

The semantics of nominal reference

Mass, count, singular, plural

1 Some relevant facts and questions

1.1 Interpretive issues

What sort of thing could be the argument of the predicates *number few* and *total seven*?

- (1) a. The brave (people) number few.
- b. The runs totaled seven.

We can ask a similar question about the verb *exceed*:

- (2) a. The errors exceeded the runs.
- b. The wine exceeded the water.

What's going on in the following examples?

- (3) a. The protesters gathered in Federal Plaza.
 - b. The cards are scattered all over the floor.
 - c. Leaves collected in the gutter.
 - d. Fido and Fifi are similar.
 - e. The players congratulated each other.
- (4) a. *The protester gathered in Federal Plaza.
 - b. (*)The card is scattered all over the floor.
 - c. *A leaf collected in the gutter.
 - d. (*)Fido is similar. (\neq Fido is not unique.)
 - e. *Sammy congratulated each other.

In some of these environments, mass nouns are like plurals:

- (5) a. (?)Intelligent slime gathered in Federal Plaza.
- b. Blood is scattered all over the floor.
- c. Rain collected in the gutter.

But not in others:

- (6) a. (*)Gold is similar.
- b. *Dust piled on top of each other.

1.2 Distributional facts

Mass and singular/plural count nouns differ in their distributions:

- (7) *Plural marking*
- rings, lakes, bottles
 - ??golds, waters, wines
- (8) *Determiners*
- a ring, two lakes, several bottles
 - *a rings, two lake, several bottle
 - ??a gold, two water(s), several wine(s)
- (9) *Classifiers/measure phrases*
- a kilo of rings, two thousand square miles of lakes, several boxes of bottles
 - ??a kilo of ring, two liters of lake, several boxes of bottle
 - a kilo of gold, two liters of water, several bottles of wine
- (10) *many/few vs. much/little*
- many/few/*much/*little rings/lakes/bottles
 - *many/*few/?much/?little ring/lake/bottle
 - *many/*few/much/little gold/water/wine
- (11) *comparatives*
- more/fewer/*less rings/lakes/bottles
 - ?more/*fewer/?less ring/lake/bottle
 - more/*fewer/less gold/water/wine

Anaphoric reference provides some interesting distinctions as well. In general, pronouns agree with their antecedents in morphological number.

- (12)
- The rings are expensive because they (*it) are (*is) made of unusual gold.
 - The ring is expensive because it (*they) is (*are) made of unusual gold.
 - The gold is unusual because it (*they) is (*are) only found in deep sea vents.

Conjoined count NPs trigger plural agreement:

- (13)
- Kim and Lee are late because they were in a traffic jam.
 - The boy(s) and the girl(s) are late because they were in a traffic jam.

Interestingly, perhaps, conjoined mass nouns do too:

- (14)
- The gold and (the) silver in this ring are unusual because they (*it) are (*is) only found in deep sea vents.
 - Gold and silver are precious because they (*it) are (*is) rare.
 - When hydrogen and oxygen combine, they (??it) become(??s) water.

An exception is the case in which a plural NP denotes an ‘amount’:

- (15) Twenty five dollars (clams, marbles, blicks) is far too much! I refuse to pay it (??them).

1.3 Inferences

Mass terms and plurals are alike, and different from count nouns, in displaying the property of *cumulative reference*:

- (16) *Cumulative reference*
If *a* has property *P* and *b* has property *P*, then the sum of *a* and *b* has property *P*.
- (17) a. If the stuff in glass A is water and the stuff in glass B is water, then what you get by pouring the stuff in glasses A and B together is water.
b. If the things in box A are hammers and the things in box B are hammers, then what you get by putting the things in boxes A and B together is hammers.
c. *If A is a hammer and B is a hammer, then what you get by putting A and B together is a hammer.

NB: Not all singular count nouns fail cumulative reference (e.g., *puddle*, *line*, *sequence*, etc.), but all (?) mass nouns and plurals have this property.

A second property that may similarly group mass+plural vs. count nouns is homogeneity, though this is a bit trickier.

- (18) *Homogeneity*
If *a* has property *P* and *b* is a part of *a*, then *b* has property *P*.
- (19) a. If the stuff in glass A is water, then part of the stuff in glass A is water.
b. ?If the things in box A are hammers, then part of the things in box A are hammers.
c. *If A is a hammer, then part of A is a hammer.

The problem here is that there are arguably parts of water that are not water (the hydrogen atoms), and this problem is even more obvious when we consider plurals (the individual elements that comprise 'hammers' do not satisfy the plural predicate *hammers*). However, it is still possible that as far as language is concerned, mass nouns and plurals are treated *as though they are homogenous*.

How can we tell? Find linguistic data that seems to be sensitive to this feature. For example:

- (20) a. Kim is eating rice. → Kim has eaten rice.
b. Kim is eating beans. → Kim has eaten beans.
c. Kim is eating an apple. ↯ Kim has eaten an apple.
- (21) a. Kim almost ate rice.
b. Kim almost ate beans.
c. Kim almost ate an apple.

1.4 The task

Can we come up with a semantic analysis of nominal reference that derives this (abbreviated) set of facts that satisfies compositionality? [Digression on compositionality.]

2 A non-starter

Perhaps the simplest way of capturing the mass/count/plural distinctions and similarities would be to make the following assumptions:

- (22)
- a. mass nouns denote quantities of stuff
 - b. singular count nouns denote atomic objects
 - c. plural (count) nouns denote sets of atomic objects

This approach would be unsatisfying for a couple of reasons:

- We will need to posit a systematic ambiguity for all predicates that can take both singular and plural arguments, since these are of different semantic types.
- This approach doesn't explain why mass nouns and plural count nouns are similar.

In order to handle the second point in particular, we need to take into account the structure of the domains we're talking about: how (atomic or plural) objects are related to pluralities of which they are a part, how quantities of matter are related to other quantities of matter, and how quantities of matter are related to objects (and pluralities).

As it turns out, once we add the structure we need to capture these connections, we no longer need to posit (systematic) ambiguities for predicates, though we will need to complicate our predicate meanings a bit.

3 Gillon's syntactic/pragmatic analysis

Gillon (1992) takes the distributional data mentioned above (along with some other facts) as an indication that the mass/count distinction is morpho-syntactically encoded.

- (23) *Syntactic assumptions*
- i. Nouns are assigned the syntactic features +/-CT and +/-PL
 - ii. Ns and As/Dets must agree in the value of +/-PL
 - iii. +CT Ns may take either value of PL
 - iv. -CT Ns must be -PL (with a few lexical exceptions)

The assumption that plurality has morphosyntactic representation is uncontroversial, but what about +/-CT? Surely (23iii-iv) should follow from something deeper?

As far as the semantics goes, the mass/count distinction is basically the one above:

- (24)
- i. The denotation of N_{+CT} comes from the domain of objects
 - ii. The denotation of N_{-CT} comes from the domain of quantities of stuff

In order to understand the analysis of plurality, let's consider some collective/distributive data involving 'demonstrative' mass/count NPs:

- (25) *Plural: collective, distributive, 'mixed'*
- a. These men wrote operas. (Mozart, Verdi, Gilbert and Sullivan)
 - b. These men wrote musicals. (Rogers, Hammerstein, Hart)

The facts in (24) are used to argue for the importance of ‘aggregates’, which are constructed out of sets. Collective readings arise when the maximal aggregate is the argument of the predicate; distributive interpretations are the result of distributing over members of the aggregate.

- (26) *Mass: collective only?*
- a. This fruit was wrapped in that paper.
 - b. This jewelry contains one ounce of gold.
 - c. This fruit contains bugs.
 - d. This rice contains microscopic bugs.
 - e. This water contains arsenic.

The similarities between mass nouns and plurals comes from the interpretation of +/-PL: roughly, -PL NPs introduce sets of cardinality 1, while +PL NPs introduce sets of cardinality greater than 1.

- Plural nouns introduce sets of cardinality greater than 1, and so allow aggregation of the elements.
- Mass nouns are always -PL, but because they denote quantities of stuff, they allow aggregation. (There’s a natural ordering on quantities that’s parallel to the aggregate ordering on sets of objects, though I don’t think BG explicitly says this.)
- Singular count nouns introduce sets of cardinality 1, so they do not allow aggregation.

The weird thing about the analysis is that aggregates are not actually part of the semantics; rather, the actual semantics is pretty much the same as the ‘non-starter’ analysis I mentioned above. In fact, the actual semantic analysis of sentences like (25) is non-compositional:

“The main idea is that a predicate whose argument is a [plural NP like the ones above] is evaluated, not with respect to the [NP’s] denotation, but with respect to the elements in the aggregation constructed from its denotation, where the choice of aggregation is determined pragmatically.” (p. 620)

I’m not quite clear on how Gillon handles quantified NPs.

The intuition here about what kinds of meanings plurals and mass nouns give rise to seems on the right track, but it’s not clear that the theoretical cost of the analysis is worth it, especially when we consider the stipulation about the relation between count nouns and plurality. If we can come up with a fully compositional analysis that achieves at least the same level of descriptive adequacy.

4 Link’s logic of plurals and mass terms

I’m going to try to provide a somewhat informal but hopefully fairly accurate interpretation of Link’s (1983) analysis of mass terms and plurals, and show what it buys us. Link’s paper contains an extremely detailed presentation of the actual logic (and how it supports a compositional semantics of a fragment of English), but we don’t need to go through everything to understand his core proposals.

(27) *Core assumptions*

- i. The set of objects from which natural language predicates (of which mass, count and plural nouns form a subgroup) find their denotations has structure. This is not a linguistic fact; it is an ontological fact.
- ii. Mass, singular count, and plural nouns denote objects with different structural (in the sense above) properties.
- iii. Predicates in general can specify the sort of objects that fall under their denotations.

More precisely, the model we need to account for noun denotation has the following four components:

1. A set of atomic objects A .
This set consists of both ‘familiar’ objects (me, you, the Linguistics Department house, etc.), parts of objects (my arm, this room, etc.), and quantities of stuff (the air in this room, $100c^3$ of the air in this room, etc.).
2. A structured set of atomic and plural objects $E \supseteq A$, with join operation \sqcup_i and intrinsic ordering relation \leq_i .
Think of this as what we get by taking the individual objects in A and combining them in various ways, treating those combinations as new objects, and combining those as well. There are lots of combinations here that we would never talk about (like *George Bush and the water in my arm*), but they are all there in principle.
3. A structured set of quantities of objects $D \subseteq A$ with join operation \sqcup_m and ordering relation \leq_m .
Think of this as what we get by taking every quantity of stuff in A and further dividing it up into all of its subquantities.
4. A homomorphic mapping from E to D such that:
 - (a) if $a \leq_i b$, then $h(a) \leq_m h(b)$, and
 - (b) $x \in D \leftrightarrow h(x) = x$

The mass/count distinction is again pretty similar to the ‘intuitive’ version we considered at first; the difference is that we now have a clearer picture of how everything fits together:

- Count nouns denote (functions from) objects in A (to truth values).
- Mass nouns denote (functions from) quantities in D (to truth values).
- Plural nouns denote (functions from) proper plural objects in E (to truth values).
- Objects and their constitutive quantities of stuff are related by the h function.

In particular, plurality is handled fully compositionally by introducing an operator (the denotation of the plural morphology) that combines with an expression to return a new predicate whose domain is E .

- (28) a. $\text{Domain}([_N \text{book}]) = \text{the set of atomic books}$
 b. $\text{Domain}([_N[_N \text{book}]_s]) = \text{the set of individual sums built from the set of atomic books}$

Let's see how this system explains some of the facts we observed at the beginning:

number, exceed, etc. Presumably predicates like these are properties of individual or material sums (and not merely sets of objects). But do we have to say a bit more about the meaning of *number*? In particular, do we need to add something like a measure function? I suspect so.

Collective and distributive predicates In general, predicates can be assumed to contain both atomic objects and sums in their domains; such predicates will allow for both collective/distributive interpretations. Differences between determiners (e.g., *all* vs. *each* and *the PL* vs. *all the PL*) are accounted for in the semantics of the determiner system.

At the same time, predicates may be lexically or morphologically marked to apply only to sums (collective predicates) or only to atoms (distributive predicates). The latter should not allow mass nouns, unless the mass noun denotation can be construed as containing atoms (*fruit, furniture, jewelry, etc.*).

What about:

- (29) a. *Fruit is piled on top of each other.
 b. *Furniture is piled on top of each other.

Pluralization Crucially, in order for pluralization to have a semantic effect, the input domain must consist of atomic objects. The domain of a mass noun is not atomic objects, but structured quantities, so pluralization is semantically vacuous, and therefore anomalous.

- (30) a. $\text{Domain}([_N \text{gold}]) = \text{the set of quantities of gold (a join semilattice)}$
 b. $\text{Domain}([_N[_N \text{gold}]_s]) = \text{the set of individual sums built from the set of quantities of gold, which is the same thing, since quantities of gold already have this structure}$

If a mass noun can be construed as picking out distinct *units* of some substance, pluralization should be ok, thus the interpretation of *wines, waters*, and so forth.

Determiners This can be handled semantically. For example, *three* can be analyzed as a function that takes a structure in *E* and returns all the i-sums that contain three atoms. Mass noun denotations don't contain atoms, so *three MN* is out.

Classifiers/measure phrases I want to worry about this next week, but the core idea is surely that the function of a classifier or measure phrase is to take something that is not an atom and return an atom (of some size).

many, few, much, little and comparatives Presumably something similar to what we say about *exceed*, classifiers and measure phrases.

Anaphoric reference This should be fairly straightforward, except for the business about conjoined mass nouns. Maybe this is a good paper topic...?

Cumulative reference and homogeneity The domain of plurals and mass nouns are structurally parallel; in particular, both obey cumulativity and (potentially) homogeneity.

5 Some questions of ontology

Link (1983): “[I]f we have, for instance, two expressions *a* and *b* that refer to entities occupying the same place at the same time, but have different sets of predicates applying to them, then the entities referred to are simply not the same.”

So, for example, both (31a-b) could be true, though the predicates are mutually incompatible, indicating (by this logic) that *the gold in my ring* and *my ring* are not the same entities.

- (31) a. The gold in my ring is very old.
b. My ring is not very old.

Of course, we do get equivalences like (32a-b) as well, assuming in this case that my ring is 100% gold.

- (32) a. The gold in my ring weighs 100g.
b. My ring weighs 100g.

But this assumption just goes to show that this relation is indeed contingent.

What do we think about this?

References

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