow any adjectival modification. Consider:

- (57) a. I bought two beautiful slices of pizza.
b. ?I bought two beautiful pounds of pizza.
c. I thought of a beautiful number/amount.

In sentence (57a) beauty is imputed to the slices as such, not necessarily to the pizza. Instead to the extent that we can interpret (57b), it is the pizza that has to be beautiful, not the pounds. And, as (57c) illustrates, this is not because amounts and other abstract entities cannot be beautiful.

These simple considerations suggest that we don't want to interpret measure phrases as singularities or atoms in our domain. Take a pound of rice. There might or might not be an actual naturalistic object (a pile, a scoop, etc.) corresponding to it. But our talk about pounds of rice is independent of there being such objects. Reflecting this, we will follow e.g. Lonning (1987) among others, and treat measure phrases along the following lines:

- (58) a. n pounds $(P)(Q) = \exists u \in P[pnd(u) = n \wedge u \in Q]$
 b. John bought three pounds of rice $\Rightarrow \exists x[\text{rice}(x) \wedge pnd(x) = 3 \wedge \text{buy}(J, x)]$

Not treating pounds as real individuals accounts straightforwardly for their restricted distribution.²⁰ We have to assume that in this use of measure phrases, the presence of grammatical number features on them is purely syntactic.

Measure phrases can also be used as classifiers. This happens when singularities (typically, containers) corresponding to amounts can be individuated. A simple way to shift the meaning of measure phrases making it analogous to that of classifiers is as follows:

- (59) a. $\text{pound} = \lambda u \lambda y [R(u)(y) \wedge pnd(y) = 1]$, where:
 i. R is a variable ranging over a classifier, whose value is supplied by the context.
 ii. u is a variable ranging over pluralities
 b. Example:
 Most liters of wine were polluted $\Rightarrow$
 Most $(\lambda y [\text{bottles of } (i\text{wine})(y) \wedge \text{liter}(y) = 1], \lambda y \text{ polluted}(C(y)))$

When used as classifier phrases, measure phrases behave as normal count nouns. So for example, a sentence like (59b) (analogous to the deviant sentence (56b) above) is acceptable if the wine comes in suitable liter-sized containers of some kind. Similarly, it is easy to imagine how classifier phrase such as *cup*, *coil*, etc. can be turned into measure functions and used accordingly (see again on this e.g. Lonning 1987).

So to summarize, classifier phrases, though not limited to mass nouns, constitute a way of mapping mass noun denotations into sets of atoms (slices, grains, stacks, etc.) that can then be counted in the usual way. A classifier phrase behaves fully like a count noun. Measures attach numerical values to things and even though measure phrases are part of the quantificational system of a language, their distribution is more restricted than that of ordinary count nouns. Measure phrases too, however, can be indirectly used to (re)partition a set into discrete singularities.

3.3. Quantifiers

In this section we are going to investigate the properties of quantification over a domain with the structure we are assuming (properties 4–7). The first thing to note is that there are some very natural quantifiers that are purely sensitive to general lattice-theoretic properties of the domains. One we have already met is the function ι , encountered above in (16), which provides us with a very natural semantics for the definite article:

- (60) a. $\text{the}(X) = \iota(X)$
 b. $\text{the}(X) = \lambda PPP(\iota(X))$

Definition (60b) constitutes the generalized quantifier version of (60a). As noted by Sharvy (1980) and Link (1983), this definition extends beautifully to mass nouns: something like *the water on the floor* will denote the maximum set of aggregates of water which are on the floor. On the present theory this follows directly from the fact that mass noun denotations are **U**-closed sets of atoms. Actually, if we want to stick to the generalization that singular definite NPs denote atoms, we want to interpret something like *the water on the floor* not as a plurality, but as the corresponding quantity. This means that *the N* translates as $\iota(N)$, but mismatches between syntax and semantics have to be resolved. In particular, if N is singular and $\iota(N)$ is a plurality, then *the N* translates as a contextually salient quantity made up by the members of $\iota(N)$, i.e. $g(\iota(N))$.²¹

ι is an operation based on the supremum operator, which explains its properties. Are there others like it? Consider *some* and its negation *no*. Their standard definitions require that the extension of their first and their second argument be, respectively, non empty or disjoint. However, we have already seen that this definition leads to difficulty with *no*. By restating the semantics of *some* and *no* in terms of the notion of "ideal", defined in (61a), we can easily avoid this difficulty:

- (61) a. For any u in U , the ideal $\pi(u)$ generated by u is $\{x: x \leq u\}$
 a. $\text{NO}(X)(Y) = \pi(X) \cap Y = \emptyset$
 b. $\text{SOME}(X)(Y) = \pi(X) \cap Y \neq \emptyset$
 where for any $X \subseteq U$, $\pi(X) = \pi(\mathbf{U}X)$

For any set X , $\pi(X)$ is the set of all the elements which are components of the supremum of X (i.e. the ideal generated by $\mathbf{U}X$). The function π has the following properties. If X is the denotation of a mass noun, then $\pi(X) = X$, since X will already contain all the components of its supremum. If X is singular and count, $\pi(X)$ will yield the **U**-closure of X . Finally, if X is plural, $\pi(X)$ will add the atoms to it. In any case $\pi(X)$ yields a complete atomic sublattice of the domain. *SOME* and *NO* can be viewed as operations on these structures. This solves at once our problems with *NO*. Sentences like *no men lifted the piano but John did* or *no man lifted the piano but John and Bill did* both come out as contradictory. Moreover, since these operations are based upon the π -operator, which is a total function, they will also be total functions. This

explains why the determiners *no* and *some* can operate on any kind of noun (singular, plural or mass).

At the same time, the structure of our domain provides us with some natural classes, and we might expect there to be functions sensitive to them. Count nouns (singular and plural) together clearly form a natural class and are identified through our function SG, which checks whether a predicate foregrounds a set of atoms or not. As we saw, a noun can restrict a numerical quantifier only if its singularities are foregrounded or presupposed.

There are also quantifiers that are defined just for singular count nouns and others defined solely for plural ones. Here are some examples from English and Italian:

- (62) i. Singular quantifiers: every, nessun 'no', qualche 'some'
 a. every man/*every men/*every water
 b. nessun uomo 'no man'/*nessun uomini 'no men'/*nessuna acqua 'no water'
 c. qualche uomo 'some man'/*qualche uomini 'some men'/*qualche acqua 'some water'
 ii. Plural quantifiers: many, several, a few, a number of, alcuni 'some'
 a. several men/*several man/*several water
 b. alcuni uomini 'some men'/*alcuno uomo 'some man'/*alcuna acqua 'some water'

In principle, one could regard this as a syntactic phenomenon. One could for instance claim that Italian *alcuni* is the plural form of *qualche*. But while that might be right in some cases, it seems rather implausible in general. These two Italian forms of existential quantification are not morphologically or historically related; they do not display any attested form of Italian pluralization (including the "irregular" ones). It appears more plausible to maintain that *qualche* denotes a function defined just over singularities, while *alcuni* denotes one defined just over pluralities. There is an easy way to do it, which involves restricting further our domain regulator SG. Let S be the restriction of SG to At. This means that for any subset X of the domain, $S(X) = X$, if $X \subseteq \text{At}$ and otherwise $S(X)$ is undefined. Then, let $P = \text{SG} - S$ (thinking of SG as a set of ordered pairs). This means that for any X , $P(X)$ lets X through, only if X is a good plural denotation. Now we can use S and P as domain regulators, as we did with SG:

- (63) a. $\text{EVERY}_S(X)(Y) \leftrightarrow S(X) \subseteq Y$
 b. $\text{QUALCHE}_S(X)(Y) \leftrightarrow S(X) \cap Y \neq \emptyset$
 c. $\text{ALCUNI}_P(X)(Y) \leftrightarrow P(X) \cap Y \neq \emptyset$

In general a function D_S is defined only for singularities, while D_P is defined only for pluralities. D_S and D_P are special cases of count quantifiers (i.e. quantifiers sensitive to presupposed atomicity).

Some such restrictions make sense. For example, a distributive universal quantifier like *every* must be restricted to singularities, for that is what being

distributive means. Other restrictions appear to be idiosyncratic. For example, there is no obvious reasons why Italian chooses to have two separate, partial existential quantifiers, rather than a single, total one, like English.

Another natural class of quantifiers are those restricted to plural and mass nouns. These two kind of nouns have in common that their extension (when non empty) is always **U**-closed. The domain checking device we can use to capture sensitivity to **U**-closure can be defined as follows:

- (64) For any $X \subseteq U$, ${}^U X = X$ if for some $A \subseteq \text{At}$, $X = \text{PL}(A)$ or $X = {}^*A$; else undefined.

This restriction seems to be at play with quantifiers like "all":

- (65) a. all boys are tired
 b. all water is wet
 c. *all boy is wet
 d. $\text{ALL}(X)(Y) = {}^U X \subseteq Y$

It also seems to play a role with quantifiers like Italian "molto", which translates both "many" and "much". This is a vague quantifier with several readings. All of its readings are based on a way of measuring and comparing its restriction and scope. It might be interesting to consider its semantics. To get at it, let us start by a consideration of its English count counterpart "many". The (non-proportional) reading of *many* is usually characterized as follows:²²

- (66) $\text{MANY}(X)(Y) = |X \cap Y| > n$ (first version)

Here n is a contextually set parameter. This simple definition is not quite right. First, we want "many" to be restricted to pluralities. This can be done by using the domain regulator P . Second, and more importantly, (66) clearly does not work for infinite (or just large) sets. We judge the following sentences as possibly true:

- (67) a. Many stars belong to our galaxy.
 b. Many numerals don't end with a "0".

yet no n can be picked that does the trick. For (67b), setting n to infinity will not work (the set of numerals that end in "0" is as infinite as the set of numerals that don't); nor will it work setting it to anything smaller than that. The problem is that we cannot limit ourself to some simple counting of the singularities. We need to have some suitable measure; in the case of (67b), for example, we want one that determines the density of a given set of numerals relative to their totality. Generally speaking we can regard measures as functions from objects into numerical values. Hence a better definition for *many* might be:

- (68) $\text{MANY}(X)(Y) = \mu(\mathbf{U}(P(X) \cap Y)) > n$, (second version)
 where:
 (i) μ is some suitable measure (specified in the context)

- (ii)
- n
- is a parameter (also specified in the context)

According to (68), we take the sum of the plural members of the intersection of X and Y and we measure it. This accounts for the fact that *many* cannot apply to singulars (i.e. we cannot say things like "many man"). In the case of count nouns with a finite extension, the pragmatically most salient measure function will simply count the cardinality of the set. Now Italian "molto" has the same meaning as "many", only the domain regulator is the one for plural and mass nouns:

$$(69) \text{ MOLTO}(X)(Y) \mu(\mathbf{U}(\mathbf{U}X \cap Y)) > n$$

The following examples illustrate:

- (70) a. *Molta acqua e' sul pavimento* $\Rightarrow \mu(\mathbf{U}(\mathbf{U}\text{water} \cap \text{on the floor})) > n$
 'much water is on the floor'
 b. *Molti ragazzi sono in classe* $\Rightarrow \mu(\mathbf{U}(\mathbf{U}\text{PL}(\text{BOY}) \cap \text{in class})) > n$ 'many boys are in class'
 d. **Molto tavolo*; ($\mathbf{U}\text{PL}(\text{table})$ is undefined)

Now we can deal also with quantifiers defined just for mass nouns like *much* and *little*. Clearly, *much* must be interpreted just like *many*, only restricted to mass noun denotations. Given the system we have got so far, the way to give the semantics for *much* might be as follows:

$$(71) \text{ MUCH} = \text{MOLTO} - \text{MANY}$$

Thinking of functions as sets of ordered pairs, we start from the unrestricted function MOLTO defined in (69) and we take out of it all the ordered pairs contained in the restricted function MANY. This leaves us with pairs of the form $\langle X, Y \rangle$, where X is $\mathbf{U}$ -closed but not plural. Thus MUCH, as defined in (71), will have in its domain mass nouns but not plurals.

There are other conceivable ways of achieving similar results. For example, just like we defined SG (and its restrictions P and S), we could define a new domain regulator M that singles out mass noun denotations:

- (72) For any X , $M(X) = X$, if X is an atomic sublattice of U , undefined otherwise.

The domain of determiner functions D , could then be regulated by using M , obtaining restricted functions D_M . However, if this approach was correct, we would expect quantifiers restricted to mass nouns to have the exact same status as quantifiers restricted to singulars or to plurals. But this doesn't seem to be so. Quantifiers restricted to mass nouns appear to have a marked status. Their markedness manifests itself in at least two clear ways. For one thing, in English there are few quantifiers that are so restricted and in languages like Italian, which, concerning the mass/count distinction, have otherwise the same phenomenology as English, there aren't any at all. Moreover, the English quantifiers *much* and *little* are documented to come in very late in acquisition.

According to Gordon (1982), they are learned around the 6th year, i.e. in school age, while the rest of the basic mass-count distinction comes in very early on (from 2 to 3 years). If we assume that Universal Grammar doesn't make available any domain restrictor for mass nouns, and that functions restricted to mass nouns arise by taking out the count portion from unrestricted functions, the relative delay in their acquisition as well as their relative crosslinguistic scantiness finds a reasonable explanation.

English too has other functions similar to "molto" restricted to plural and mass noun. A case in point is *most*, which is also measure based:

$$(73) \text{ MOST}(X)(Y) = 1 \text{ iff } \mu(\mathbf{U}(\mathbf{U}X \cap Y)) > \mu(\mathbf{U}(\mathbf{U}X \cap \bar{Y}))$$

Like for *many*, when the restriction is a count noun with a finite denotation, the measure function will simply boil down to counting the singularities.²³

It is interesting to remark on the difference between *most* and the partitive construction *most of the*. This is not the place to try to give a detailed analysis of the partitive; however, note that while *most* is restricted to plurals and mass nouns, *most of the* admits also singulars that have natural parts. Compare (74) and (75):

- (74) a. most of the boys
 b. most of the water

 (75) a. most of the country
 b. most of that cake
 c. most of my soul

The reason for this might be the following. Suppose that the NP following *of* denotes an individual. This is in fact what one would expect, given the semantics of *the* and of the definite determiners allowed in partitives. The whole construction is then simply analyzed as *most parts of x*, perhaps because of the actual presence of a null (plural) head with that meaning. If the NP is plural, the relevant parts would be the subgroups. If it is mass, they would be the parts of the substance, which on the present approach also amount to subgroups of the supremum (down to the atoms). If it is something like *the country*, they would be its standard portions (e.g. its regions). Quantifiers, including *most*, would then have their usual meaning.

It is time to take stock. We have three basic domains, corresponding to three basic noun types:

- (76) a. singular count nouns $\approx$ subsets of At
 b. plural count nouns $\approx$ $\mathbf{U}$ -closed subsets of $U - \text{At}$ generated by a set of atoms via PL
 c. mass nouns $\approx$ $\mathbf{U}$ -closed atomic sublattices of U

Each type of noun can in principle restrict the domain of a quantifier. Conversely, one might a priori expect there to be quantifiers restricted to each of

these domains and to any combination thereof. What we in fact find is summarized in the following chart. We give examples from both English and Italian; the examples given are not meant to be exhaustive.

- (77) sg = singular; pl = plural; m = mass
- sg: every, *nessuno* 'no', *qualche* 'some'
 - pl: many, few, several, a few, *alcuni* 'some'
 - m: much, little
 - sg + pl: the numerals and their variants (at most *n*, at least *n*, etc.)
 - sg + m: none attested
 - m + pl: most, *molto*, ('many' and 'much'), *poco* ('few' and 'little')
 - sg + pl + m: the, some, no

The so called null determiner would belong to line (77f). But as I already mentioned, addressing the problem that such an alleged determiner raises would take us too far afield. Our account of the distribution summarized in (77) is the following. First, there are functions sensitive to the general lattice-theoretic structure of the domain. These functions will be unrestricted (cf. 77g). Second, some functions are sensitive to presupposed atomicity, which is captured by the function SG used as domain regulator (cf. 77d). Purely singular and purely plural determiners are special cases of SG, i.e. particular atom-oriented functions (cf. 77a–b). Finally, some functions sensitive to closure under **U**, restricted to plural and mass nouns (77f). All measure based quantifiers appear to be of this kind. Mass oriented determiners (77c) have a marked status and arise as restrictions on the latter type of functions. All this can be schematized as follows.

- (78) a. Unrestricted functions: *ι*, NO, SOME

b. $SG \begin{cases} P \\ S \end{cases}$

- c. functions sensitive to **U**-closure (all of the measure based)

If we assume a system of this sort, the non-existence of functions restricted to singular and mass noun denotation follows immediately: there is no natural domain regulator that would have the effect of thus restricting the left argument of a determiner.

The main generalizations emerging from (78) are:

- (79) i. One counts singularities. A noun can restrict a numerical quantifier only if its singularities are foregrounded or presupposed.
- There are no singular measure based quantifiers.
 - Quantifiers restricted to mass nouns are marked.
 - There are no quantifiers for mass and singular nouns that exclude plurals.

Crosslinguistic variation would be expected to be possible within the bounds of these generalizations.

Some interesting open problems remain. Let me mention two. Consider the following a priori plausible generalization:

- (80) A language either has an unrestricted function or has a set of restricted functions whose union covers the domain and range of the unrestricted function.

For example, English has unrestricted SOME, while Italian has a singular one (*qualche*), a plural one (*alcuni*) and the bare partitive *del* for mass and plurals. Together these three partial functions do what SOME does. The rationale for (80) would be straightforward functional considerations of expressive power and economy. The generalization in (80), however, appears to be counter-exemplified by Italian *nessun* 'no', which is restricted to singulars. Italian has no mass or plural counterpart of *nessun*. Yet another triumph of functionalism?

The second interesting problem is the following. We have observed that there are quantifiers like *most* or Italian *molto* that are restricted to mass and plurals and are moreover measure based. I wasn't able to find a quantifier that is measure based and not restricted to plurals and mass (e.g. a quantifier like *most-of-the*). If this correlation holds, it remains unexplained on our approach. Measures can obviously be defined over singularities (one can measure anything) and it is not clear why in the determiner system they should be restricted to operating on pluralities. So either the given generalization is wrong, or else something is missing from the picture we have given.

In spite of these drawbacks, we have made some progress. A rather simple system of quantification emerges, based on the straightforward idea that some quantifiers may be partial (i.e. in a sense, presuppositional) depending on what they quantify over. Certain distributional properties of determiners receive an elegant explanation (e.g. the behavior of the unrestricted determiners). Others can at least be precisely individuated.

3.4. Shifts of meaning

Property (8) states that the same slice of reality can be regarded as count or as mass. Take for example the pair *coin/change* and let us say, for the sake of argument that, once we factor out their (un)countability, they mean essentially the same thing. On the present system, it is perfectly clear how this can happen. While *change* is true of singular coins and all the sets thereof, *coin* is just true of singular coins and *coins* is true of all the sets thereof. The reason why cases like this are relatively rare resides in the well-documented tendency of languages to severely limit synonymy in the lexicon (cf. on this Markman 1989). However, while scanty within one language, mass/count near synonyms appear to be more widespread across languages. Here are some examples of mismatches drawn from English and Italian:

(81)	<u>count</u>	<u>mass</u>
	capello	hair
	bagaglio	luggage
	mobile	furniture
	calzatura	footwear
	posata	cutlery
	relative	parentela
	servant	servitu

The lexical entries in (81) constitute minimal pairs at variance only in their (un)countability.

We also discussed interpretation of nouns predominantly belonging to one class that can be forced, more or less felicitously into the other (properties 9–10). This is possible by means of type-shifting devices. For example, some classifiers (like *bottle of*, *carton of*, etc.) can be used implicitly to turn basically mass nouns (like *beer* or *milk*) into count ones. Another typical type-shifting function of this sort is *type of*:

- (82) A blood was singled out $\Rightarrow \exists x$ [type of (blood)(x) $\wedge$ singled out (x)]

In the other direction, the most common way to turn a count noun into a mass one is by means of a part-of operator. One we have already met. It is the ideal forming operator π , which neutralizes the singular-plural contrast. This is involved in examples of the following kind:

- (83) a. You've got plenty of house.
b. I am going to buy a lot of shrimp.
c. $\pi(\text{shrimp})$

A prominent reading of (83b) is equivalent to "I am going to buy many shrimps". The translation of "shrimp", in its mass use, will be (83c). Next to π , there will be a "natural part-of" relation of the following kind:

- (84) For any set of atoms X , part-of(X) = λy [y is a piece or an aggregate of pieces of X]

Such an operator is involved in examples like:

- (85) There is a lot of shrimp in this sauce

The part-of corresponds to David Lewis's universal grinder. I view it as a cover term for a host of part-of relations that atoms can contract with each other. So for example, our domain of quantification contains me as well as my body parts. My arm is as much an atom as myself. How many of my body parts are there going to be in U ? That will vary from context to context, since the word *part* is pretty vague. But in principle, there can be as many body parts as there are ways of slicing me up. Grind me, and you will have Chierchia all over the floor. As the parts get smaller, we will get more resistant to call that stuff *Chierchia*.

So the domain of quantification in a given context must contain not only

tables, chairs, horses, but also as many of their parts as may be required to make sense of sentences like (85). The important thing to note is that even if mass nouns weren't around, we would have to do exactly the same. For we can say things like *there is a portion of horse left* or *there are three portions of horse* and there are a host of count relational nouns like *portion*. Whatever you do about these nouns, marriage to the Inherent Plurality Hypothesis suffices to explain the behavior of mass nouns. Positing a mysterious domain of atomless substances does not help.

A question one might ask is the following. If the mass-count distinction has nothing to do with the material structure of the denotatum, as the present approach claims, why do liquids and more generally natural substances tend to be universally classified as mass? The answer that naturally emerges from the present approach is simply that for liquids and substances there are no minimal parts readily accessible to our perceptual system. This, in the absence of standard aggregates or lumps in which liquids and substances are given to us in nature, suffices to make it impractical, even undoable, to isolate a suitable set of singularities for the relevant lexical entry to denote.

Come to think of it, the simple considerations just made entail the following universal:

- (86) There is no natural language that only has count nouns.

The standard predicate calculus is an (artificial) language which violates universal (86). Such a universal says that no natural language is, in this respect, like the predicate calculus. A counterexample to universal (86) would be a language whose common nouns can all be directly modified by numerals (without the mediations of classifiers or measure phrases). If the present approach is right, the explanation for this universal is not to be sought in the architecture of Universal Grammar, for nothing, as far as UG is concerned, bans such a language. Universal (86) must be explained in terms of the interaction between UG and other extralinguistic modules. What could the relevant modules be? An obvious candidate is our perceptual system, for the reasons just hinted at. Soja, Carey and Spelke (1991) argue that the pre-linguistic child already possesses a notion of non-solid substance clearly distinguished from the one of solid object. It is to be expected that every language will have nouns corresponding to concepts that are so salient in our cognitive system. The minimal parts of non-solid substances are typically not within the reach of our perceptual system. Hence, of the two options that grammar makes available for common nouns, we will choose for liquids the one that does not call for the individuation of a set of atoms or singularities. Universal (86) looks like a clear example of a linguistic generalization, whose account is not purely grammar internal.

At this point one might wonder whether the following claim, symmetric to (86), also holds universally:

- (87) There is no natural language that only has mass nouns.

A counterexample to this hypothetical universal would be a language whose

common nouns can never be directly modified by numerals. As is well known, there are plenty of such languages. And for good reasons. But before getting to that, we might want to explore some further consequences of the present theory.

4. FURTHER CONSEQUENCES AND COMPARISONS

The main argument we have offered in favour of the present approach is one of simplicity. The plural-singular contrast reveals that the domain of quantification must have a certain structure. Singular nouns individuate singularities, pluralization allows us to refer to arbitrary groups of singularities (i.e. it closes up singularities under some kind of set forming operation). This minimal amount of structure, detected thanks to singular and plural, also suffices to explain mass and count. Mass nouns come out of the lexicon already closed under set formation. Hence they do not single out atoms; and operations like counting atoms cannot directly apply to them. In terms of this idea we seem able to explain the whole relevant phenomenology. No amount of structure specific to mass nouns is superimposed on the domain of quantification. Can we understand the mass/count distinction with less? Can there be a more sober apparatus?

I want now to draw the reader's attention to some consequences of the present theory, consequences that no other theory, as far as I know, can derive equally straightforwardly. I will consider three of them.

4.1. The supremum argument

The first has to do with properties of the supremum operator. I will illustrate it by means of an example. Consider now the following two sentences:

- (88) a. The furniture is from Italy.
b. The pieces of furniture are from Italy.

These two sentences have the same truth-conditions. The NP *the furniture*, according to our theory, denotes a group made up of pieces of furniture. The NP *the pieces of furniture* denotes the maximal set of pieces of furniture. These denotations are distinct: the first is a singularity, the second a plurality. In spite of this difference, sentences of the form given in (88) are predicted to have the same truth conditions. Let us see how. *From Italy*, in most contexts, is construed as a distributive predicate: its truth or falsity in applying to a group or plurality depends ultimately on the individuals that make it up. The logical forms of the sentences in (88) are as follow:

- (89) a. $[[\text{from Italy}]]_C (g_1(\text{furniture}))$
a'. $\forall x[x \in C(g_1(\text{furniture})) \rightarrow \text{from Italy}(x)]$ (by definition (39b) of $[[\]_C]$)
a''. $\forall x[x \in C(i(\text{furniture})) \rightarrow \text{from Italy}(x)]$ (by definition (37) of C)
b. $[[\text{from Italy}]]_C (i(\text{pieces of furniture}))$
b'. $\forall x[x \in C(i(\text{pieces of furniture})) \rightarrow \text{from Italy}(x)]$

Since $i(\text{furniture})$ and $i(\text{pieces of furniture})$ are the same set, (89a') and (89b') are logically equivalent. Thus, for example, if the pieces of furniture are a , b and c , all the formulae in (89) become:

- (90) $\forall x[x \in C(\{a, b, c\}) \rightarrow \text{from Italy}(x)]$

And under the assumption that the cover is distributive, we get:

- (91) $\forall x[x \in \{a, b, c\} \rightarrow \text{from Italy}(x)]$

The same holds, *mutatis mutandis*, if we choose a predicate that applies to groups:

- (92) a. The furniture is gathered in a pile.
b. The pieces of furniture are gathered in a pile.

The logical form of these sentences boils down to (90). But the salient cover now maps the plurality $\{a, b, c\}$ into the corresponding group. Hence, we get:

- (93) gathered in a pile ($g\{a, b, c\}$)

There can be predicates and contexts that select groups that are smaller than the maximal one. The result will not change: the two sentences will come out as equivalent, if the context of the relevant pair of sentences is kept constant.

It should be noted that the force of this argument does not depend on the details of how group predication is built up. In particular, it does not depend, as far as I can make out, on the contextual relativization to covers. The crucial thing is that the supremum of the mass noun (e.g. *furniture*) and the supremum of the corresponding count nouns (e.g. *pieces of furniture*) are going to be the very same thing. Hence, under any reasonable construal, the corresponding groups or quantities are also going to be the same. This is perfectly general. For example, it goes through also with intensional predicates:

- (94) a. John wants/is thinking of/dreamt of that furniture
b. John wants/is thinking of/dreamt of those pieces of furniture

This is simple enough to constitute a test that every theory should pass. We will call it the supremum test.

The same argument goes through, I think, for vague mass nouns like "water" or "rice"; but one needs more help from the context: what counts, in context, as minimal parts has to be made clear. In a situation where it is clear that only whole grains of rice count as rice, then the following will have the same truth conditions:

- (95) a. The rice is from Italy.
b. The grains of rice are from Italy.

The argument does not apply if the chosen classifier phrase does not pick out minimal parts. So, for example, (96a) and (96b) might well both be true.²⁴

- (96) a. The blocks of styrofoam are blue (they have been painted).

- b. The styrofoam is not blue (the styrofoam constituting the blocks).

The fact that (96a) and (96b) don't have the same truth conditions, remains true even if sometimes "the blocks of styrofoam" can be used to refer to the styrofoam that constitutes them. But to do that we have to resort to type shifting (cf. (55) above).

Other theories, of which Link (1983) is a good representative, do not pass the supremum test. Since "furniture" and "pieces of furniture" take their value from different subdomains, **U**(furniture) and **U**(pieces of furniture) have to be distinct entities. This makes it hard to capture the equivalence in (88). It can be done, by resorting to type shifting or meaning postulates. And a certain amount of type shifting is independently needed. But a Link-style theory cannot directly capture the equivalence in question as a matter of logical form. On the basis of such theories, things would be simpler if one found predicates *P*, such that *P*(**U**(furniture)) is true but *P*(**U**(pieces of furniture)) is not. One would simply block the type shifting that links **U**(furniture) to **U**(pieces of furniture) to handle such cases. On the present theory, the existence of such predicates would make things more complicated as **U**(furniture) and **U**(pieces of furniture) are the same entity.

But is really true that there are no predicates for which the equivalence in question does not hold? According to the present theory, they would have to be sensitive not to the distinction between groups and ordinary individuals, but to the one between groups (which are atoms) and pluralities. And in fact, there are very few predicates of such kind. The typical case discussed in the literature, is that of reciprocals:

- (97) a. Those pieces of furniture are leaning against each other.
 b. *That furniture is leaning against each other.
 c. Committee A and committee B fight each other.
 d. *Committee A fights each other (c and d are Landman's examples).

As (97) shows, reciprocal predicates are sensitive to being plural vs. being singular. Our theory predicts that this is the *only* class of predicates that can differentiate "the furniture" from "the pieces of furniture". A Link-style approach is not as restrictive. Such a theory is compatible with there being other kinds of predicates differentiating "the furniture" from "the pieces of furniture". But before discussing reciprocals, we want to point out a further consequence of the present theory, as it is more directly related the supremum argument.

4.2. The translation argument: Pavarotti's hair

The second consequence has to do with translation. This is a problematic notion. But there are many cases in which we have no doubt that a certain phrase or word of language *L* is a good literal translation of a phrase or word of another language *L'*. The present theory predicts that if β and ∂ are two

such words, that differ just for β being mass and ∂ being count, then there are systematically predictable phrases built out of β and out of the plural of ∂ that are going to have the very same intension. Here is an illustration of this prediction. The Italian *capello* translates as English *hair*, even though the first is count and the second mass.²⁵ On the present theory this simply means the following:

- (98) For any *w*, $V(\text{capello}_w) = \{x \in \text{At} : x \in V(\text{hair}_w)\}$, where *V* is the evaluation function

It is moreover also uncontroversial that (99a) is the correct English translation of (99b).

- (99) a. Pavarotti's hair
 b. I capelli di Pavarotti

From (98) and the semantics of the possessive, whatever its details may be, it will immediately follow that the noun phrase in (99b) denotes in every world *w* the set containing all of the hair that grows on Pavarotti's head in *w* and (99a) denotes the corresponding group or quantity. Hence, by the same reasoning used intralinguistically in the preceding section, any sentence containing the NP in (99a) will be true in the very same conditions under which its translation containing (99b) will be true, in spite of *hair* being mass and *capello* being count. Consider for example the following English sentence:

- (100) Pavarotti's hair has all been burned by a crazy fan

The floated quantificational element *all* emphasizes that *is burned* is construed distributively, i.e. as applying to each and all of the thread-like growths on Pavarotti's head. Hence the logical form of this sentence will ultimately turn out be:

- (101) $\forall x[x \in \iota(\text{hair of Pavarotti's}) \rightarrow \text{burned}(x)]$

The Italian translation of (100) is:

- (102) I capelli di Pavarotti sono stati tutti bruciati da un fan impazzito

This sentence winds up having the same logical form as (100), viz. (101). All we need is assumption (98). From it, it follows directly that that $I(\text{hair of Pavarotti}) = \iota(\text{capelli di Pavarotti})$.

It is interesting to remark that the Italian noun *capello* is every bit as vague as *hair*. If you take one threadlike growth on Pavarotti's head and cut it in two you still get stuff that qualifies as hair; in Italian it would qualify as two *capelli*. If you keep going, you'll get to a point where you will not want to call what you have got *hair* or *capelli*.

On the present theory, we expect these kinds of interlinguistic shifts to occur in systematic form only for mass vs. count. They won't occur in comparable ways with other categories like group-level vs. non group-level. For

example, in certain contexts, "the soldiers" can refer to the same thing as "the army", a group-level predicate. Now, there can be languages in which "soldier" is mass, but not a language in which it is group-level, for a hypothetical group-level cognate of "soldier" will have to leave out individual soldiers, if it really is group-level, and hence will not correspond to "soldier" as minimally as "capello" corresponds to "hair". Mass-count shifts are unique in that respect. This finds striking confirmation in the typological variations discussed in section 5.

The logic of the translation argument is the same as the previous one. However, looking at it interlinguistically dramatizes what the central point is. Pavarotti's hair is Pavarotti's hair, whether we talk about it in Italian or in English, i.e. whether we get at it through a mass noun or through a count noun. We might call it the translation test and it should be an easy one to pass for any theory. Yet, on most theories, Pavarotti's hair is some kind of atomless substance in English, but turns into an atomic one in Italian. If we don't want semantics to start looking like magic, we have to say that in the real world "hair" and "capello" obviously denote the same stuff and what grammar is about is something like "intended atomicity" or "presupposed atomicity". But what does that exactly mean?²⁶

The answer afforded by the present theory is straightforward. And it directly preserves the intuition that the mass/count contrast has to do with "real world" reference: "hair" and "capello" refer to different classes of the same things.²⁷

4.1.3. *A note on reciprocals.* Reciprocals are a highly complex topic. Here we are interested in them mainly because predicates with reciprocals provide a clear example of a context sensitive to the distinction between groups and pluralities. The argument we will consider is due to Gillon (1992, 628–9). For our purposes, we can adopt a proposal that goes back to Fiengo and Lasnik (1973), who credit Higginbotham for it, according to which the interpretation of reciprocals works as follows. Take a simple sentence like:

(103) My students copied each other.

where *my students* is the antecedent of *each other*. In simple cases, the interpretation of (103) requires that the expression that has the reciprocal and its antecedent as arguments express a relation that holds of each pair in the denotation of the antecedents and of its converse. So for any *a* and *b* that are my students, the copy relation must hold between $\langle a, b \rangle$ and $\langle b, a \rangle$, for (103) to be true. More complex cases require the relativization to covers. For example, sentence (103) can be true if I teach two classes, class A and class B and the students of class A copied each other and the student of class B also did. So the requirement that the copy relation be total and symmetric is not to be stated directly over the denotation of the antecedent but over a cover thereof (which, in the example just given, would be constituted by the students of class A and the students of class B).

As noted above, reciprocals give rise to contrasts such as (97), repeated here:

- (97) a. Those pieces of furniture are leaning against each other.
b. *That furniture is leaning against each other.

The ungrammaticality of (97b) could be accounted for by assuming that reciprocals require an antecedent which is syntactically plural. However, this assumption does not suffice in accounting for all of the relevant pattern. To see this, consider the following example, from Gillon (1992):

- (104) The drapes and the carpets resemble each other.

According to one reading, this sentence is true if the drapes resemble each other and the carpets resemble each other. The relativization to covers affords us this interpretation as follow. Assuming that conjunction is interpreted as sum, the denotation of the subject NP will be the set constituted by all the drapes and all the carpets. The carpets and drapes taken separately constitute a cover for this set and the resemble-relation holds symmetrically within each cell of such cover. Now, Gillon notices that (104) contrast minimally with:

- (105) The drapery and the carpeting resemble each other.

This sentence only admits a reading whereby the drapery resembles the carpeting and viceversa. It lacks the reading discussed in connection with (104). Why? *The drapery* and *the carpeting* on our theory denote two quantities (i.e. two singularities), say *x* and *y*, respectively. Their conjunction will thus denote the set $\{x, y\}$. The cover must be chosen relatively to this set and has no access to the pluralities that constitute *x* and *y* respectively. Hence, the contrast between (104) and (105) is nicely accounted for, crucially exploiting the difference between a quantity or group *x* and the plurality or set $p(x)$ that constitutes it.

In Link style theories definite plurals (like "the pieces of furniture") and definite mass nouns (like "the furniture") denote different kinds of sums. Why then are reciprocals able to look at the inner structure of plural sums, but not at the inner structure of mass sums? It seems to me that such theories cannot offer an answer as straightforward as the one offered here. Evidently, it has to be assumed that, at least when combining with reciprocal predicates, the mass sum is packaged into a singularity (via suitable axioms or via type shifting). This can surely be done. But why should that be so? If there are mass sums distinct from count ones, why aren't reciprocals capable of partitioning both? And why isn't there a device just like reciprocals, but specialized for mass sums? On the present theory, the answer is: there aren't mass sums distinct from count ones. Mass definites denote singularities (i.e. groups) because they are morphologically singular.

While this account (as much as the argument) is, in essence, due to Gillon, I do not quite see how the implementation he proposes works. In Gillon's

approach the role of our sets is played by what he calls "aggregates" and that of covers by "aggregations". The domain of aggregates forms an atomic join semilattice and the denotation of nouns is drawn from it. The denotation of a definite singular count noun phrase must be something of size one. The denotation of a definite plural count noun can be something of size greater than one (cf. p. 620). It is not clear whether such denotations are aggregates or sets thereof. The denotation of definite mass noun phrases is the maximal aggregate satisfying the content of the noun. This maximal aggregate is viewed as something of size one (cf. p. 627). There are various possible ways of understanding this proposal. One might be as per the following chart:

(106)	<u>definite singular</u> <u>count NP's</u>	<u>denotation</u>	<u>size</u>
	the piece of furniture	aggregate	1
	the pieces of furniture	set of aggregates	greater than 1
	the furniture	aggregate	1

Under this understanding, the denotation of singulars and plurals is kept separate and some version of the treatment of reciprocals given above can be maintained. But it is difficult to see how the relevant denotations can be built out of the meaning of the common noun and the meaning of *the*, while keeping a uniform (i.e. non ambiguous) interpretation for the definite article. Alternatively, one can maintain that the denotation of *the pieces of furniture* is the maximal aggregate of pieces of furniture, but then it would have size one (just like the maximal aggregate of furniture) and we would no longer have a semantic distinction between singulars and plurals. We can try several variants of Gillon's strategy, but I see no way of coming to an approach compatible with his line on reciprocals and a uniform theory of the definite article, and one that, moreover, has fewer stipulations than my proposal.

Let us take stock. Besides accounting rather directly for the basic properties generally associated with the mass/count contrast, the Inherent Plurality Hypothesis has certain further empirical consequences: it predicts the actual synonymy of certain sentences involving mass and count nouns both intra- and interlinguistically. In particular it predicts that sentences containing phrases like *the pieces of furniture* and *the furniture* have the same truth-conditions, in spite of the fact that the denotation of these two phrases is not the same. The latter difference in denotation explains the different behavior of these phrases with reciprocals.

5. LANGUAGES WITHOUT COUNT NOUNS

In the present section I want to test the present theory against some typological facts. In order to count, we need to access homogeneous sets of atoms from our domain. This is what nouns do and they do it in two ways. The first is via count nouns that single out sets of atoms. The second is via classifiers that

apply to qualitatively uniform substructures of the domain (isolated via mass nouns and plurals) and partition them into discrete atomic cells. Clearly there is a certain redundancy here: we have two ways of counting. Could there be languages that have only one? How could this redundancy be eliminated?

There seem to be two logically possible ways. The first, which, however, we already found to be not viable, would be by making every noun countable. In such a language, the function PL would be total, i.e. defined for every predicate. The role of classifiers would be rather reduced, for in no case would they be indispensable to count the instances of a kind or the parts of a substance. However, we observed that the elementary parts of liquids, pastes and the like are not readily accessible to our cognitive system. The inherent characteristics of these objects make it impractical to count by referring to their elementary parts. Thus the non existence of these languages has a reasonable explanation. The second logically possible way to eliminate the redundancy is by making every noun mass and by doing the counting through classifiers. Now, there is no obvious a priori reason, grammatical or otherwise, why this option shouldn't be attested. Let us see what characteristics such a language is expected to have.

In a language of this sort, every noun denotes a (qualitatively homogeneous) sublattice of the domain. Since every noun is, as it were, inherently plural, there is no need for a plurality forming operator. PL will be undefined for every predicate and hence this language will lack a singular/plural contrast. In order to count the instances of a kind, we will need to resort to classifiers. This is so, because no noun individuates singularities and the domain regulator SG, which checks whether a predicate does, will be totally undefined. The classifier system of this language will have to be, conversely, rich enough to cover the entire lexicon. Moreover, since the indefinite article is just a variant of the first numeral, such a language will lack the indefinite article, i.e. there will be no morpheme that combines directly with a noun and means what *a* means in English. What about the definite article? Its role as maximality operator requires some discussion.

The definite article applies to a set and returns its greatest element. Suppose that we are in a language with no count nouns, where every predicate extension *X* is an atomic sublattice of the domain. Clearly, in such a language, we could uniformly retrieve *X* from $\text{Max}(X)$. Let me illustrate by means of an example. Consider a plurality $\{a, b, c\}$. In English such a plurality could be obtained via *Max* in one of two ways:

- (107) a. $\text{Max}([\{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}]) = \{a, b, c\}$
 b. $\text{Max}([\{a, b, c, \{a, b\}, \{a, c\}, \{b, c\}, \{a, b, c\}]) = \{a, b, c\}$

In case (105a) such a plurality would be the supremum of a plural *count* predicate extension. In (105b), it would be the supremum of a *mass* predicate extension. Just by looking at $\{a, b, c\}$ we couldn't tell from which of these two predicate extensions it comes from. But if we are in a language where every noun is mass, there is no choice. Case (107a) is impossible. The only option is

(107b). This means that in such a language noun denotations and their maximal elements will be in one-one correspondence: they codify the same information. But then, once the extension of a noun is set, what use will there be for *Max*? It would be reasonable to expect that such an operator is left unused. So the present theory offers some reasons to expect that languages in which every noun is mass have no use for the definite article, i.e. a morpheme that combines directly with a noun and means what *the* means in English.

Summing these considerations up, while it is implausible that there be a language where quantification goes exclusively through sets of atoms (i.e. a language where all nouns are count), there can well be languages where all nouns are interpreted as atomic **U**-closed subsets of the domain. Such languages are expected to have the following characteristics:

- (108) a. Absence of PL
 b. generalized classifier system
 c. tendential absence of definite and indefinite article

As is well known languages with these characteristics indeed exist. The following examples are taken from Chinese:

- (109) a. yí lì mǐ
 one CL rice “one (grain of) rice”
 b. liǎng lì mǐ
 two CL rice “two (grains of) rice”
 c. yí zhāng zhuōzi
 one CL table “one (piece of) table”
 d. liǎng zhāng zhuōzi
 two CL table “two (pieces of) tables”

These examples illustrate in what sense Chinese does not seem to differentiate between mass and count nouns: every noun can combine with numerals only through classifiers; moreover these examples evidenciate the absence of plural morphology. It is also well known that Chinese lacks both the definite and the indefinite articles.

The above considerations are still largely speculative, as NP structure in Chinese is less well documented and agreed upon than, say, in Germanic or Romance. Moreover, it should be emphasized that we are talking here of *lexical* items. The idea that the extension of all common nouns is mass applies to them as they come out of the lexicon. This is perfectly consistent with the possibility that the mass/count distinction reemerges at some phrasal level. After all, liquids and solid objects form different natural classes and classifiers might well be sensitive to such a distinction. So, for example, some classifiers might make a noun count, while others might keep them mass, depending on intrinsic properties of the noun denotation. Assuming that at the lexical level every noun has a mass extension enables us to reduce the typological characteristics listed in (108) to one simple lexical switch. We seem to be dealing here with a form of semantic variation. In light of the results of the Principles and

Parameters framework, a rather intriguing hypothesis arises: we might have run into a semantic parameter. In the rest of this paper, I am going to explore this possibility, albeit in a preliminary and somewhat impressionistic manner.

Saying that the extension of a noun is mass, is to say it is the ideal $\pi(x)$ generated by some plural individual x . For each mass noun, there is a plural individual x of which the noun extension constitutes the ideal. Now we might think of plural individuals as kinds, in the sense of Carlson (1977). For example, the dog-kind, can be thought of as the totality or sum of all individual dogs, the discontinuous entity constituted by all the dogs.²⁸ We might then say, building on an insight of Krifka (1995), that common nouns in Chinese are not predicates but names of kinds. More generally, every member of the lexical category *N* is a name of something: if it names a singularity, we have a proper name, if it names a plurality, we have the name of a kind. However, nouns must also serve as quantifier restrictions and as predicate nominals. To fulfil this role, they will have to be turned into predicates. It is natural to assume that this will happen via the operator π . We might assume, in other words, that, whenever necessary, the kind x denoted by a noun is automatically shifted to a predicate by taking the ideal $\pi(x)$ generated by x . But this means that we are going to get mass predicates throughout.

In this way, the typological properties of Chinese would appear to fall into place. Consider for example (109d). Assume that *liǎng* “two” is a quantifier with the same meaning as its English counterpart. It looks for a restriction. The noun *zhuōzi* “table” is a name for the table-kind. We can turn it into a predicate $\pi(zhuōzi)$. However, *liǎng* cannot apply directly to it, because $\pi(zhuōzi)$ is mass. *Liǎng*($\pi(zhuōzi)$) is ungrammatical for the same reason that *three furnitures* is. A classifier, in the case at hand *zhāng*, is needed to individuate a level suitable to counting. Furthermore PL, the interpretation of the plural morpheme is, as we saw, a predicate modifier. But $PL(\pi(zhuōzi))$ will be undefined, again because $\pi(zhuōzi)$ is mass.

This way of looking at things has a further interesting consequence. Common nouns are in a way assimilated to proper names in Chinese type languages. They are names of kinds. Kinds are individuals, just like you and me. And individuals can be taken as arguments by predicates. So just as we can say “I saw John”, in Chinese type languages we would expect to be able to say things like “I saw bear”, without any determiner. This ought to mean something like “I saw the bear-kind” or “I saw that kind of animal (yesterday at the zoo)”, which means roughly “I saw instances of that kind”. As is well known, this expectation is borne out:

- (110) wò kànjiàn xióng le
 I see bear ASP “I saw (some) bears” (from Krifka 1995)

We can systematize the above considerations as follows. Following Montague’s notation, let e be the type of individual, and $\langle e, t \rangle$ the type of predicates. What we are saying is that in Chinese type languages, the following correspondence holds:

(111) $N \Rightarrow e$

The syntactic category N is mapped onto the semantic type e . This means that members of that category take individuals (singular individuals or kinds) as their semantic value. The following properties can all be derived from this single constraint:

- (112) a. Every noun extension is mass.
 b. There is no plural marking.
 c. A numeral can combine with a noun only through a classifier.
 d. There is no definite or indefinite article.
 e. Nouns can occur bare in argument position.

What about English? English has none of the characteristics in (112). However, it has the mass/count distinction and, interestingly, mass nouns, unlike singular count nouns, can occur bare as arguments:

- (113) a. Water is dripping on the floor.
 b. John saw water on the floor.
 c. *Table is in the corner.
 d. *I saw table in the corner.

This suggests the following possibility. Mass nouns are names of kinds. Count nouns are, instead, predicates. Being names of kinds, mass nouns can freely occur bare in argument positions. To be turned into quantifier restrictions (or predicate nominals), the π -operator will have to be used, which will give them a mass extension. Whence, the impossibility of being pluralized, and the behavior with quantifiers we have seen in the previous sections. This means that the category-type mapping for English is:

(114) $N \Rightarrow e, \langle e, t \rangle$

The way to interpret (114) is that members of the syntactic category N can either denote individuals or predicates. If a noun lexically opts to denote an individual, there are two possibilities. It either denotes a singular individual, in which case we will have a proper name. Or it applies to a plural one, i.e. a kind, in which case we will have a mass noun. If instead a noun opts to denote a predicate, we will have a count noun.

The hypothesis that bare nouns denote kinds is of course well known from G. Carlson's seminal work. He motivated it primarily for bare plurals, but noted that his approach extended to mass nouns as well. Now the question that has to be asked is: if our perspective is on the right track, why can bare plurals (which are count) occur as arguments? Answering this takes more space than we have here. I can merely indicate a line to follow, which is directly suggested by the logic of our hypothesis. The type assignment in (114) is compatible with nouns being either arguments or predicates. This must mean that a noun can start out in a certain way, but during the computational process, it can be wind up in a different way. We have argued that mass nouns

start out as names of kinds. However, when they occur in quantifier restrictions, they get shifted via π . So, for example, the meaning of "no water" is something like $\text{NO}(\pi(\text{water}))$. By the same token, we can expect that in a language with the type assignment in (114), count nouns (that come out of the lexicon as predicates) can be shifted to the corresponding kind. The shift amounts to going from the extension of a predicate P to its largest member, the discontinuous object made up of all the things satisfying the predicate (viz. ιP). However, this makes sense only for *plural* count nouns. The ι -operator applied to a singular is either undefined (whenever the noun is true of more than one thing) or it is not a kind. This is why plurals can occur as bare arguments but singulars cannot. Although important details remain to be worked out, this looks like the beginning of a plausible explanation for the parallel behavior of mass nouns and count plural ones.

By looking at the category-type associations in (111) and (114), anyone will immediately realize that there is a final logical possibility to consider, namely:

(115) $N \Rightarrow \langle e, t \rangle$

In a language with this category-type constraint, every noun will be a predicate. This does not mean that the mass/count distinction is not attested. Such a distinction concerns primarily the extension of a predicate, as we saw throughout this paper. So in such a language mass nouns will have the ten properties discussed in 1.2. But no noun (count or mass, singular or plural) will be able to occur by itself as a bare argument, for predicates are of the wrong logical type for that. So in a language with the type assignment in (115), one would expect to find the mass/count distinction in the familiar way, with the exception of the possibility of occurring bare. French seems to fit this characterization.

- (116) a. *trois laits
 b. *Je veux lait

Wrapping up, the system we have sketched governs the correspondence between the syntactic category N and semantic types or denotation spaces it corresponds to. We can think of it as a system with two binary features, $\pm \text{arg}$, $\pm \text{pred}$. A $+\text{arg}$ specification means that nouns can denote individuals (of type e); a $-\text{arg}$ specification, that they cannot; similarly for $+\text{pred}$ and $-\text{pred}$. This gives us four possibilities; but the $[-\text{arg}, -\text{pred}]$ choice is ruled out by the requirement that nouns have to be interpreted. The range of options we get is thus:

- (117) $N \Rightarrow [+ \text{arg}, - \text{pred}]$ Nouns can be of type e , cannot be of type $\langle e, t \rangle$ (Chinese)
 $N \Rightarrow [+ \text{arg}, + \text{pred}]$ Nouns can be of type e , can be of type $\langle e, t \rangle$ (English)
 $N \Rightarrow [- \text{arg}, + \text{pred}]$ Nouns cannot be of type e , can be of type $\langle e, t \rangle$ (French)

This seems to constitute a pleasingly simple system where a cluster of properties of the nominal system can be reduced to two simple lexical switches governing how the reference of things of category *N* can be set.²⁹

Suppose, now, that we view the mappings in (117) as a parameter, a dimension across which languages may freely vary. How would it be possible for the child to learn what the right setting is in her language? On the face of it, the answer doesn't seem to be harder than for any other parameter that has been proposed: parameters are learned through their overt morphosyntactic manifestations, on the basis of something like the subset principle (cf. Wexler and Manzini 1987) or whatever subsumes its effects. In particular, it seems plausible to maintain that the child assumes that the unmarked setting is [+arg, -pred], which is the most restrictive and entails, e.g., the absence of plural marking, the obligatory presence of classifiers with numerals and the absence of articles. Encountering plural morphology or articles, or the failure of classifiers to appear with numerals would constitute the evidence prompting the child to switch to $\langle e, t \rangle$. This requires that these phenomena are mastered in acquisition fairly early on, for otherwise a child exposed to, say, English would have to stick to a Chinese-like grammar until late stages of the learning process, an implausible consequence. Indeed, empirical research shows that, at least for plural morphology, the child appears to master it rather early on (cf. De Villiers and De Villiers 1973). If it turns out to be correct that at the initial state the parameter is set to the Chinese option, then, in a way, Quine (1960) is vindicated: the child does go through a phase where *N* is mapped onto *e* and hence every noun is mass. But this by no means entails that the psychological concept of "solid object" or the logical ones of "individual" and "domain of quantification" arise through language, as Quine would have had it. Much to the contrary, acquisition has to be driven by these very concepts (i.e. a structured domain of the kind we have hypothesized).

If the child finds out that his language is not Chinese, through the readily accessible positive evidence we mentioned, he will revert to the second most restrictive option, namely the French one, which simply bans bare nominal arguments across the board. Finally, upon seeing that bare arguments of a certain kind persist, in spite of the presence of plural morphology, etc., the child will revert to the English-like setting. So the expected order of acquisition is *Ns*-as-argument $\Rightarrow$ *Ns*-as-predicates $\Rightarrow$ *Ns*-as-both. The switches can all in principle be made on the basis of positive evidence alone. This makes rather detailed predictions concerning the actual acquisition path. But we cannot explore them here.

If this is correct, our proposed semantic parameter is learned through its syntactic manifestations, and it is hard to see how else it could be. In fact, hypothetical semantic parameters of the kind we are beginning to explore appear to be better off than what sometimes happens in syntax, where the formulation of a parameter can make reference to "hidden" aspects of phrase structure (e.g. the "strength" of abstract features that occur in a given node), while its acquisition must be triggered by some of its "concrete" manifestations

(e.g. the actual occurrence of certain morphemes in certain positions). The reason why it is legitimate to regard the parameter proposed here as "semantic" is that it is most naturally couched in a semantic vocabulary (one that employs the notion of logical type, which governs how denotation is set). We can of course say, if that makes us happier, that the parameter is really the presence vs. absence of plural morphology, plus the possibility of occurring bare as a bare argument, and what not. But the question is whether the result is any different and/or any more enlightening than what we have. We know that whether a certain cluster of grammatical differences is to be accounted for in syntactic or in semantic terms (or by some combination of the two) is a purely empirical issue. In the present case, direct appeal to semantic notions has the advantage of identifying the principles governing a class of phenomena (plural marking, classifier systems, presence of the article) that it is not clear have a non ad hoc account on syntactic grounds alone. Within the generative tradition, the notion of semantic parameter has so far been surrounded by (sceptical?) silence. At least, we can now address the question of their existence on clearer empirical grounds.

There are a couple of further consequences of the present view that are worth bringing out. If we were to attempt a word-by-word translation of Chinese phrases like (109), we would have to go for something like:

- (118) a. two standard portions of tablehood
b. two flat bodies of table

Confronted with phrases of this sort, infamous considerations as to how Chinese and English may "carve reality in radically different ways" would seem hard to resist. As Pinker (1994) remarks, from clumsy translations of this sort to a radical relativism à la Sapir-Whorf, there is a short step. Our conclusions are quite different and confirm in a semantic domain the discoveries made in syntax over the past 20 years. There is no significant difference between how reality is structured in Chinese and in English. Both systems enable us to talk about the very same stuff and to make the very same distinctions through abstract structures of a particular kind: atomic, join semilattices. There is every reason to think that structures of this kind are part of Universal Grammar (UG). At the same time, different languages may opt to exploit the universal structure that UG makes available in a limited number of different ways. In the case at hand, changes are limited to the category-type map.

Our approach makes in a precise form certain distinctions, like for example:

- (119) a. atoms vs. pluralities
b. count noun extensions (sets of atoms) vs. mass noun denotations (**U**-closed sets of atoms)
c. groups vs. non groups

Are these grammar internal distinctions or are they lifted from some other domain?

The physical interpretation of the distinction is not in question. The relation between the denotation of common nouns like *water* and its physical make up is clear (once the vagueness of the natural language term is factored out): *water* denotes aggregates of molecules of water. At the same time it is also clear that English can refer to the same physical amount in two ways: through mass terms and through count ones. Thus, it is evident that the root of the distinction does not lie in the physical structure of referents, even though, as we have seen, such structure may contribute to determine the mass or count character of a noun.

There also doesn't seem to be any obvious correlation between the mass/count distinction and some pre- or extralinguistic psychological notion. It has emerged from recent experimental work (e.g. Spelke 1985, Soja et al 1991) that our cognitive system is endowed with clearly identifiable notions of "solid object" vs. "non-solid substance", which seem to be active even in the pre-linguistic child since the earliest stages of his cognitive development. These notions are defined by Spelke as follows:

- (120) a. A solid object is something that is bounded, cohesive and moves as a whole through continuous paths.
 b. Non-solid substances are not cohesive or bounded and do not retain their internal connectedness or external boundaries as they move and contact one another.

From our point of view, it is interesting to remark that these psychological concepts do not correspond with any of the distinctions in (120). "Solid object" does not coincide with "atom" or "count noun denotation" and "non-solid substance" does not coincide with "plurality" or "mass noun denotation". Surely bread and furniture qualify as solid objects (while being mass) and drops of waters or gusts of wind qualify as non-solid (while being count).

Finally, there is no compelling logical reason or communicative pressure that would induce a language to build into its grammar anything like the mass-count distinction. From a logical point of view, there are going to be an infinite number of abstract structures that could be used to convey in a compact form the same information that natural language conveys. What we express in the logic we have adopted could be expressed in many other logics in no more complex ways and without ever resorting to anything like the mass/count distinction. From a pragmatic point of view, Gricean maxims or anything having to do with felicitous communication, exchanges would certainly not prevent us from having a language where instead of saying things like "there is a little water on the floor" we would have to say "there are a few water drops on the floor".

How does this square with my claim that given the characteristics of our perceptual apparatus, liquids will tend to be classified as mass? The point is that my claim makes sense only under the assumption that the domain has the structure we have hypothesized. Given the option of classifying something by reference to its minimal parts or by reference to any homogenous aggregate of

the appropriate kind, why should we go for the first when the relevant minimal parts are hard for us to grasp? If, however, we *wouldn't* have a structural characterization of atom vs. non atom, we simply would have no choice. And if the domain would have a different structure (say the structure of a full blown model of set theory), the choices would be different.

So, at the present stage of our understanding, the mass/count distinction does not appear to be reduceable to any physical notion; it does not appear to be based on any pre- or extralinguistic psychological feature of our cognitive system; it does not descend from logic; it does not arise purely as a response to pragmatic needs. It is hard to avoid the conclusion that we are dealing with a domain-specific architectonic feature of grammar, resembling, say, agreement or movement. But unlike agreement or movement, the mass/count distinction seems to have to do with how reference is set.

6. CONCLUDING REMARKS

In this paper we have explored the idea that the denotation of mass common nouns differs from that of count common nouns merely in the fact that the former come out of the lexicon already pluralized. So, while singular count nouns single out a set of atoms (thereby individuating a level suitable for counting), mass nouns do not. This enables us to account in a principled manner for the similarities between mass nouns and plurals as well as for the differences between mass and count nouns. We have offered, on this basis, an analysis of the distribution of quantifiers. We have proposed, moreover, somewhat speculatively that languages that don't have count nouns (at the lexical level) differ from those that do in the type of their denotation: in languages with no count nouns the denotation of the noun is the maximal aggregate of entities of the appropriate kind; in languages with mass nouns, lexical nouns are predicates true of atoms (if the noun is count) or of pluralities of atoms of the appropriate kind (if the noun is mass). This has been couched in the form of a semantic parameter. In so far as I can tell, we have the makings of a truly minimal theory of semantic variation in this domain. But it should be borne in mind that the issue of whether the notion of "semantic parameter" is viable is independent of the theory of mass nouns developed here. One can buy the latter, while deriving the related crosslinguistic differences in more traditional ways.

Besides the specific merits or demerits of the present proposal, there are some general consequences that appear to descend from it. The first is that the interpretive domain is simpler than most people seem to think: there is no mass domain distinct from the count one. We can do without unexplanatory notions like "atomless substance". The second is that there is some limited variation in semantic structure, or at least in the way it is linked to syntactic structure. The third is that if indeed for every plurality there is a group (i.e. an atom) that corresponds to it, then some kind of non-standard set theory (such as, for example, property theory) must underlie the interpretive component of

grammar. These are fairly far reaching consequences. Whether the hypothesis we have developed turns out to be as much on the right track, as the evidence considered here suggests, remains for further, more detailed analysis of cross-linguistic variations in NP structure to determine.

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NOTES

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¹ Assume, for the sake of argument that these terms are perfect synonyms, modulo their difference in (un)countability. We will return to the relevant issues below.

² For a good overview of the issues and extensive bibliographical references, see Pelletier and Schubert (1989).

³ If there is a null determiners in bare nominals such those illustrated in (a), then it would belong to this class

(a) Mary saw water/bugs on the floor.

⁴ On this, the classical reference is Carlson (1977).

⁵ For example, the distribution of bare nouns differs significantly between English and Spanish or between Spanish and French. See e.g. Contreras (1986), Torrego (1989), Delfitto and Schroten (1992). See also Chierchia (1996) where a general theory of bare arguments on the basis of the present view of mass nouns is developed.

⁶ We need a proviso here that if X is a singleton, i.e. if $X = \{u\}$ for some u , then $\mathbf{U}X = u$ (rather than $\mathbf{U}X = \{u\}$ as (15) would have it). This inelegance could be avoided if we modeled individuals as singletons (cf. Landman 1989), or if we adopted what Schwarzschild (1991, 1996) calls "Quine's innovation". I find the structure in (12) easier to grasp intuitively, even if, as the reader will see, from a formal point of view it makes life slightly more complicated.

⁷ 'i' corresponds to Link's σ -operator. 'X' is Link's notation.

⁸ Strictly speaking, $\text{PL}(A)$ is a characteristic function and hence should be defined along the following lines:

$$\text{PL}(A)(u) = \vdash A(u) \wedge \forall u' [[\text{At}(u') \wedge u' \leq u] \rightarrow A(u')]$$

⁹ The following sentence is not contradictory:

(a) No man lifted the piano by himself. John and Bill did lift it together.

However, the presence of the modifier *by himself* is crucial to rescue the sentence in question from contradictoriness. Such a modifier evidently restricts the interpretation to singularities.

¹⁰ See Landman (1996) for a very articulated and rich event based approach compatible with our assumptions.

¹¹ See Landman (1989b) for a related notion of groups as "sets under a guise".

¹² See, e.g. Chierchia (1983) or Chierchia and Turner (1985). Straightforward cardinality considerations prevent us from developing the construction outlined in the text using standard set Zermelo-Fraenkel set theory. The conditions in (27) require each set (of atoms) to have a corresponding group among the atoms. I.e. there has to be a one-one function from sets into atoms; but the sets constructable out of the atoms is essentially bigger than the atoms.

In case one goes for the first approach outlined in the text, reference to a grouping criterion will be implicitly assumed. I.e. wherever I write g , it should be understood as g_p . It should also be noted that in a way, our g -function corresponds to the operator ' $\uparrow$ ' of Landman (1989a). The structure of plural domains developed by Landman can be regarded as a way of developing

"vertically" what we are developing in a flat, "horizontal" way. Another difference is that we are leaving open the possibility of groups belonging to themselves.

¹³ I abbreviate $g(\{a, b\})$ as $g\{a, b\}$.

¹⁴ Similar conclusions are reached independently in Landman (1995).

¹⁵ Strictly speaking, p is undefined for ordinary individuals, so if $C(u)$ picks a set of ordinary individuals, definition (37) has to be modified by replacing p with a function p^* such that:

i. for any group x , $p^*(x) = p(x)$

ii. for any ordinary individual x , $p^*(x) = x$.

¹⁶ One straightforward way to make PL undefined for mass nouns is to restrict its domain to subsets of At. However, on contradictoriness as a sufficient ground for ungrammaticality, see, e.g., Barwise and Cooper (1981), Chierchia (1983, ch. III), Schwarzschild (1991, 1996) among many others.

¹⁷ This point is very nicely made, in a different context, in Kratzer (1989).

¹⁸ Definition (49a) doesn't work for downward monotone quantifiers like "at most n ". Furthermore, I am ignoring here predicative NP's (which, however, can easily be accommodated). Moreover, I am assuming that the second argument of the generalized quantifier has been already shifted via the function $[[\]]_C$.

¹⁹ Actually, if a mass noun N has an empty extension, something like "three N 's" would come out as false rather than undefined (because $\emptyset \subseteq \text{At}$). Similarly if N 's extension is a singleton. These oddities can be straightened out by making SG intensional. Then the problem would remain of necessarily empty properties. SG still wouldn't distinguish necessarily empty mass properties from necessarily empty count ones. People that cannot live with that will have to resort to more intensional views of properties, such as Property Theory (cf. Chierchia 1983, Chierchia and Turner 1985). For an interesting discussion of mass nouns in Property Theory (that goes in a different direction from the one explored here), see C. Fox (1993).

²⁰ Measures phrases can be used predicatively. Their predicative meaning can be obtained via Montague' BE, from generalized quantifiers.

(a) BE(three pounds of rice) = $\lambda x [\text{rice}(x) \wedge \text{pound}(x) = 3]$.

This could also be the meaning involved in relative clause modification like:

(b) The three pounds of rice that I brought in that store

A full treatment of these phenomena would require a more thorough analysis of the syntax of NP. See e.g. Selkirk (1977) for a classical reference.

²¹ Here is one way of formalizing the semantics of "the" discussed in the text:

(a) the $(X) = \begin{cases} i(X), & \text{if SG}(X) \text{ is defined} \\ g(i(X)), & \text{otherwise} \end{cases}$

²² Although in the text I focus on the non proportional reading, the point I want to make goes through also for the proportional one. On the various readings of "many", see, e.g., Partee (1988).

²³ Higginbotham (1995) appears to suggest that the difference between mass and count quantification is that the former is always based on an underlying measure function while the latter never is. Such a generalization, if intended, would be wrong in both directions. As the text makes clear, there are important mass quantifiers that are not based on an underlying measure and there are plenty of count ones that are.

²⁴ I owe this point to Chris Fox.

²⁵ A caveat. Italian distinguishes between *capello* (which is a threadlike growth on the upper part of the head) and *pelo* (which is a threadlike growth from anywhere, excluding the top part of the head).

²⁶ C. Fox (1993) works out an interesting approach (based on property Theory). His idea is that count nouns are those whose atomicity can be proven as a theorem of semantics. Mass nouns are those that cannot be. This entails that the word for "hair" must be shown to be atomic in Italian but not in English. The question is whether this is substantially different from simply attaching the label "count" to certain nouns and not others. The intuition that the mass count distinction has to do with "real world" reference gets muddled.

²⁷ These considerations apply, I believe, to mereological approaches like Montague (1973) or Bunt (1985) as well as to more recent algebraic approaches like Lonning (1987) or Higginbotham (1995). However, I cannot get into a detailed discussion of these alternatives within the limits of the present work.

²⁸ This view of kinds is too extensional, as noticed already in Carlson (1977). Intensionality has to be brought in. But I cannot do this within the limits of the present paper and must ask the reader to bear with me just for the argument's sake. See Chierchia (1996) for further developments.

²⁹ In Chierchia (1996) it is argued that the difference between French and English holds in fact throughout the Germanic vs. Romance families.

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