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How universal is the mass/count distinction?
Three grammars of counting.

1. On the (non) universality of how we count

The mass/count distinction manifests itself in very different ways across different languages, to the point that doubts have repeatedly been put forth as to whether such distinction is universal.[1] This is what this paper investigates: is there a universal mass/count distinction, in spite of a prima facie huge diversity in the grammars of counting? If so, what is its basis?

The heart of the mass/count distinction is how we count. Things in the world arguably fall into natural kinds, classes, or sorts: sets whose members are identified by common qualitative traits. Cats, chairs, sailors, Italians, etc. are kinds of things. Gold, sand, blood, etc. are kinds of substances or 'stuff'. Cats and the like come organized into units that can be counted. Gold and the like do not. Gold can of course be measured along several dimensions: its mass can be measured in, e.g., kilos; its purity can be measured in carats. 'Measures' or 'ways of measuring' can be thought of as functions from entities into numbers; for example $\mu_{KG}(x) = n$ tells us that the mass (or weight) of x in kilos is n. Another important example of a measure function is 'cardinality' that applies to sets or classes; if x is a set, its cardinality $\mu_{CARD}(x)$ (often notated in set theory as $|x|$) is the number of its members. The universe of measures is as diverse as the universe itself.

The view just sketched presupposes two macro categories, loosely denoted as 'things' (or 'objects') vs. 'substances' (or 'stuff'), where objects come in natural units and substances do not. In particular, cats are pluralities of individual cats, which have a natural cardinality based measure: the number of cats in a particular plurality. This macro-distinction between objects and substances can be made in slightly different but ultimately equivalent terms as follows. There are natural ways of measuring things along some of their most salient dimensions. Cats can in principle be measured in terms of their mass (kilos, or the like); but they are most typically measured in terms of their natural units; if x is a plurality of cats, we tend to 'measure' it in terms of a function like $\mu_{NU}(x)$ which gives us the number of cats in x (a cardinality based measure); gold, on the other hand, is measured most naturally through a mass based measure (like grams or the like); if x is gold it is hard to imagine what $\mu_{NU}(x)$ would yield, for there are many ways in which gold comes in nature or conventionally packaged.

An important point that I think has emerged from much research over the past thirty years or so is that the distinction between objects and substances as outlined above is not about a 'way of speaking'. It is not, that is, a distinction based in language/grammar. This is so because human infants seem to make it at few months of age, *before* developing language. And so do other non human species, that cannot be said to have language in the

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[1] For recent stands on this, see Wiltschko (2010), Lima (2010), Darlymple and Morfu (2012). For an early discussion of the relevant issues, see the essays in Pelletier (1979), and Pelletier and Schubert (1989).

same sense in which humans do. Research by cognitive psychologists like S. Carey and E. Spelke provides rich evidence that pre-verbal infants make a distinction between objects and substances very close to the one we are after.[2] Objects are expected to be 'bounded' (i.e. endowed with natural boundaries), cohesive (i.e. with parts that 'stick together'), to move across space along continuous paths, and to retain their identity upon aggregating (or colliding) with other objects, while substances have none of the above properties. The evidence that shows that pre-verbal children make this distinction is varied and carefully controlled. A typical experimental paradigm used in this connection is the following. An object (say a teddy bear or a toy car) is displayed in front of an infant. Then a screen goes up and the child sees a second object of the same type being placed behind it. At this point, the screen goes down and one of two things happens, depending on the experimental condition. In the 'expected' condition, the child sees *two* objects and she shows no sign of surprise. In the unexpected condition, thanks to an experimental manipulation, the child finds only *one* object; and she reacts with great surprise. No similar reaction is found in control conditions with substances like sand or clay. The conclusion is that the pre-verbal child, as it were, expects or 'knows' that if you add a toy car to a toy car you should get *two* toy cars; and if you add one car to two cars you should find *three* cars. But if you add sand to sand, you do not get two sands. Similar experiments have been replicated with rhesus monkeys and even with mammals lower down on the evolutionary scale.[3] This capacity is linked to the existence of two different modes of counting/measuring that humans share with non-human mammals (two counting/measuring functions if you wish). One is precise and applies to discrete objects, and only works for up to three objects (e.g. the rat knows that one cheese ball plus one cheese ball is two cheese balls, and if you add one more you get three; after three its tracking system crashes); the other measure function is continuous and approximate and applies to any amount of objects or stuff (if two piles of food are sufficiently different, the mouse rapidly learns to hone onto the larger one). These two ways of measuring enable pre-verbal children/non-human primates etc. to track objects and substances differently.[4]

So there are two categories, linked to two modes of measuring/counting present across a variety of human and non human species and this brings up considerations directly relevant to our inquiry. The first is that the distinction between objects and substances, as outlined, is not in any sense 'conventional' or 'formal' or 'arbitrary'. A car is an object, some sand or some clay is not. The human infant or the rhesus monkey has no choice on whether to categorize something as an object vs. a substance. The second consideration is that we are clearly dealing with a pre- or extra-linguistic distinction. This is not the place to speculate whether the object/substance distinction is rooted in some extra-mental aspect of reality or in some very general categorization schema shared across species and widely used to conceptualize reality. What matters in the present context is that there is no other reasonable conclusion but the independence of the categories of substance vs.

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[2] The bibliography on this is abundant. See for example Carey (1985), Carey and Spelke (1996), Soja Carey and Spelke (1991).

[3] See, e.g., Hauser and Carey (2003), Hauser and Spauldoing (2006).

[4] Cf. Spelke and Dehaene (1999), Feigeson, Carey and Spelke (2002).

object from linguistic categories in the narrow sense, if the line of research above is on the right track.

Usually, by mass/count distinction one refers to linguistic phenomena that somehow track the substance/object distinction. And now perhaps the question whether such a distinction manifests itself across all languages acquires a more determinate sense. Generally speaking, we may wonder how systematically the contrast between substances and objects is reflected in grammar, particularly in those aspects of language having to do with counting, quantifying and measuring. Let us refer to all of those jointly as the 'grammar of counting'. It is evident that the English grammar of counting seems to be pervasively affected by the contrast (and we shall review how shortly). Put in other terms, English has a robust grammar of mass vs count. So do all other Indo European languages. The next question is: is every language similarly affected? What are the range of ways in which a language may code the distinction between substances and objects? Are there languages in which *no* systematic reflection of the distinction is found? The hope is that by asking questions such as these we may find a particularly perspicuous way of understanding the relationship between grammatical categories in the narrow sense and extra-grammatical ones.

In what follows, I will first discuss the mass-count distinction in English and sketch an epistemic approach to it (where it is not 'atomicity' per se that matters but 'epistemically ascertained' atomicity/lack thereof). Then I will compare the English grammar of mass-count with that of rich classifier languages, such as Mandarin, on the one hand, and with languages with a 'sparse' classifier system, such as Yudja, on the other.[5] Both such languages have been claimed to lack the mass-count distinction. The epistemic take to be presented below lends itself to accounting for these three extremely diverse language systems in terms of elementary parametric switches. This will facilitate an assessment of the (non) universality of the mass-count distinction. [6]

2. Mass vs. count in English.

The mass-count distinction in English is extremely rich and fairly well chartered, so much so that we won't be able to do full justice to it within the limits of the present paper. I will presently review five aspects of the mass-count distinction that jointly serve well the purpose of illustrating its most problematic aspects. The five properties I will discuss involve (a) pluralization and counting, (b) measure phrases, (c) so called psuedopartitive constructions with phrases like *quantity of*, *amount of*, etc. (d) so called fake mass nouns (like *furniture*, *footwear*, etc.) and (d) ambiguous nouns (like *beer*, *rope* or *chicken*) and coercion (like *there is apple in the salad*). In presenting this phenomenology, I will have to oversimplify things greatly but, I hope, without being too misleading.

2.1. Some difficult test cases for the mass/count distinction.

Pluralization and counting are a primary way of teasing apart count nouns from mass ones, at least in languages that obligatorily mark number on nouns. Lexical count nouns

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[5] For Yudja, I will heavily rely on Suzi Lima's work, as it appears through, e.g. Lima (2010) and through our conversations on this matter.

[6] The approach I will be presenting is based on Chierchia (2010).

naturally pluralize and directly combine with numerals; lexical mass nouns do not. The former typically denote objects, the latter substances:

(1) Pluralization and counting.
    a. i. table/tables; cat/cats, etc.
      ii. blood/*bloods; salt/*salts, etc.
    b. i. Those tables are three   ii. I bought three tables
    c. i. *That blood is three   ii. *I donated three bloods
    d. i. That blood is three ounces/drops   ii. I donated three ounces of blood

I refer to numeral-noun constructions like *three cats* as NumPs ('Number Phrases'). Measure Phrases like *three kilos of* typically form so called pseudopartitive constructions;[7] they combine with both lexically count nouns, which have to appear in the plural, like *apples* (2a), and with mass nouns (2b). In the case of mass nouns, the insertion of a measure phrase is obligatory if one is to use a number:

(2) Measure phrases in psuedopartitive constructions
    a. three (kilos of) apples   b. three *(kilos of) salt

A special class of pseudopartitives involves words like *quantity* or *amount*. Like genuine measure phrases, they can combine with both mass and count nouns.

(3) Quantities and amounts
    a. i. that quantity of apples   ii. those apples
    b. i. that quantity of water   ii. that water

The characteristic of these constructions is that they are typically used to refer to the very same things as the corresponding noun they are in construction with; the word *quantity* doesn't seem to add much to the noun it modifies.[8] For example, the noun phrases in (3a.i) and (3a.ii) will denote the same plurality of apples; yet (3a.i) is grammatically singular, while (3a.ii) is grammatically plural. Accounting for this observation is not

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[7] A precise characterization of partitive vs pseudopartitive is a complex matter. At a descriptive level, partitive constructions are those in (a), with a definite inner noun; pseudopartitives (cf. bi-ii) differs from the latter in that the inner noun is determinerless (and hence indefinite).
    (a) i. three kilos of that flour
        ii. two quantities of the pizza
    (b) i. three kilos of flour
        ii. Two quantities of pizza
An early and still very useful characterization of the constructions in (a) and (b) can be found in Selkirk (1977); for a more recent discussion, see, e.g. Stickney (2009).
[8] As Greg Scontras pointed out to me, the noun phrase in (3a.i) and (3b.i) also have a very different reading that can be made salient in contexts of the following ort:
    (a) Tomorrow, I would like you to bring me that quantity of apples again
This 'amount' reading requires a different analysis, which we cannot get into here.

trivial, as it turns out.[9] By the same token, (3b.i) and (3b.ii) refer to the same stuff; but (3b.i) is grammatically a count construction (it pluralizes, etc.), while (3b.ii) is grammatically mass (it doesn't pluralize, etc.). At one level, one may want to think of *quantity of* and the like as measure phrases; but they also have something in common with words like *group of*, *aggregate of*, etc. The reason to bring them up is that they seem to raise special problems, in that it appears that the plural/singular and object/substance contrasts become void of semantic content when such words are involved. Understanding *quantity of*-phrases is important also from a crosslinguistic point of view as they may be playing a key role in the grammar of languages with a 'sparse' mass-count phenomenology like Yudja, to be reviewed below.

The fourth phenomenon mentioned in the above list involves nouns associated with kinds of objects but appear to act as grammatically mass. They typically involve superordinate nouns like *furniture*, *jewelry*, *footwear*, etc.

(4) Fake mass nouns
    a. * I bought three furnitures yesterday
    b. This table is good furniture
    c. * This piece of my desk is good furniture

Examples like (4b) are meant to show that nouns like *furniture*, though 'superordinates', are not collective: a single table or chair is furniture; examples like (4c) show that *furniture* does come in natural units much like count nouns do: a part of a table is not furniture, just like it is not a table.[10] These nouns are interesting because they clearly show that grammar introduces a degree of freedom of categorization with respect to the distinction individuals vs. substances. While the pre-verbal child has no choice as to how to conceptualize a table (it has to be an object, not a substance) an English speaker does have a choice here: tables can be conceptualized as pieces of furniture or as furniture.

Finally, some nouns appear to be just about equally felicitous in mass or count frames. Moreover, mass nouns can be coerced into count ones and count nouns into mass ones, with greater or lesser degrees of felicity, depending on the context.

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[9] For example, on Sauerland's (2003) interesting approach, the semantic contribution of singular and plural takes place at the level of the maximal Determiner Phrase, via functions of type $<e,e>$ that check whether the DP denotes an atom or not. Clearly, at that level the denotation of (3a.i) would not be distinguishable from that of (3a.ii) and the two nouns would have to come out either both singular, or both plural. Sauerland is aware of this issue. While otherwise following the general take of Sauerland's on singular/plural checking, we will modify this aspect of his proposal.

[10] See on this Barner and Snedeker (2005).

(5) Noun ambiguity and coercion
　　a. Ambiguous nouns: rope, rock, beer, chicken,…
　　　　i. I got three ropes/a lot of rope at the convenience store
　　　　ii. This is good rope/these are good ropes. I wish we had more of it/them
　　b. Coercion: mass-to-count
　　　　i. At a vampire bar: They ordered three bloods on the rocks
　　　　ii. In a lab: We store three bloods here
　　c. Coercion: count-to-mass
　　　　i. There is apple in the salad
　　　　ii. There was cat all over the floor

Ambiguous nouns such as those in (5a) appear to have distinct meanings. Imagine a long rope wrapped in a coil at the convenience store. A part of it is not *a* rope, though it is rope. If you cut a piece from the rope coil, you bring about a change in the world and what was merely rope now becomes *a* rope in its own right (at least, if it is long enough to tie something with). But this involves a real change of state. The mass uses and the count uses of *rope* may involve the same spatiotemporal entity, but they focus on different aspects or dimensions of it. A rope has naturally set boundaries; rope is material from which we can potentially extract many different ropes (by cutting it into pieces). Also the count sense and the mass sense of chicken are quite different. One is a biological species, the other is food material. Coercions happen by analogy with these ambiguities. Count-to-mass coercion involves shifting from individuated objects that form natural units to materials, typically food-like. D. Lewis coined the name 'grinding' for this type of shift.[11] Mass-to-count involves going from a substance to types thereof (as in (5b.ii)) or to standardized servings thereof (as in 5b.i, where the intended analogy is with *whisky*). Pelletier uses the term 'packaging' for this kind of shift. In the case of packaging, standardization appears to be crucial, as witnessed by contrasts of the following sort:

(6) a. Three quantities of blood were found on OJ's sock
　　b. * Three bloods were found on OJ's sock

Sentence (6a) is natural. Sentence (6b) is ungrammatical, presumably because no plausible 'standardization' is available. The fact that there are three continuous stains of blood is not enough for us to speak of *three bloods*. [A heads up: the word by word translation of (6b) in languages like Yudja is grammatical]. It is worth emphasizing in this connection that fake mass nouns do not involve 'ambiguity' or coercion. The difference between, say, shoes vs footwear appears to be solely a difference of form; no grinding or packaging is going on. Similarly, nothing changes in the world if you regard something as a piece of furniture or as furniture.

　These cursory remarks suffice to show the great complexity of the problem. The main question that arises from a linguistic point of view is whether there is a way of regarding

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[11] See the essays in Pelletier (1979); for a comprehensive overview, see Pelletier and Schubert (1989).

the contribution of pluralization, numerals, etc. in a consistent and uniform way across this range of phenomena.

2.2. Background

Let us start by reviewing some assumptions we need to get started. Everything I will present is object of controversy. But this background part is meant to be relatively less controversial, or, to put it differently, whatever controversy there might be is orthogonal to the mass/count issue. Any modern account of the plural-singular distinction, since at least Link (1983), adopts models that are isomorphic to the following:
(7) Plural-singular structures.

   a. $a \cup b \cup c, a \cup b \cup d, \ldots$ SUMS
                                   $a \cup b, b \cup c, a \cup c, a \cup d, \ldots$
                                   a ,   b,   c, d,…   ATOMS
   b. Relevant features of singular/plural structures.
     i.   a binary join operation : $a \cup b$ (commutative, associative, idempotent)
     ii. atomic: there are elements that aren't sums
     iii. generated: every sum is generated out of AT (via iterated applications of $\cup$),
     iv. partially ordered: $a \leq a \cup b$

The universe is classified as constituted by a set of 'atoms' (= singularities) and all of their joins (groups thereof, the pluralities). Formally, an 'absolute' atom is anything that has only itself as a part in the above structure. It should be noted that these structures are not mereologies: the 'part of' relation is not to be identified with 'material part of'. Among the atoms there are things that are mereological parts of each other (e.g. me and my right arm could both be atoms in spite of the fact that the latter is spatiotemporally included in the former). These structures are used to individuate the semantic contribution of pluralization along the following lines. A singular count noun is taken to denote a set of qualitatively uniform atoms (in each world/situation). For example, the singular noun *cat* will be true only of (absolute) atoms.[12] Its pluralization denotes the closure of that set under join. In other words, a plural noun is true in an undifferentiated manner of both atoms and all the pluralities thereof.[13]

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[12] My insistence on the term 'absolute' will become clearer shortly. But roughly speaking, 'absolute' atoms are the atoms in the whole structure. 'Relative' atoms are the smallest members of a property denotation. Imagine a property true of pluralities/groups with the following denotation:

$$P = \begin{array}{l} a \cup b \cup c \\[6pt] a \cup b, b \cup c \end{array}$$

The individuals $a \cup b$, $b \cup c$ are not absolute atoms (i.e. atoms relative to the whole structure). They are, however, relative P-atoms, i.e. the smallest things of which P is true.

[13] The inclusion of atoms in the denotation of plurals is to get contrasts like (a)-(b) right:
   (a) There were no cats on the mat
   (b) There was no group of cats on the mat

(8) A standard take on singular vs. plural nouns.
 In a world w with three cats:
 i. cat = {a, b, c}   ii. cats = { a , b, c, a∪b, b∪c, a∪c, a∪b∪c }

We should find place in the structures in (7) also for kinds. Kinds are involved in understanding what sentences like those in (9), and related examples, mean:

(9) a. i. Dogs evolved from wolves   [from Carlson 1977]
      vs.:
      ii. Those are nice dogs
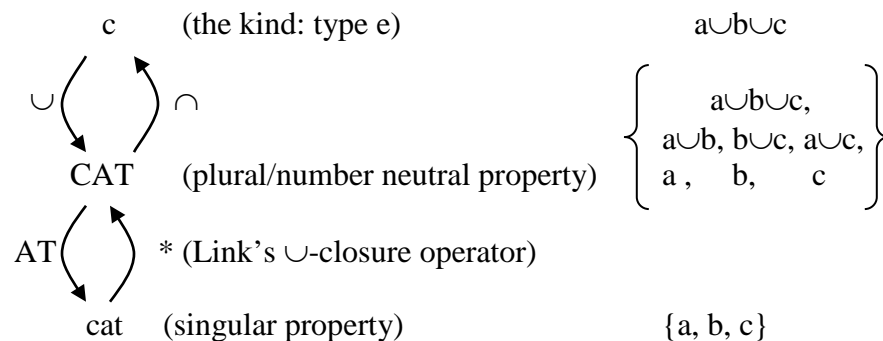   iii. The dogs you see
   b. Dinosaurs are extinct
   c. Green bottles come in three sizes

Sentences such as those in (9a.i)-(9c) appear to be saying something of the kind as a whole. Only a whole kind can evolve from wolves, become extinct, or come in three sizes. As the examples in (9a) illustrate, sometimes (plural) nouns are kind denoting (in (9a.i), (9b) and (9c)), in other contexts (e.g. in postcopular position (9a.ii) or after a determiner (9a,iii)) they denote predicates (or properties). Kinds and properties are different types of semantic creatures. For our purposes, we can think of kinds (in a world w) as the maximal plural individual that comprises all of the manifestation of the kind (in w). Predicates (i.e. the extension of a property in a given world/situation) can be modelled as sets (or characteristic functions thereof). Thus, we wind up with a 'semantic triad', which can be represented as follows:

(10) The semantic triad (from Chierchia 2010).
   a. In any context/situation/world w_0,

            c   (the kind: type e)   a∪b∪c

   ∪(   )∩   { a∪b∪c,
                                                a∪b, b∪c, a∪c,
       CAT   (plural/number neutral property)   a ,   b,   c }

   AT(   ) * (Link's ∪-closure operator)

      cat   (singular property)   {a, b, c}

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Sentence (a) would be false if there is a single cat on the mat; sentence (b) would be true in such a case.

b. Definitions of the morphisms in (a):

$\cap$: i. Type = $<<s,<e,t>>, e_k>$

ii. $\cap P = \lambda w.\, \iota P_w$

$\cup$: i. Type = $< e_k, <s,<e,t>>>$

ii. $\cup k = \lambda w.$ $\begin{cases} \lambda x.\, x \leq k_w \text{ , if } k_w \text{ is defined} \\ \\ \varnothing, \text{ otherwise} \end{cases}$

AT: i. Type = $<<s,<e,t>>, <s,<e,t>>>$

ii. $AT(P) = \lambda w \lambda x[\, P_w(x) \wedge \forall z[P_w(z) \wedge z \leq x \rightarrow z = x]]$ [14]

* : i. Type : $<<s,<e,t>>, <s,<e,t>>>$

ii. $\lambda w \lambda x \exists Y[\, Y \subseteq AT(P)_w \wedge x = \cup Y]$
   [Link's (1983) puralization operator]

The members of a semantic triad are intensional structures: function from worlds/situations into extensions of the appropriate type. A simple, singular property cat_w denotes in any world w a (possibly empty) set of atoms. A plural property CAT_w denotes the closure under $\cup$ of a set of atoms. A kind c_w denotes a (maximal) plural individual. (I will sometimes omit reference to the world/situation, dropping the w-subscript). The entities in the semantic triad ultimately code the same worldly information, in the sense that they are linked via natural morphisms as indicated in (10b). '$\cap$' maps a (plural) property into the corresponding kind; '$\cup$' a kind into the corresponding (plural) property; 'AT' extracts the smallest members out of a property denotation; '*' closes a property denotation under join. The semantic triad constitutes the logical space in which noun denotations live.

   Let us turn now to the interpretation of numbers. Several options are open and viable. For our purposes, we shall regard them as adjectival, property-modifiers (ultimately based on cardinality predicates). For any property P, 3(P) is true of three membered pluralities of the smallest things to which P applies. For example, *three cats* = 3(CAT) will be true of all pluralities in CAT constituted by exactly three CAT-atoms. Here is an example, in a situation with only three cats a, b and c.

(11) a. Example of how *n cats* work (in a world with three cats)

$$\begin{array}{ll} a \cup b \cup c & 3(CAT) = \{\, a \cup b \cup c\} \\ CAT = \quad a \cup b,\, b \cup c,\, a \cup c & 2(CAT) = \{\, a \cup b,\, b \cup c,\, a \cup c\ \} \\ \quad a,\quad b,\quad c & \end{array}$$

b. General definition of *three* as predicate modifier

$3_{<<s,<e,t>>,<s, <e,t>>>} = \lambda P \lambda w \lambda x \exists Y[x = \cup Y \wedge Y \subseteq AT(P)_w \wedge \mu CARD(Y) = 3\ ]$ [15]

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[14] The notion of absolute atom, as used in (7) becomes then:

(a) $AT(\lambda w.D_w)$

where, were $\lambda w.D_w$ is a function from worlds/situations in the total domain D_w of individuals in w.

c. Three uses of NumPs in simple clauses
   i. Those are three cats   Predicative
   ii. 3(CAT)(those)
   iii. The three cats are ugly   Argumental, definite
   iv. ugly(ι3(CAT))
   v. Two cats stole the sausage   Argumental, indefinite
   vi. $\exists x[\, 2(CAT)(x) \wedge$ stole the sausage$(x)]$

Number Phrases like *two cats* or *three cats* denote a 'quantized' property (cf. (11c.i-ii)). In the example in (11a) there is only one group of three cats. Hence, *three cats* is a singleton property and it would be appropriate to use it in a definite description like *the three dogs* (cf. (11c.iii-iv)). In contrast, *two cats* has three pluralities in its extension in the above situation. Accordingly it would be infelicitous to use the noun phrase *the two cats*, though we could say things like *two cats stole the sausage*. In absence of a determiner, *two cats* in argument position undergoes $\exists$–closure winding up with the truth conditions in (11c.vi).

  As mentioned above, this general story can be varied upon in a number of ways, but it is not hugely controversial. One would like to maintain something like it as much as possible in presence of more complex cases. Consider in this light the word *quantity* in constructions like two *quantities of apples*. Imagine a situation in which there are four apples on the table: two (say, a and b) are in a bowl, two (c and d) in a packaged carton. In such a situation we might equally felicitously utter (12a) or (12b).

(12) a. There are two quantities of apples on the table. You guys take that one, we the other.
     b. You guys take those apples, we take those others.
     c. Denotation of *quantity/ies of apples* in context:
       i. quantity of apples $= f_n(APPLE) = \{\, a\cup b, c\cup d\}$
       ii. quantities of apples $= * f_n(APPLE) = \{\, a\cup b, c\cup d, \; a\cup b\cup c\cup d\}$
     d. i. those apples $=$ those$_j(APPLE) = a\cup b$
       ii. that quantity of apples $=$ that$_i(f_n(APPLE))) = a\cup b$ [16]

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[15] I follow on numbers the basic line of Ionin and Matushansky (2006). Treating numbers as predicate modifiers paves the way for a compositional analysis of complex numerals (like *two hundred and thirty three*), which we cannot pursue here.

  It should be noted that *3* in (11b) is used differently in the right (the *definiens*) and in the left (the *definiendum*) of the identity sign. The occurrence to the left is of the type of predicate modifiers, the one to the right is of type e (an ordinal).

[16] Here is a general definition of *quantity* (of type $<<s,<e,t>>, <s,<e,t>>>$):
(a) General definition of *quantity*:

      quantity$_n = \lambda P\lambda w[f_n(P_{w@})]$

      where f is a variable of type $<<e,t>,<e,t>>$ such that for any $X_{<e,t>}$, and any y and

      z in $f_n(X)$, $x\cap y = \bot$; $w@$ is the world of the context.

How can we maintain the above theory of plurality in such a way that the sentences in (12a) and (12b) come out as truth-conditionally equivalent? How can it be that *that quantity of apples* and *those apples* can denote the same thing but one is a singular Determiner Phrase (DP) and the other a plural one? A reasonable idea is that plurality vs singularity is factored in *before* the contribution of the determiner, at the level of the property. Here is the story in informal terms. Imagine that *quantity* applies to a plural count noun and partitions its denotation in contextually salient ways (with the preposition *of* just a semantically vacuous case marker). Think of the word *quantity*, if you like, as ranging over variables on partition functions. There are many ways of partitioning a property, whence the n-subscript *quantity*$_n$; only some of them will be salient in any given context. In the case at hand, with our four apples, the denotation of the noun is partitioned between the apples in the bowl (a$\cup$b) and those in the carton (c$\cup$d), as indicated in (12c.i). While the (context dependent) property *quantity of apples* is true of plural individuals, it still may qualify as a *singular* property because it is not closed under join. In other words, it is not an individual entity that is to be regarded as plural or singular, but a property. A property is singular whenever it is not closed under join, plural when it is.[17] The denotation of a morphologically singular count noun like *cat* remains singular under this revised definition of singularity (and, of course, *cats* remains plural). Pluralization, then, follows its usual course and closes *quantity of apples* under join as in (12c.ii). On top of it all, determiners do their usual thing. In particular, demonstratives extract from a property the individual associated with the relevant demonstration and one may wind up with situations like the one exemplified in (12d), with a plural and a singular DP denoting the same entity. We can thus retain a uniform theory of pluralization, where the contribution of the plural and singular morpheme is always the same under a fairly natural analysis of the *quantity of* construction. But we need to assume that properties are plural or singular (and individuals may be only in a derivative sense).

2.3. An epistemic take on mass nouns

It's time to address the mass/count contrast in English. This part of the proposal is going to be way more controversial than the background reviewed above. Ideally, in developing an analysis mass vs. count, we would like to retain as much of our background as possible. In particular, we would like to maintain in so far as possible the analysis we have sketched of kinds, pluralization and *quantity of* constructions. Note in this connection that mass nouns appear to be either property or kind denoting in ways that are fully parallel to those of count nouns:

This definition guarantees that *quantity of water* is a constant property with an (indexically fixed) extension.

[17] The proper definition should more be like:
   (a) P is singular iff it is not closed under join or trivially so
The part after the disjunction is to allow empty or singleton properties to count as singular (in spite of being technically $\cup$-closed), as singular properties can of course turn out to have singleton or empty denotations.

(13) a. gold is scarse/comes in different alloys   Kind
       b. i. This is pure gold   Property
          ii. The gold in this ring comes from South Africa

So, we should think in terms of mass properties and mass kinds. The big question is what is it that makes a mass property uncountable. There are of course many ways to go and many proposals out there from which to draw. Let me mention two prima facie tempting strategies. One is to assume that mass properties (and, eventually, mass kinds) are constructed from a different somehow non atomic domain of entities.[18] The question that arises in this connection is what would make such a domain 'non atomic'. A domain D with an ordering relation ≤ is non atomic iff no member of it is minimal with respect to ≤. If we take this literally, it would entail that any member of x of D would have to have an infinite number of smaller and smaller parts. Such domains can be constructed.[19] But how plausible is such a move? Any physical entity does have minimal parts. The above model would force us to think of material substances like gold or water as being composed of never ending smaller and smaller gold/water particles. A second strategy is to simply 'paint' mass properties of a different color from the count ones in some formal way. We could easily bend the 'separate domain' approach to this purpose. We say that count nouns get their denotation a domain C with the structure above and mass nouns from a separate domain M (with a structure to be negotiated). Taking your denotation from M makes you uncountable.[20] But this looks arbitrary. In particular, nothing would prevent, it would seem, a language from interpreting all the nouns for objects in the mass domain M (making them all mass) and all the nouns for substances in the count domain C (making them count). We surely do not want our theory to give us such an interpretive freedom. Yes, English does allow nouns of objects like *furniture* to act like mass nouns (and we need to understand how and why). But on a limited scale. Most basic mass nouns in English are nouns of substances. And no known language that has some grammatical manifestation of the distinction mixes things up by letting its grammatically count nouns denote substances and viceversa. For that matter, no known language that has some manifestation of the contrast is indifferent to the object/substance dichotomy, in the sense that it doesn't care how its basic nouns are lexicalized. [21]

   Given these non trivial constraints, a move that strikes me as particularly plausible is to set the mass/count contrast on an epistemic grounding. If we know that x is a cat, we know that in no world/situation that very same object can be two or more cats. This is even true of earthworms. No individual earthworm is a plurality of earthworms, even if it so happens that I can take an earthworm, cut it in half, and get two earthworms (unlike

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[18] Link (1983) has inspired many theories of this sort. See also Landman (1991) for important modifications of Link's original proposals.

[19] Bunt (1979) explicitly models mass nouns in this way, using his concept of ensemble (a set with infinitely descending ∈-chains).

[20] Landman's (1991) can be interpreted in this way. Cf. also the approach developed in Higginbotham (1994)

[21] Even though technically not a 'double domain' theory, the proposal developed in Chierchia (1998a) does allow this type of interpretive freedom. So do the approaches developed in Rothstein (2010) and Landman (2011), in so far as I can see.

what happens with cats). An important note: we may well be uncertain as to whether a particular object is a cat or not (think of dead cats, cat embryos, or what have you). The point is that it is part of how we use words like *cat* that if we decide/determine x to be a cat, then we can no longer regard it as a plurality of cats. For mass nouns things work out differently. If x is water, we must countenance that for all we know it might be an aggregate (i.e. a plurality of smaller water quantities). Again this is a characteristic of how we use the noun *water*, not a claim about the chemical make up of water. The intuition is simple, and its formal rendering is also fairly simple. Here is our proposed definition of what it is to be count vs. mass:

(15) a. COUNT(P) =

$\forall w \forall x [P_W(x) \wedge \forall z[P_W(z) \wedge z \leq x \to z = x] \to \Box \forall y[P(y) \wedge y \leq x \to y = x]]$[22]
If x is a P-atom in any world w it must be a P- atom in every world compatible with what is known in w.

b. MASS(P) =

$\forall w \forall x [P_W(x) \wedge \forall z[P_W(z) \wedge z \leq x \to z = x] \to \neg \Box \forall y[P(y) \wedge y \leq x \to y = x]]$
$= \forall w \forall x [P_W(x) \wedge \forall z[P_W(z) \wedge z \leq x \to z = x] \to \Diamond \exists y [P(z) \wedge z < x]]$
If x is a P-atom in w it is consistent with what is known in w that x may be a plurality of smaller Ps

Everything stays the same in our semantics. We work with a totally canonical atomic domain D of the kind described above. What do the constraints in (15) concretely demand of noun denotations? Take a prototypical count noun, say *cat*. What (15a) requires is that if something is a cat-atom (i.e. a single cat) in no epistemically accessible world that turns out to be more than one cat. On the other hand, if something is a minimal quantity of water, say a drop of water, you have to be able to view it as a plurality of smaller quantities thereof.

An immediate question that arises in this connection is what about water molecules? Isn't a single H2O molecule water in any w? And won't it be required by (15b) to be constituted of submolecular water particles, which is, we are told, a chemical impossibility? My line of reply to this is that I do not know the answer to these questions. I do not know whether a single water molecule (that in my very poor understanding is something like a probability distribution in space of the position and momentum of subatomic particles) counts as water or not given the way normally competent speakers use this term. What I know is that we do not have to settle this matter to competently use

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[22] A note on notation Formula (15a) in the text (and similar formulas I use throughout) should be written as follows:

(a) $\forall w \forall x[P_W(x) \wedge \forall z[P_W(z) \wedge z \leq x \to z = x] \to \forall w' \in K_w \forall y[P_{W'}(y) \to \wedge y \leq x \to y = x]$
where K is the relevant accessibility relation (of type <w, <w,t>>, w the type of words/situations.

In the abbreviation in (15a) I omit the w-subscript after '$\Box$', because that is what the latter operator binds (and hence notating w on P as a free variable would be misleading). If the convention adopted in the text confuses you, just replace it with (a) throughout.

the noun *water*. The constraint in (15) is to be understood as relativized to 'natural contexts', i.e. common grounds (/set of worlds) that are shared by competent (but typically scientifically naïve) speakers.[23] In such contexts, a smallest water quantity will have to be large enough (however the vagueness of 'large enough' is resolved) to be perceived without the aid of complex experimental machinery. So (15b) winds up requiring that any smallest *perceivable* water quantity can be conceived of being composed by smaller unperceivable ones. This how (15b) goes, in so far as 'concrete' mass properties are concerned. For abstract ones (like, say, *honesty*, or, perhaps, *space*) nothing prevents us from thinking of them as being made up of an infinite set of smaller and smaller abstract units. Thus, in so far as I can see, modalizing our understanding of what is it to be mass vs. count affords us a reasonable take of the distinction that works for both concrete and abstract nouns. The constraints in (15) are meant to reflect how nouns are used; as such, they should to be consistent with laws of nature without unduly restricting how such laws may turn out to be.[24]

Let us construct an example. Suppose we are in a context with just three grains of rice a, b and c. In such a context, there will be *many* grain sized quantities of rice. There will be the three grains, of course. But half of grain a and half of grain b (i.e. (½a+½b)) is also a grain sized quantity of rice. And so is 1/3 of grain a and 2/3 of grain b; and so on. All of these many grain sized quantities of rice can constitute our minimal rice quantities (and we could go smaller, of course). The point is that each minimal quantity of rice can be viewed as an aggregate of smaller amounts of rice in an endless number of ways.

(16) A mass triad.

Rice in a world w_0 with 3 grains of rice

r	$a \cup b \cup c$	The rice-kind
RICE	$\{ a \cup b \cup (½a+½b),\dots$	The $\cup$-closed rice-property
	$a \cup b, a \cup (½b+½c),\dots \}$	
rice	$\{a, b, c, (½a+½b); (½a+½c),\dots\}$	The minimal rice-property

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The total sum which constitutes all of the rice in this world w spatiotemporally coincides with the sum of the three grains a∪b∪c (and that is why I am representing it that way in (16)); but rice has many more parts than a, b, and c (including spatially discontinuous ones, likes one half of grain a and one half of grain b). And all such parts, for all we know, may turn out to be aggregates of smaller rice parts. So, on this view, there are two sorts of P-atoms in correspondence with two sorts of natural properties. The P-atoms that are epistemically stable and those that are not. Cat-atoms are stable; rice-atoms are not. Conversely, if a property has stable relative atoms, it is count. If all of its minimal instances are epistemically unstable, it is mass. We have now reconstructed the mass/count distinction as a formal-grammatical one.

This view has several interesting consequences. Let me discuss four of them.

First, we can now think of mass-kinds/properties in a way fully parallel to their count counterparts, (thereby providing a basis for a uniform account of bare plurals and bare mass nouns in English, and across languages that have the singular/plural distinction and allow for bare arguments). Mass kinds are qualitatively homogenous, maximal plural individuals with unstable minimal instances/parts.

Second, the present approach strongly constrains the mapping between mass/count qua language internal categories (as defined in (15)) and substances/objects. If something is a substance, we won't know what its minimal parts look like (scientist may; but that is irrelevant). Hence we have no choice but to categorize them as mass. For objects, it will certainly be natural to categorize them as count; but we might be able to categorize them as mass, if the language gives us a way of doing so as English does (and we still have to see how that is possible).

Third, counting the members of P, means counting P-atoms (cf. the definition of numbers in (11) above).[25] But if P-atoms are structurally undetermined (i.e. epistemically unstable), we cannot do it. We can only count the minimal instances of a property that is known to have them; we cannot count the minimal instances of a property that is not known to have any. Differently put, counting goes via AT. If *blood* is mass in the sense of (15b), it follows from logic alone that AT(blood) is necessarily empty. Hence n(AT(blood)) is a logically contradictory property. This constitutes an arguably elegant explanation for why things like *three bloods* are weird.

Fourth, suppose that *quantity* works on mass nouns just as it does on count ones: it partitions its denotation along contextually determined lines. Then it will follow that the result of this partition will have stable minimal atoms. Being contextually set, such a property has to have stable minimal parts. So while AT(blood) is necessarily empty; AT(quantity$_n$(blood)) will not be; and counting with it will produce interpretable results.[26]

All of these are quite direct consequences of our epistemic take. What about pluralization? Here we have some lee-way. We have seen that a substance must be

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[25] In the new modal setting the definition of the AT function becomes (a) (or, in primitive notation (b)):

(a) $AT(P) = \lambda w \lambda x[\, P_W(x) \wedge \square \, \forall z[P(z) \wedge z \leq x \rightarrow z = x]]$

(b) $AT(P) = \lambda w \lambda x[\, P_W(x) \wedge \forall w' \in K_W \forall z[P_{W'}(z) \wedge z \leq x \rightarrow z = x]]$

[26] Cf. fn 16 for a formal definition of 'quantity of X' which has this consequence.

categorized as mass. But as a mass what? Sticking to properties, there are two choices. A mass property *rice* in (16) true of just the (unstable) minimal rice quantities. If we choose *rice* as denotation for the corresponding noun, nothing would prevent it from pluralizing (i.e. getting closed under '∪' via the *-operator). Perhaps, some languages take this route; it is a fact that several languages do allow their mass nouns to pluralize, without allowing direct combinations with numbers (cf. Tsoulas (2006) on modern Greek; Gillon (2010) on Innu Aimun, and Algonquian language).[27] Or maybe a language may choose to lexicalize its mass nouns as ∪–closed mass properties, such as RICE in (16). In such a case pluralization would perhaps become impossible because mass nouns would already be plural, as it were. One would have to work out an economy condition that prevents pluralizing something that is lexically ∪-closed, a not implausible move.

I see one drawback to the proposal that mass nouns in English (or Italian, etc.) are lexicalized as being ∪-closed. The drawback is that singular morphology has been defined above as semantically requiring that a property be *not* ∪-closed. In languages like English (unlike modern Greek), mass nouns carry invariably singular morphology. So we would be forced to say that singular morphology on mass nouns does not have its usual semantic import. While this is perhaps liveable with, one might want to explore an alternative that does not have such a consequence. G. Magri (pc) has proposed an interesting take on this issue. A singular property is, according to our definition, a property which is not ∪-closed or it is trivially ∪-closed. The disjunction is necessary to let empty sets and singletons count as singular (a singular noun may turn out to have an empty or a singleton denotation). Now we might stipulate that all mass nouns are coded in English as singleton properties, thereby making them semantically singular: they are true just of the *totality* of the instances of the properties.[28] For example, *water* would be true of the totality of water, *blood* of the totality of blood, and so on. This would require some fiddling with the definition of some quantifiers, but nothing really major. It would make mass properties 'proper name' like.[29] It would also give us an additional reason why numerals cannot combine with mass properties: mass properties, when non empty, would have a logically fixed cardinality, and combining such properties with numerals seems pointless (a functional observation that can be readily turned into a formal one). This approach would enable us to maintain a uniform, exceptionless meaning for singular morphology. As it may be evident from my way of presenting it, I am unable hide my sympathy for this proposal.

Magri's suggestion has a further advantage. It would allow us to make sense of the phenomenon of fake mass nouns. If mass nouns are singleton properties, some nouns

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[27] Also Ojibwe has a singular/pural contrast on mass nouns, but with a different semantics than the one found in Greek and Innu Aimun; see on this Mathieu (2012).

[28] Recall that properties and kinds are of different semantic types: <s, et> vs. <s,e>. We are assuming that mass nouns in English start out their semantic life as properties, though they wind up denoting kinds in specific contexts.

For a suggestion similar to Magri's, see Zamparelli (2008).

[29] In many languages (northern Italian, Portuguese, Modern Greek) proper names require the definite article. It is natural to analyze proper names in these languages as singleton properties. Cf. on this e.g. Chierchia (1998b). For a different take, cf., e.g. Longobardi (1994).

associated with objects (like *furniture*, *footwear*, etc.) might take on the same shape as mass nouns and be coded as singleton properties. That way they would be forced to behave just like mass nouns: they would fail to pluralize, they would not be able to combine with numerals and so on.[30] The prediction of this approach is that the phenomenon of fake mass nouns could arise only in those number marking languages that disallow pluralization of mass nouns, for only in such languages mass nouns would have to be coded as singleton properties. To the extent that I know, this prediction is borne out. In particular, modern Greek just does not have fake mass nouns (Tsoulas pc). If on the right track, this would constitute strong support in favor of Magri's conjecture.

Be that as it may, I think that any theory will want to differentiate fake mass nouns from standard ones. When it comes to standard mass nouns, languages appear to have little choice. If a language has the mass/count distinction at all, substances must be lexicalized as mass. When it comes, instead to coding kinds of objects as mass, there is huge variation even across closely related languages and in many languages fake mass nouns appear to be unattested. This suggests that the difference should be captured in type theoretic terms, without loosening too much the mapping from linguistico-semantic categories into extra-linguistic ones.

Finally, the present approach can lift wholesale the traditional view of grinding and packaging. Standardized grinding is a highly partial and context dependent type shifting function gr such that for any count property P_{COUNT}, $gr(P_{COUNT})$, if defined, is a mass property (rooted in unstable atoms). For example, we might assume that *chicken* refers primarily to the biological species, and gr(CHICKEN) maps the biological species into chicken meat. Gr is not shape or function preserving; though it is typically 'matter' preserving, in the sense that anything which is gr(CHICKEN) must be a spatiotemporal part of a chicken (albeit, a dead one). Similar considerations apply to packaging. For any mass property P_{COUNT}, $pk(P_{COUNT})$, if defined, is a count one, with stable atoms. For example, one might argue that count vs. mass senses of *beer* are modulated via pk. BEER is a kind of alcoholic substance and pk(BEER) is the property of being a (contextually salient) standard serving of beer; ROPE and pk(ROPE) can be viewed along similar lines, with the latter as the property of being a physically bounded and connected piece of rope, etc. For 'ambiguous' nouns P_{COUNT} / $gr(P_{COUNT})$ or P_{MASS} / $pk(P_{MASS})$ are equally salient, natural, frequent, etc. For most properties, a special context is required for felicitous shifting, as some properties are more resilient to it than others. Pk doesn't apply

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[30] Notice that on the present approach, 3(FURNITURE), where FURNITURE is the ∪-closed property true of all pieces of furniture, would come out as well defined, because FURNITURE has stable atoms. This is fully consistent with the fact, amply documented in Barner and Snedeker (2005), that the units of furniture are accessible to counting and provides a further argument against modeling fake mass nouns as ∪-closed properties, as proposed by Chierchia (2008a). On the singleton property approach, furniture would denote:
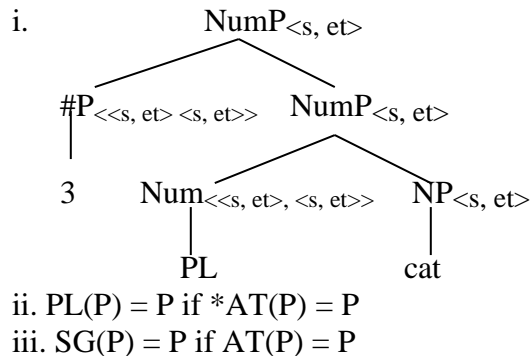
(a) $\lambda w \lambda x[\ x = \cup FURNITURE_w]$

As argued in the text, we can readily build into the definition of number the idea that they are infelicitous with properties with a logically fixed cardinality.

easily to snow, blood or honesty.[31] Gr does not apply in a natural way to triangles, kilos or computer programs, for example.

Summarizing, the English system might look roughly as follows.

(17) three cats

    i.

$$
\begin{array}{c}
\text{NumP}_{<s,\,et>} \\
\diagup \qquad \diagdown \\
\text{\#P}_{<<s,\,et>\,<s,\,et>>} \qquad \text{NumP}_{<s,\,et>} \\
| \qquad\qquad\qquad \diagup \quad \diagdown \\
3 \qquad \text{Num}_{<<s,\,et>,\,<s,\,et>>} \quad \text{NP}_{<s,\,et>} \\
| \qquad\qquad\qquad | \\
\text{PL} \qquad\qquad\qquad \text{cat}
\end{array}
$$

    ii. PL(P) = P if *AT(P) = P
    iii. SG(P) = P if AT(P) = P

Following tradition, nouns in English are (or enter the semantic computation as) property denoting. In order to be turned into an argument an NP will need eventually a determiner (or covert type shifting along the lines of Chierchia (1998b), Dayal (2004)). Number marking encodes a function from properties into properties that checks whether a property has the right semantic structure. A singular property must be non ∪-closed (or trivially so, as per (17.iii)); a plural property must be ∪-closed (as per (17.ii)). Mass nouns fail to combine with numerals, because numerals have built into their semantics the AT function, which requires stable P-atoms. Concerning PL and SG morphology, at least a couple of options may be available, only one of which is implemented in (17). In (17), both SG and PL require that the property be stably atomic (as they are based on AT). Mass nouns fail this test, because they are not stably atomic. To use mass nouns in such languages, they must be made uniformly stably atomic, but without changing their basic meaning. The repair strategy is to code mass nouns as singleton properties true of maximal plural individuals, which can be regarded as stably atomic. So If a language makes the choice in (3) concerning its singular-plural morphology, three consequences follow: (a) its mass nouns must be coded as singleton properties, (b) mass nouns cannot pluralize (because pluralization cannot change the basic meaning – the ∪-closure of a singleton is a singleton), and (c) fake mass nouns will come about. A second strategy is to weaken the meaning of PL vs. SG so that it still requires ∪-closure vs. lack thereof, but

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[31] As mentioned in the text, there is a further type-shift *kd* that maps sortal properties into a kind-level ones. Such a type shift probably applies to both count and mass properties. If WHALE is true of whales, kd(WHALE) will apply to subkinds thereof (sperm whales, hump heads, etc.). And if BLOOD is true of quantities of blood, kd(BLOOD) is true of types or subkinds of blood. Kd is involved in the interpretation of sentences like (a). According to Dayal (2004) it is also involved in the interpretation of (b), and in the interpretation of definite singular generic uses of the definite article (c).

    (a) We keep three blods in this lab
    (b) Most whales are exctinct
    (c) The dodo is extinct

without going through AT i.e. without requiring of properties to be stably atomic).[32] In such a case, mass nouns will be expected to pluralize (and no fake mass nouns are expected to be attested) but they will still be unable to combine with numerals (which universally go through AT). Finally, on top of this, meaning changing lexical shifts from mass to count and viceversa are possible on a context dependent basis; and *quantity of* (and other similar constructions like *amount of*, *part of*) can turn a mass noun into a count one, by anchoring its denotation to a contextually salient partition of the property (which by construction will have stable atoms).

3. Two more nominal systems

In the present section I will review in an even more cursory way than what I did for English two very different nominal systems, and show how the mass/count distinction may come through. This will also provide us an interesting way of testing the theory of mass nouns sketched in Section 2.
3.1. Classifier languages.
    Classifier languages (ClLs) are those in which no noun can directly combine with a numeral. The word by word translation of *three cats* is ungrammatical in a ClL; one must always use a classifier in such combinations, yielding something that in English would look like *3 units of cat*. Mandarin, Japanese, Korean and Bangla are examples of ClLs. In light of this restriction, the macrogrammar of counting in ClLs resembles that of mass nouns in English, and this has prompted the speculation that these languages lack the mass/count distinction, in that all nouns are coded as mass. While it may be descriptively accurate to maintain that in ClLs all nouns are mass *like* from an anglocentric point of view, it turns out to be wrong to claim that all nouns are literally mass, and thus that ClLs do not have a grammatical manifestation of the mass-count distinction. The distinction in question manifests itself mostly through the classifier system. This point has been by now repeatedly shown in the literature, starting with Cheng and Sybesma (1998, 1999), and here is a summary of their main line of argumentation. ClLs turn out to have many families of classifiers, two of which are relevant to our discussion. Taking Mandarin for illustration, the first class involves classifiers like the generic one *ge* and more specific ones like *zhi* (that goes with words like *bi* 'pen') or *ben* (that goes with words like *shu* 'book'). These are sometimes referred to as 'individual' classifiers. The second class involves measures functions like *bang* 'pound' or *mi* 'meter'. Just like in English, classifiers of this second type go with either substances (like *meat* in (18a)) or objects (like *cherries* in (18b))

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[32] The weakening in question can for example be along the following lines:
    i. $PL(P) = P$ if $*P = P$
    ii. $SG(P) = P$ if $\forall w\ \forall x\ [P_W(x) \rightarrow \forall z[P_{W'}(z) \wedge z \leq x \rightarrow z = x]]$
(ii) corresponds to the non modal characterization of (relative) atomicity AT in (10c) above.

(18) a. san bang rou
      three pound meat   'three pounds of meat'
    b. san bang yintao
      three pound cherry   'three pounds of cherries'

Individual classifiers, on the other hand, only go with kinds of objects. When combined with a substance noun, re-interpretation of the noun (i.e. shifting) is required. If standardized packaging is not available, use of a mass noun with a count quantifier is deviant (cf. (19b)).

(19) a. Successful standardized packaging
    (In a hospital):
    gei won na   san   ge xie
    to   me   bring three Cl blood   'bring me three bags of blood'
    b. Unsuccessful packaging:
    (After getting cut):
   *wo diu le   san   ge xie
    I   loose Asp three Cl blood
    c. 'Ambiguous' nouns
     i. wo mai le   san   bang xia
      I   buy Asp three pound shrimp   'I bought three pounds of shrimps.'
     ii. wo you   san   zhi/?ge xia
      I   have three Cl   shrimp   'I have three shrimps.'

On top of this main contrast, the syntax and semantics of individual classifiers vs. measure-classifiers differs in a number of other ways, which we won't review here.[33] What matters to us is that the natural way to tease apart individual classifiers from measure based ones relies on the semantic properties of the nouns they combine with; individual classifiers only go with nouns associated with kinds that come in natural units. As individual classifiers have a different syntactic distribution from measure based ones, this constitutes clear evidence of a grammaticized manifestation of the mass/count distinction in ClLs.

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[33] An important syntactic difference between individual and measure quantifiers is that the latter but not the former can combine with the noun modifier *de*:
(a) * san ge de ren
    three cl DE person
(b) san bang de yintao
  three pound De cherry 'three pounds of cherries'
For relevant discussion, see Cheng and Sybesma (1998, 1999), Jiang (2010). A number of authors have provided counterexamples to this generalization; cf. e.g. X. Li (2011):
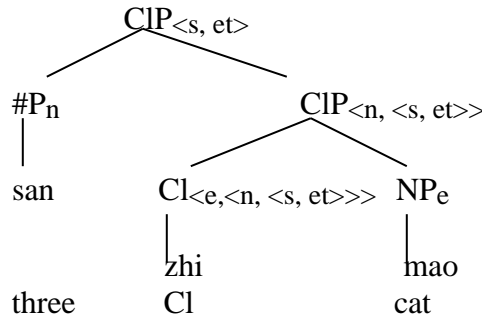(c) ta   yilian   xie le liang-bai   duo feng de xin
   she continuously write Perf two-hundred more Cl DE letter.
   'She continuously wrote more than 200 letters.'
These counterexamples are limited, however, just to 'high' numbers.

From the present point of view, a natural way to conceptualize ClLs is by marrying the theory of mass-count sketched in section 2 with the Nominal Mapping Parameter, developed in Chierchia (1998b). The core idea of the latter proposal is that languages may vary in the way their nouns choose their lexical denotation from semantic triads. English, as we saw, requires its nouns to be property denoting and number morphology is a function that checks whether such properties are singular or plural. ClLs require their nouns to be kind denoting. This hypothesis provides a natural account for the obligatory existence of classifiers, along the following lines. Numerals, we have hypothesized, are functions from properties into quantized properties. If this is universal (as one might want the semantics of numbers to be) and some languages insist on their nouns being kind denoting, a mismatch will arise preventing numbers from directly combining with nouns. It is natural to conjecture that classifiers become necessary in such languages to obviate this type mismatch. While there are several ways in which classifiers might be viewed as fulfilling such a requirement, one that strikes me as particularly effective has been developed in Jiang (2012), who in turn builds on Krifka's (1995) classic proposal. Jiang argues that all classifiers can be viewed as binary functions that take a kind and a number to yield a (quantized) property. Here is an illustration with both individual and measure classifiers (cf. also X. Li 2011).

(20) a. Structure of ClPs
[Tang 1990, Cheng and Sybesma 1999, Jiang 2012, among many others]

$$ClP_{\langle s, et\rangle}$$

$$\#P_n \qquad ClP_{\langle n, \langle s, et\rangle\rangle}$$

san

$$Cl_{\langle e, \langle n, \langle s, et\rangle\rangle\rangle} \quad NP_e$$

zhi   mao

three   Cl   cat

b. Individual Classifiers   [Jiang 2012]

   i. san shi mao ➜ $\lambda w \lambda x[three(AT(^{\cup}c))_w(x)]$

   ii. shi mao ➜ $\lambda n \lambda w \lambda x[n(AT(^{\cup}c))_w(x)]$

   iii. shi ➜ $\lambda k \lambda n \lambda x[n(AT(^{\cup}k))_w(x)]$

c. Measure Classifiers

   i. san bang rou ➜ $\lambda w \lambda x[\ ^{\cup}meat_w(x) \wedge \mu_{pound}(x) = 3]$
      three pound meat

   ii. bang rou ➜ $\lambda n\ \lambda w \lambda x[\ ^{\cup}meat_w(x) \wedge \mu_{pound}(x) = n]$

   iii. bang ➜ $\lambda k \lambda n \lambda w \lambda x[^{\cup}k_w(x) \wedge \mu_{pound}(x) = n]$

Classifier phrases have a structure that is fully parallel to that of NumPs in English. In particular, ClPs built out of individual classifiers are analyzed as quantized properties

which can be used in the typical ways of NumPs in English: predicatively, or in generic sentences, or as restrictors of quantifiers, or undergo ∃-closure in argument position. In (20a.ii-iii) we track the compositional make-up of classifier phrases, following the hypothesized structure in (20a). The lexical classifier *ge* applies to kinds, and turns them into number-seeking properties using '∪' and the AT-function. The *zhi mao* subconstituent looks for a number; by applying it to *san* 'three', we obtain a quantized property. It follows from the use of AT in definition (20b), that individual classifiers like *zhi* (or *ge*) will be defined only for count-kinds, endowed with stable minimal parts. Uses with mass-kinds will be possible only through the canonical mass-to-count shifts. Measure classifiers have the same logical type as individual ones and are analyzed by analogy with measure phrases in English. They combine with a kind first, then with a numeral and yield a quantized property that uses a non atom-based measuring function (in the case at hand, something like *kilo* or *pound*).[34]

On the present take, the existence of a generalized classifier system is triggered by a type mismatch: ClLs have kind denoting nouns. Numbers combine with properties and hence in ClLs they cannot directly combine with nouns. The classifier is required to lift noun denotations to the right type for combining with numbers (creating, moreover, number-taking functions); if they do so via AT, they will only combine with kind denoting nouns that have stable atoms (count kinds); if they do so via some other, non cardinality based measure function, they will be able to combine with nouns of any type (mass or count), to the extent that such nouns have the relevant dimension (weight, length or what have you). Now, there clearly are many conceivable alternatives or variants to this general approach. However, the present one has a consequence that other proposals I am familiar with fail to have.[35] It derives in an arguably principled manner the observation that every ClL allows bare arguments.

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[34] The main argument in favour of adopting the one in (20) as the basic type of classifiers is that structures parallel to (20), with possible word order variations, are attested in every ClL. On the other hand, only some ClLs allows also bare (i.e. numberless) classifier noun sequences. For example:
(a) zek gau zungji sek juk (Cantonese)   Cheng and Sybesma (1998)
    CL dog like eat meat   'The dog likes to eat meat.'
(b) *jia gau be lim zhui (Min)
     CL dog want drink water Intended: 'The dog wants to drink water.'
The interpretation and distribution of bare classifier-noun sequences varies significantly across classifier languages. Jiang (2012) proposes that this asymmetry between numeral-classifier-noun structures (always attested with a uniform interpretation) and bare classifier-noun ones (attested on a language particular basis and with varying interpretations) is due to the fact that the latter is derived from the former through a process of 'detransitivization' of classifiers (that amount to plugging into a classifier the numeral *one*), and is available on a parametric basis.
Also relevant to the present discussion is the distribution and interpretation of 'plural' noun phrases in ClLs. Cf. Li (1999) for an influential proposal. See Jiang (2012) for a reanalysis of Li's generalizations along lines consistent with the present approach.
[35] Cf., e.g., Longobardi (1994), Borer (2005).

(21)   a. Every ClL allows verbs to merge with bare nouns
     b. i. xiong jue-zhong le   Krifka (1995)
        bear   vanish-kind ASP   'bears are extinct'
      ii. waiman gou zai jiao
        outside dog PROG bark   'dogs/the dog are/is barking outside'

The converse of (21a) does not hold: there are plenty of languages that allow bare arguments, and are not ClLs. A prime example is that of languages like Russian or Hindi that have no overt determiners and freely allow numbers to directly combine with their count nouns. To see the empirical robustness of the generalization in (21a), notice that there is no a priori reason why there couldn't be a ClL, which disallows bare arguments and requires some overt structure (a determiner or a classifier) of all its nominals in argument position (the way in which, say, French, always requires an overt determiner). The generalization in (21a) follows from the present approach in a straightforward manner. Nouns in ClLs are kind denoting, and kinds are of an argumental type. Under the hypothesis that categories can be freely syntactically merged with each other, modulo type consistency, we come to expect structures such as those in (21b) to be well formed in every ClL. Our parametric setting on noun denotations catches two birds with one stone: the obligatory presence of a classifier in the grammar of counting has to come with the availability of bare arguments.

   In Chierchia (1998b) I speculate that since ClLs do not need determiners to turn their nouns into arguments, they will never develop lexical determiners on economy grounds. This speculation turns out to be wrong. Jiang and Hu (2010) and Jiang (2012) show that Yi, a ClL historically related to Mandarin, does have a lexical definite determiner, namely *su* 'the'. Jiang (2012) argues that this is in fact to be expected, contra Chierchia (1998b)'s speculation: if ClPs are of a predicative type, determiners may well develop to turn them into arguments. She makes the further interesting prediction that if a ClL develops a determiner, it will be able to apply only at the level of ClPs, which is property-denoting, and not at the level of the bare noun, which is kind denoting, under the plausible assumption that determiners are universally property seeking functions.

   The present sketchy remarks should suffice to illustrate how the mass-count distinction turns out to be grammatically encoded in ClLs in ways which are very different from the English one. Such a distinction is encoded in the classifier system: individual and measure classifiers, while partaking in structures like (20), have otherwise widely diverging syntactic and semantic properties, all traceable back to the presence of the atomizing function in individual classifiers but not in the measure ones. The present approach to mass/count that relies on a basic, universal distinction between properties/kinds with epistemically stable minimal instances and properties/kinds with epistemically unstable ones, appears well designed to capture such variation through a conceptually minimal shift in the denotation of nouns.

3.2. A plunge in a 'less familiar' language

In the following brief paragraphs I am going to report on Suzi Lima's research on Yudja, a language of the Juruna family, Tupi stock, spoken by 294 people in the Xingu Indigenous Park, in Brazil. My goal is to explore, in a very preliminary way, the

consequences of Lima's findings for the present approach to mass and count. All the examples below are from her fieldwork. Yudja is a determinerless language whose nouns are number neutral.[36] Bare arguments are freely allowed.

(22) ali ba'ï ixu
    child paca to eat   "The/a/child(ren) eat(s)/ate the/a paca(s)"

The language has a few classifiers, but they are typically not obligatory. A most striking characteristic of this language is that numerals can freely combine with nouns of any type. With notionally count nouns, numerals have their usual meaning. With mass nouns, the readings one systematically get are two: one is the 'standardized packaging' reading. The other, however, involves 'unconventional contexts', as Lima puts it:

(23) a. Conventional container reading.
      Txabïu ali eta awawa
      three child sand to get   'Children got three sand(s) in the beach'[37]
      (The) children got three containers with sand from the beach
   b. Context: the children dropped a little bit of sand near the school and a little bit
      near the hospital (the drops have different sizes and shapes):
      Yauda ali eta apapa
      two child sand drop.redupl   'Children drop two sand(s)'
      The children dropped two quantities of sand.

The behavior in (23a) is sort of expected. The mass noun *sand* can in principle be mapped onto the meaning 'standardized container of sand' by the packaging function. Packaging into standardized containers/units may happen more easily in Yudja than in, say, English, but the general phenomenon appears to be the familiar one. The case of unconventional contexts is, however, clearly different from what happens in Indo European and in ClLs, where construals such as those in (23b) are disallowed. Lima has tested it carefully with a wide variety of unconventional contexts and mass nouns, including *water, flour, blood*. Here is an example with *blood*:

(24) Context: someone cut his finger and dropped a little bit of blood near the school, and
    also dropped blood near the hospital and near the river (the blood drops have
    different sizes and shapes):
    Txabïu apeta ipide pepepe
    three blood on the floor to drip.redupl (three events)
  'Three bloods dripped on the floor'

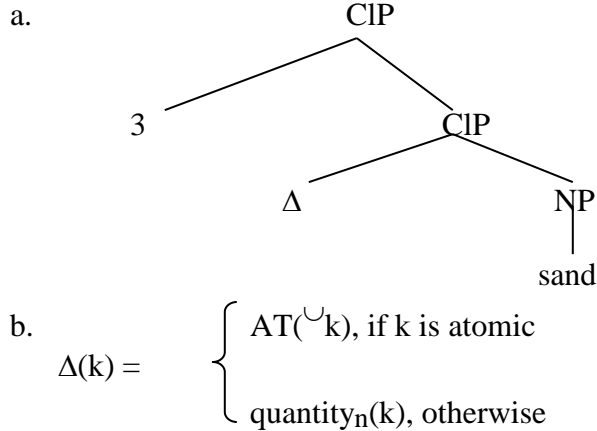Should we conclude that Yudja lacks the mass-count distinction altogether? Have we finally found a language that doesn't care how its nouns are lexicalized? Even though the

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[36] There is a morpheme -i- associated with plurality, but it is always optional and restricted to human nouns.

[37] As is evident from these examples, numerals in Yudja preferentially float at the beginning of the clause.

evidence is somewhat sparse, at a closer inspection it looks like the answer should be 'no'. There are at least two pieces of evidence that point in this direction. The first is the behavior of numerals in combination with count nouns; such combination do have the canonical interpretation, even when the context might make a non standard interpretation salient. One cannot take a table, cut it in three parts and then say something like "now we have got three tables", meaning 'now we have got three quantities/parts of table'. By the same token one cannot assign three places on a canoe to three boys and say "the boys are occupying three canoes" meaning 'the boys are occupying three parts of a canoe'. Nor can one divide a whole lot of canoes in three sets, assign each set to a team and say 'each team got one canoe" meaning 'each team got one quantity of canoes'. If the language really didn't care about mass vs. count, these things ought to be possible (particularly given the flexibility we observe with mass nouns). Or to put it differently, the construction *three N* means 'three quantities of N', if N is mass; but it does not (and cannot) mean 'three quantities of N', if N is count. This is evidence that the mass-count distinction is lexicalized in the language. The second piece of evidence involves the pair of quantifiers *urahu* 'a lot' and *xinahu* 'little/few'. These quantifiers can freely combine with either mass or count nouns, but with different meanings. In combination with mass nouns the quantifier pair means 'a lot/a little'; with count nouns, however, they can only get an adjectival reading ('big/small'):

(25) a. Urahu ahuanama txa
      A lot milk   'A lot of milk in a single place'
   b. Xinaku ahuanama txa
      Little milk   'Little milk in a single place'
   c. Urahu ali
      big child   'The child is big'
   d. xinaku ali
      small child   'The child is small'

Even though the nouns of the language are number neutral, something like (25c) cannot be interpreted as 'a lot of children'. This generalization about quantification with *urahu/xinaku* could not be stated without the substance/object contrast and constitutes a way of coding it into grammatical morphemes.[38]

    Considerations of this sort suggest that even in Yudja grammatical manifestations of the mass-count distinction are attested. What Lima is exploring in this connection is an analysis in terms of a very general classifier that modulates counting in Yudja. Within the present set of assumptions, Lima's insight could be couched along the following lines. Nouns in Yudja are kind denoting, like in Mandarin. This enables them to occur as bare

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[38] There is a third relevant data set, involving the rest of the quantifier system, for example the quantifiers *itxïbï* 'many' and *kïnana* 'few'. Such quantifiers in combinations with mass nouns of the form *itxïbï ahuanama txa* 'many milk' are glossed as 'many containers of milk'. It would seem from these glosses that such quantifiers force mass-to-count shifts of the canonical kind and would be deviant in unconventional contexts. If this turns out to be so, it would constitute further piece of evidence for a grammatical manifestation of the mass/count distinction.

arguments and requires classifiers for counting. But Yudja, unlike Mandarin, has a poor classifier system, because it relies on an unrestricted 'logical' one that typically can be dropped. The structure of Yudja's ClPs might be something like:

(26) Cl-drop languages[39]
    a.

                    ClP
            3   ClP
                Δ   NP
                        sand

    b.

$$\Delta(k) = \begin{cases} \text{AT}(^{\cup}k), & \text{if k is atomic} \\ \\ \text{quantity}_n(k), & \text{otherwise} \end{cases}$$

The term 'classifier drop' is by analogy with 'pro drop'. The idea is that Yudja's main classifier has a logically set meaning and in view of its great generality, it goes unpronounced (it is 'retrievable'). With count nouns, such a classifier simply extracts the natural units/atoms; with mass nouns it has the same semantics as 'quantity of', which makes the noun count by linking it to a contextually salient partition of the noun-denotation. Crucially, 'quantity of' includes but is not limited to standardized servings/containers and the like. The latter is the main difference between 'Δ' and *ge*: *ge* goes with count nouns or forces re-interpretation on mass nouns in terms of standardized units/containers); 'Δ' means *atom of* with count nouns and *quantity of* with mass nouns, without being restricted to standardized servings/containers. The system win (26) would explain the flexibility of Yudja's grammar of counting, while at the same time accounting for the constraints discussed above that seem to characterize the behavior of count nouns and of quantifiers. It also enables us to retain the same semantics for numerals as for English and Mandarin. It is clear that this is not the only possible analysis of Yudja. At the same time, it is a fairly simple one that fits nicely in an arguably general, semantically driven typology.

4. Concluding remarks

We have explored in a cursory way three very different grammars of counting in so far as it concerns the mass-count distinction. Our tentative conclusion on this limited basis is that such distinction is attested, in parametrized form across these three types of languages, contrary to what it may prima facie appear.
    Our starting point is the observation is that there exists a pre-linguistic categorial distinction between 'objects', structured in qualitatively uniform natural classes with

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[39] I am assuming that the surface word order is obtained by floating the numeral to a clause initial position.

cognitively salient minimal parts, and 'substances' that are not so structured. This pre-grammatical distinction turns through grammar into a formal, epistemically grounded one. Count nouns have to map onto properties or kinds with minimal instances that are known to be such across contexts. Mass nouns have to map into properties/kinds whose minimal instances are epistemically unstable. A minimal instance of a mass property has to be set to something that may turn out to be constituted by smaller units. The reason why counting with mass nouns tends to be disallowed by grammar is that we cannot count minimal instances of properties, if such instances are epistemically undetermined.

This proposal is similar to traditional approaches in that it differentiates among count (i.e. atomic) and mass (i.e. non atomic) properties/kinds in terms of the things they apply to. It differs from them in that it has a built in mapping onto the extra linguistic distinction between objects and substances, provided by its modal, epistemic standpoint: a property/kind whose minimal instances are inaccessible to our cognitive system, must be construed as mass in the formal sense.

At the same time, we have explored a number of possible parameters that can condition aspects of this mapping and thereby the grammar of counting. A primary divide is between property oriented and kind oriented languages. In property oriented languages, numbers will be able to combine directly with count nouns on type theoretic grounds. In kind oriented ones, they will not be able to and classifiers (overt or null) will be needed. Kind oriented languages are expected to freely allow bare arguments, and the mass/count distinction is expected to manifest itself in the grammar of the classifier system and of quantifiers.

In the two kind oriented languages we have looked at, this takes place in different ways. If the language has a rich classifier system, there will emerge (at least) two classes of classifiers, one, atom based, will combine with count kinds; the other, measure and container based, will be able to combine with a broader set of nouns; such classes will have a partially overlapping, but diverse distribution. At the opposite end, we found a language that uses a very general way of extending countability to the mass portion of its lexicon (through the interpolation of something like the context dependent 'countifying' function *quantity of*). In such a language, we still detect the mass/count distinction through the different interpretation of numbers with count vs. mass nouns (and through the quantifier system).

Finally, it is worth recalling a parametric difference internal to property oriented languages. Some such languages (like modern Greek) apply number marking uniformly across mass and count nouns, allowing their mass noun to pluralize. Most languages with the singular/plural distinction, however, use it to enforce some kind of obligatory singularity on mass nouns. Following Magri, we have conjectured that mass nouns in languages of this second type are coded as singleton properties in order to meet the singularity requirement. It is in languages of this second type that the phenomenon of fake mass nouns may arise, as a sort of 'copy-cat' effect.

The study of further nominal systems may well lead to a radical reorganization of this picture. For the time being, however, it seems to me that the mass-count distinction holds up across a quite diverse range of nominal system, and that an epistemic take to it might be useful in understanding what is going on.

References

Barner, D. and J. Snedeker (2005) "Quantity judgments and individuation: Evidence that mass nouns count." *Cognition, 97*, 41-66.

Borer, H. (2005) *Structuring Sense*, Oxford University Press, Oxford.

Bunt, H. (1979) " *Ensembles* and the Formal Semantic Properties of Mass Terms" in F.J. Pelletier (ed) Mass Terms: Some Philosophical Problems, Kluwer, Dordrecht

Carlson, G. (1997) *Reference to Kinds in English*, Ph. D. Dissertation, University of Massachusetts at Amherst. Published in 1980 by Garland, N.Y.

Carey, S. (1985). Conceptual Change in Childhood. Cambridge, MA: Bradford Books, MIT Press.

Carey, S. and E. Spelke (1996) "Science and core knowledge" *Philosophy of Science, 63(4):* 515-533.

Cheng, L. and R. Sybesma (1998) "Yi-wang Tang, yi-ge Tang: Classifiers and Massifiers." *Tsing Hua Journal of Chinese Studies, XXVIII*(3), pp. 385-412.

Cheng, L.-S. and R. Sybesma (1999) "Bare and Not-So-Bare Nouns and the Structure of NP", *Linguistic Inquiry*, 30.4: 509-542.

Chierchia, G. (1998a) "Plurality of Mass Nouns and the Notion of 'Semantic Parameter'", in S. Rothstein (ed.) *Events and Grammar*, Kluwer, Dordrecht.

Chierchia,G. (1998b) "Reference to Kinds across Languages", in *Natural Language Semantics*, 6: 339-405.

Chierchia, G. (2010) "Mass Nouns, Vagueness, and Semantic Variation", Synthese: 174:99-149.

Darlymple, M. and S. Morfu (2012) "Plural Semantics, Reduplication, and Numeral Modification in Indonesian", *Journal of Semantics*, 29.2: 229-260.

Dayal, V. (2004) "Number Marking and (In)definiteness in Kind Terms", in *Linguistics and Philosophy* 27.4: 393-450.

Feigeson, L., S. Carey and E. Spelke (2002) "Infants' discrimination of number vs. continuous extent", *Cognitive Psychology, 44*, 33-66.

Gillon, C. (2010) "The mass/count distinction in Innu-aimun: implications for the meaning of plurality", in B. Rogers and A. Szakay (eds) *Proceedings of WSCLA 15*, University of British Columbia.

Hauser, M. and S. Carey (2003) "Spontaneous representations of small numbers of objects by rhesus macaques: Examinations of content and format." *Cognitive Psychology, 47,* 367-401.

Hauser, M. and B. Spaulding (2006) "Wild Rhesus Monkeys Generate Causal Inferences about Possible and Impossible Physical Transformations in the Absence of Experience", in *Proceedings of the National Academy of Science*, 103:18.

Higginbotham, J. (1994) "Mass and Count Quantifiers," in *Linguistics and Philosophy*

17:447-480.

Jiang, L. J. (2010) "Monotonicity and measure phrases in Chinese", in *Proceedings of the Chicago Linguistics Society 45*.

Jiang, L. J. (2012) *Nominal Phrases and Language Variation*, Doctoral dissertation, Harvard University.

Jiang, L. Julie and S. Hu (2010) "An overt determiner in a classifier language", paper presented at GLOW-in-Asia VIII, to appear in the proceedings of the conference,

Krifka, M. (1995) "Common nouns: A contrastive analysis of Chinese and English", in in G. Carlson and F. J. Pelletier (eds.0 *The Generic Book*, University of Chicago Press, Chicago.

Landman, F. (1991) *Structures for Semantics*, Kluwer, Dordrecht

Landman, F. (2011) 'Count nouns - mass nouns – neat nouns – mess nouns,' in M. Glanzberg, B. H. Partee and J. Šķilters (eds.), *Formal Semantics and Pragmatics: Discourse, Context and Models,The Baltic International Yearbook of Cognition, Logic and Communication,* Vol 6.

Li, Yen-Hui Audrey (1999) "Plurality in a Classifier Language," in *Journal of East Asian Language*, 8: 75-99.

Li, Xu-Ping (2011) *On the Semantics of Classifiers in Chinese*, Ph. D. Dissertation, Bar Ilan University, Israel.

Lima, S. (2010) "About the mass-count distinction in Yudja: a description" in B. Rogers and A. Szakay (eds) *Proceedings of WSCLA 15*, University of British Columbia.

Link, G. (1983) "The Logical Analysis of Plural and Mass Terms: A Lattice Theoretic approach," in R. Bäuerle, C. Schwarze, and A. von Stechow (eds.), *Meaning, Use and Interpretation of Language*, de Gruyer, Berlin, pp. 302-323.

Longobardi, G. (1994) "Reference and Proper Names: A Theory of N-Movement in Syntax and Logical Form", in *Linguistic Inquiry*, 25: 609-665.

Ionin, T. and O. Matushansky (2006). "The Composition of Comple Cardinals" in *Journal of Semantics* 23: 315-360

Mathieu, E. (2012) "Flavors of Division", Linguistic Inquiry,43:650-679.

Pelletier, J. (1979) (ed *Mass Terms: Some Philosophical Problems,* Reidel, Dordrecht.

Pelletier, J. and L. Schubert (1989) "Mass Expressions" in D. Gabbay and F. Guenthner (eds) *Handbook of Philsophical Logic,* Volume IV, Kluwer, Dordrecht.

Rothstein, S. (2010) "Counting and the mass count distinction", *Journal of Semantics,* 27.3:343-397.

Sauerland, U. (2003) "A New Semantics for Number," in R. Young and Y. Zhou (eds.), *Proceedings of SALT 13*, CLC Publications, Cornell University, Ithaca, NY.

Selkirk, E. (1977) "Some remarks on Noun Phrase structure", in A. Akmajan, P. Culicover and T. Wasow (eds) *Formal Syntax*, New York, Academic Press.

Soja, N., S. Carey and E. Spelke (1991) "Ontological Categories Guide Young Children's Inductions of Word Meanings: Object Terms and substance Terms," in *Cognition*, 38: 179-211.

Spelke, E. and S. Dehaene (1999) "Biological foundations of numerical thinking", *Trends in Cognitive Sciences, 3*, 365-366.

Stickney, H. (2009) *The Emergence of DP in the Partitive Structure*, Ph. D. Dissertation, University of Massachusetts at Amherst.

Tsoulas, G. (2006) "Plurality of Mass Nouns and the Grammar of Number," paper

presented at the 29th Glow Meeting, Barcelona.

Wiltschko, M. (2010) "How do languages classify their nouns? Cross-linguistic variation in the mass/count distinction", in H. Bliss and R. Girard (eds) *Proceedings of WSCLA 13 and 14*, University of British Columbia.

Zamparelli, R. (2008) "Bare Predicate Nominals in Romance Languages," in H. Müller and A. Klinge (eds) *Essays on Nominal Determination*, John Benjamins.