Mixed comparatives and the count-to-mass mapping

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Abstract Previous works used comparative sentences like *Sue has more gold/ diamonds than Dan* to study the mass/count distinction, observing that mass nouns like *gold* trigger non-discrete comparative measurement, while count nouns like *diamonds* trigger counting. These works have not studied comparatives like *Sue has more gold than diamonds*, which combine a mass noun and a count noun. We show that naturally appearing examples of such 'mixed comparatives' usually invoke non-discrete measurement. We analyze the semantics of this effect and other coercisons of count nouns into mass-like meanings: pseudo-partitives (*20kg of books*), degree interpretations of counting-based denominal adjectives (*more bilingual*), 'grinding' contexts (*bicycle all over the place*) and number unspecified determiners (*most, a lot of*). Based of this analysis we propose a revised system of Rothstein's context-driven counting. In the proposed account, 'impure' semantic atoms replace the role of contextual indices in Rothstein's account. The effacing/grinding ambiguity in Rothstein's system is replaced by one general count-to-mass mapping. The common *rock*-like mass/count polysemy is used as emblematic for this count-to-mass mapping instead of the rather rare *carpet/ing* alternation in Rothstein's proposal. We show advantages of this revised system in treating count-to-mass phenomena, including the unacceptability of mixed comparatives like #*more rock than rocks.*

Keywords comparatives · countability · mass terms · nouns

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1 Introduction

Common nouns are traditionally classified into *mass nouns* (MNs) and *count nouns* (CNs). In English, singular MNs and CNs differ in their ability to appear naturally as bare arguments (*I bought gold/*car*), in their plural meanings (*three golds/cars*), and in the determiners they typically combine with (*much gold/?car*), among other differences. The semantic implications of the mass/count distinction have been hotly debated. McCawley (1975) was apparently the first to recognize that comparatives can be used to probe into meanings of CNs and MNs. More recently, this test has been profitably used in examples like the following (Barner & Snedeker 2005; Bale & Barner 2009):

(1) a. Esme has more shoes/ropes than Seymour.
b. Esme has more butter/rope than Seymour.

Barner & Snedeker's experiments support the introspective judgement that (1a) involves counting and (1b) involves non-cardinal measuring. The same work also shows preference for counting with *object mass nouns* (OMNs) – MNs that intuitively refer to discrete atomic entities:

(2) Esme has more footwear than Seymour.

Despite the mass status of *footwear*, the OMN in (2) patterns with the CNs in (1a) rather than with the MNs in (1b). Similar results appear with *furniture, clothing* and *jewelry*. From this evidence Bale & Barner (2009: 226-7,246-7), Wellwood (2019: 90) and others deduce a categorical generalization:

(3) Plural CNs and OMNs trigger counting in comparatives. Other MNs – the so-called 'substance' MNs – trigger non-cardinal measurement in terms of weight, volume etc.

Against this generalization, Grimm & Levin (2012) and Rothstein (2017) propose that OMNs do not require cardinality-based comparisons. Rather, comparisons between OMNs may be based on other contextual factors, as in the following example by Rothstein:

(4) John has more furniture than Bill, so he should use the larger moving truck.

Rothstein argues that the prominent interpretation of (4) involves comparison in terms of volume, not cardinality. She proposes that with all mass nouns, including OMNs, comparatives are interpreted in terms of measurement. However, for Rothstein one of the available ways of measuring quantities is *cardinality estimation*. On the basis of psychological evidence, she argues that cardinality estimation is different from counting. Unlike counting with CNs, which is grammatically encoded, cardinality estimation is extra-grammatical and is available with OMNs despite their non-countable grammatical status (Rothstein 2017, p.133).

Examples like (1), (2) and (4) compare quantities referred to by a single noun (*shoes, rope*(*s*) etc.). Here we also examine comparisons between quantities refereed to by different nouns as in the following examples:

(5) a. Esme has more shoes than socks.
 b. Esme has more footwear than clothing.
 c. Esme has more butter than cream.

In (5a-c) the prominent reading compares cardinalities with CNs and OMNs (5a-b), and non-cardinal measures with substance MNs (5c). This is what generalization (3) expects. However, we should also consider comparatives where a CN is mixed with an MN as in the following examples:

(6) a. The first 100 days of the Narendra Modi government offer *more worries than hope.*
 b. Pirates' treasures usually contained *more gold than diamonds.*
 c. I'm still weirded out that Sharon and I have *more shelf space than books* at the moment!
 d. To obtain wealth beyond measure, seek to make *more friends than money.*
 e. While the juveniles prefer insects to greens, adults will need to eat *more vegetation than insects.*

These comparisons involve measurement rather than counting. The obvious trigger is the MN in the comparison, which is either not associated with any standard countable unit (*hope*) or is associated with units that are nevertheless not counted in the given context (*money*). A similar phenomenon is observed in comparisons between OMNs and substance MNs:

(7) a. Self storage is a great solution when you have *more furniture than space.*
 b. Let's explore 4 tips for those troubled souls who have *more artwork than wall space.*

c. I don't think they realize I never cook and the cupboards hold *more dishware than food.*

d. Be wise about the way you shop, and you will find that you can afford to purchase *more footwear than you have room to store.*

e. *More decoration than cake* but who eats the cake part anyway?

The mass nouns *furniture, artwork, dishware, footwear* and *decoration* in (7) are typically classified as OMNs (Erbach 2021: 201). In (7) they are compared with ordinary MNs like *space* and *food*, or in the case of *cake*, a "ground" countable noun in the singular (see section 2.1). In this context we do not count pieces of furniture, works of art etc. but estimate their total volume, area or weight as is often the case with MNs.

Notwithstanding, cardinality-based judgements are also possible when a CN or OMN is compared to a substance MN. When the context makes clear what the relevant units for that MN are, cardinality-based judgements may be invoked.[1] For example, in (8) below, cardinality is primed by Carl Sagan's famous comparison between the number of stars in the universe and of grains of sands on the Earth's beaches. In (9) the mass noun *hair*, usually a substance MN,[2] triggers measurement with the CN *teeth* in (9a), as expected, but counting unexpectedly appears in (9b) due to the explicit reference to individual hairs.

(8) The only way I can reasonably imagine deciding there are *more stars than sand, or more sand than stars,* is if one estimate comfortably exceeds the other by six or more magnitudes...

(9) a. She was a stooped old relic, with *more bald skin than hair and more hair than teeth.*

b. He had *more hair than teeth*, and his hairs totalled three.

Sentences (6)-(9) are evidence that generalization (3) must be refined. In these sentences, comparing the referent of the CN or OMN to the substance MN is usually achieved by applying a non-cardinal scale to the CN/OMN.

[1] We ignore the question if cardinality-based comparisons as in (8) and (2)/(5b) (or even (1a)/(5a)) are due to counting, or due to cardinality estimation as Rothstein (2017) proposes.

[2] Witness the contrast in *Dan has more hair(s) than Sue*, which predominantly involves measurement for *hair* and cardinality for *hairs.*

Regarding OMNs, Rothstein's and Grimm & Levin's approaches can analyze examples like (7) similarly to other cases where OMN denotations are measured on the basis of volume, weight or other dimensions. However, the examples with CNs above raise questions for both approaches. One question concerns the exact characterization of situations that inhibit the usual, cardinality-based, interpretation of comparatives with CNs. This is the subject of section 3. Another question concerns the nature of the semantic change that CNs undergo when they are compared to substance MNs as in (6). This question is addressed in section 4. Before approaching these theoretical questions, however, section 2 reviews some other cases where CNs show a substance-like behavior.

2 Other mass-like readings of count nouns

This section briefly reviews cases where CNs are interpreted or measured as non-discrete entities, which is more typical of MNs. For contrast we also show cases where CNs do not show such meanings despite being in a mass environment. We first discuss the familiar cases of *grinding* of CNs in mass-like syntactic environments, as well as their *measuring* in pseudo-partitives, and the lack thereof with determiners like *most* that are unspecified for mass/count. To these cases we add a less familiar one: denominal CN-based adjectives like *multilingual* (≈'of more than one language') that are used in degree constructions like adjectival comparatives (*more multilingual*) or degree modification (*very multilingual*). We propose that these phenomena stem from one systematic mass-like reading for CNs. The availability of this reading can be described using the same 'last resort' principle that was used by Cheng & Doetjes & Sybesma (2008) for describing differences in 'grinding' between Mandarin and English. This analysis is elaborated in section 3.

2.1 Non-discrete readings in mass-like environments ("grinding")

Pelletier (1975) introduced a test that he referred to as the "universal grinder". Following Gleason (1965), Pelletier puts a singular CN in a syntactic environment that is usually reserved for MNs, as in the following example:

(10) There is bicycle all over the floor.

Sentence (10) is interpreted as meaning that bicycle parts are spread all over the floor. With CNs like *bicycle*, which intuitively have well-established discrete units, this mass-like interpretation is referred to as "grinding". A greater flexibility between discrete and "ground" meanings shows up with nouns like *chicken*, where the discrete interpretation also appears to be the basic one, but the non-discrete, 'grinding' effect is at least as common.

Cheng & Doetjes & Sybesma (2008) point out that in contrast to English, Mandarin Chinese resists "grinding" with nouns whose denotation is intuitively countable. Let us consider Cheng et al.'s examples below:

(11) a. *dì-shang dōu shì shuǐ.*
floor-TOP all COP water
"there is water all over the floor"

b. *qiáng-shang dōu shì gǒu.*
wall-TOP all COP dog
"there are dogs all over the wall" (e.g. painted on a wallpaper)

Similar to typical English MNs, (11a) shows a non-discrete interpretation of the noun *shuǐ* ('water'). By contrast, (11b) shows that in the same syntactic environment the noun *gǒu* ('dog') only gives rise to a discrete interpretation, referring to individual dogs without any "grinding". Cheng et al. analyze this behavior on the basis of the following generalization:

(12) **Last resort grinding** (with CNs): in environments that allow both discrete and non-discrete interpretations, CNs get a discrete reading; "grinding" of CN denotations only takes place in environments that select for non-discrete readings.

In English, bare singular arguments are readily interpreted as mass, which triggers "grinding" in (10), i.e. reference to bicycle parts. By contrast, the Mandarin example (11) is syntactically unspecified for mass/count. Cheng et al. propose that *shuǐ* ('water') is a lexical MN and *gǒu* ('dog') is a CN, which determines the interpretations in (11). The same account is adopted for similar examples in Brazilian Portuguese and Gungbe that do not exhibit an overt mass/count distinction (Cheng & Doetjes & Sybesma 2008: 54).

2.2 Measuring with number-unspecified determiners

Languages with clear mass/count distinctions may also have environments that accept nouns of both sorts. Specifically, certain quantificational expressions freely appear with both singular MNs and plural CNs. In such environments, as with English ‘grinding’ effects, the noun’s number determines its mass/count interpretation. For example, let us consider the quantifiers *most* and *a lot of* in determiner position (13a) and partitives (13b-c):

(13) a. Weathering leads to the gradual ageing of $\left\{\begin{array}{l}\text{most}\\ \text{a lot of}\end{array}\right\}$ stone(s).

b. This year, foxes devoured $\left\{\begin{array}{l}\text{most of}\\ \text{a lot of}\end{array}\right\}$ our chicken(s).

c. She kept $\left\{\begin{array}{l}\text{most of the}\\ \text{a lot of}\end{array}\right\}$ rope(s) to herself.

The singular nouns in (13) are measured as might be expected from MNs, and their plural correlates are predominantly counted. For instance, ageing of *stone* in (13a) pertains to a large quantity of stone material, whereas ageing of *stones* predominantly (or maybe even exclusively) pertains to a large cardinality of discrete units or kinds of stone.

Different languages have different determiners that are underspecified between mass and count, but they show similar phenomena to (13). This is the case with the Dutch determiner *hoeveel* (‘how much/how many’) and the Hebrew determiner *kama* (‘how much/how many’, also ‘several’):

(14) *Jan weet hoeveel steen (stenen) Piet heeft.*
Jan knows how-much/many stone (stones) Piet has
‘Jan knows how much stone (how many stones) Piet has’

(15) *Tal yoda’at kama even (avanim) Dan carix.*
Tal knows how-much/many stone (stones) Dan needs
‘Tal knows how much stone (how many stones) Dan needs’

Similarly to (13), the plural nouns in (14) and (15) trigger counting whereas the singular nouns trigger measuring. A related phenomenon was pointed out by Rothstein (2017, p.123, following Landman 2011):

(16) a. In terms of volume, most livestock is cattle.
b. #In terms of volume, most farm animals are cattle.

Unlike the singular OMN use of *livestock* in (16a), the CN *animals* is quite unacceptable with the non-cardinal measuring in (16b). Again we see that number unspecified determiners like *most* require cardinality-based interpretations when combined with plural CNs.

Finally, let us consider the following example:

(17) I didn't think there was very much/a lot of dog inside all that fur, but he had bright attentive eyes.

We cannot interpret the singular quantification in (17) as involving many dogs. The entity that is being measured here is one dog's solid body (or some more abstract quality of "dogness") as compared to dog fur. Importantly, there is no clear sense in which this reading requires violent 'grinding' of the dog. Semantically, what is important is the reference to a part-whole structure, which is absent in 'count' environments of CNs.

2.3 Measuring in pseudo-partitives

Let us consider the following examples from (Rothstein 2017:p.143):

(18) a. five kilos of books/toys/paintings
b. five kilos of rice/glass/paint

Pseudopartitives with CNs as in (18a) involve measuring similar to the MNs in (18b). Rothstein proposes that measure phrases like *five kilos* in (18a) take a mass complement, and that CNs like *books* are shifted to MNs, both syntactically and semantically. She uses this account to analyze the (un)acceptability of the following examples:

(19) #five kilos of three books

(20) a. #Twenty kilos of books are lying on top of each other on the floor.
b. I haven't read much/#many of the twenty kilos of books that we sent.

Rothstein proposes that in (19) the numeral forces the syntactic 'count' feature of the nominal *three books*, hence it is syntactically ruled out in the pseudo-partitive. Further, the syntactic 'mass' feature of the pseudo-partitive in (20a) blocks the reciprocal expression, similarly to *#20kg of rice are lying on top of each other*. This accounts for the *much*/*many* contrast in (20b), but not for the origin of the difference between CNs and the nominals they form: why can the CN *books* syntactically be shifted to an MN in (18a) while the nominal *three books* in (19) cannot be shifted from a 'count nominal' to a 'mass nominal'? An empirical aspect of this question can be observed when considering the following mixed comparative:

(21) A king is worthy of more gold than these few trinkets.

The nominal *these few trinkets* in (21) contains the count quantifier *few* (rather than *little*), hence it syntactically has a 'count' status, and the mixed comparative triggers its measuring. In pseudo-partitives too, complex count numerals are not completely ruled out, as witnessed by the contrast between (19) and the following example:

(22) two kilos of small tomatoes

The pseudo-partitive (22) is used for measuring a set of tomatoes, each of which is discretely categorized as 'small'. Thus, measuring occurs here with a complex nominal headed by a CN whose denotation is discrete. How can this measuring be accounted for *vis à vis* the unacceptability of (19)?

To address these questions, let us first note that we can avoid the reliance on the syntactic categories mass/count in Rothstein's proposal, and describe the data only in terms of discrete and non-discrete *meanings*. Like Rothstein, we assume that measuring in pseudo-partitives results in a non-discrete denotation. Thus, *20kg of books* has a non-discrete denotation, which rules out the discrete quantifiers *each other* and *many* in (20a-b). Following Rothstein again, we assume that measuring with CNs requires shifting their discrete denotation into a non-discrete denotation. However, unlike Rothstein, we do not assume any obligatory change in the syntactic status of CNs when they undergo non-discrete measuring. Thus, in (18a), (22) and (21) the nominals *books*, *small tomatoes* and *these few trinkets* are all ordinary count nominals. Their syntactic acceptability in the pseudo-partitive triggers the shifting of their denotation into a non-discrete denotation. The unacceptability of the numerals like *three* in (19) is assumed to be syntactic, and to follow from the same general principles that govern the distribution of nominals in pseudo-partitives and partitives (Stickney 2009), which are beyond the scope of this paper. With these modifications of the descriptive perspective, we can summarize the observations in this section and section 2.2 using the following generalization:

(23) **Last resort measurement** (with CNs): in environments that allow both counting and measuring, CNs prefer counting; measuring CN denotations only occurs in environments that select for it.

In this generalization, measuring and counting with underspecified determiners (section 2.2) are regulated using the same principles that are observed above with pseudo-partitives. For example, CNs with *most* as in (13) trigger counting despite the fact that measuring is possible in this environment. By contrast, when the environment forces measuring, as with pseudo-partitives, it applies to CNs too. Viewed in this way, 'last resort' measuring is remarkably similar to the 'last resort' grinding principle in Cheng et al.'s proposal (12). This uniform description is a key to our semantic account in section 4 below. Before introducing it, however, let us consider another example of the way 'massy' environments force a coercion of CN denotations into non-discrete meanings.

2.4 Denominal quantity adjectives

Prefixes like *mono-*/*uni-*, *bi-* and *multi-*/*poly-* can be used with certain nominal roots to form adjectives that seem to have a 'count' reading. Thus we have:

(24) *mononuclear* ≈ 'having one nucleus'
unidimensional ≈ 'having one dimension'
bipolar ≈ 'having two poles'
multicentric ≈ 'having more than one center'
polysyllabic ≈ 'consisting of several syllables'
tricolor ≈ 'having three colors'

While these CN-based paraphrases seem to capture the meaning of the positive form of the adjective, they cannot be used to paraphrase its comparative form, as the following texts explicitly state:

(25) a. Bilingualism is not a categorical variable… the more proficient you are in a second language, and the more you use it in your daily life, the *more bilingual* you will be.
b. Is the UK *more multicultural* than America? The US may well have a higher percentage of different races but that it is only part of how multiculturalism works.

These quotes highlight the fact that it is impossible to categorize someone as being *more bilingual* than someone else by just counting the languages that each person speaks (as first language). Similarly, we cannot say that one place *is more multicultural* than another by simply categorizing and counting cultures (or 'races') in the two places. The following texts illustrate the same point with other CN-based adjectives:

(26) a. Australia is far *more monolingual* than it really should be.
b. Results suggested that bisexual men's arousal patterns were markedly *more bisexual* than monosexual men's.
c. The first and most straightforward prerequisite of polycentricity is that there is a distribution of large and small cities… A flat rank-size distribution is *more polycentric* than a steep one.
d. Some of these [functions of accents in German] also emerge in the study of circumflex, but they are irregular and unimportant; circumflex is *more monofunctional* than acc. 1, acc. 2, stød, and nostød. [book on German accentology]

In these cases a comparative like *more monolingual* or *more bisexual* is interpreted as a degree expression, whose meaning is similar to "closer to a situation with only one language" or "closer to the typical bisexual pattern". Such degree comparisons involve dense rather than discrete scales. Furthermore, to the extent that adjectives like *biweekly, bifunctional* and *mononuclear* are used for counting in comparatives, counting is based on a statistics using the numeric interpretation of the positive form. For example, in (27) below the comparative is used for counting occurrences of mononuclear cells, rather than for counting nuclei:

(27) The cellular composition of the foci in vaccinated mice was significantly *more mononuclear* than in normal mice.

This behavior of denominal CN-based adjectives is hardly surprising given generalizations (12) and (23) above and the well-established analysis of comparative adjectives as involving dense scales (Wellwood 2019). Thus, it is the general 'density' of these adjectival forms that triggers degree effects with CN-based adjectives. When the adjective is in an environment that requires measurement, it must be interpreted non-discretely despite the discrete denotation of the underlying CN or nominal root. A similar point holds with respect to degree modifiers like *very* and *somewhat*:[3]

(28) a. My husband and I live overseas in a *very bilingual* environment where the local language is Spanish but we speak English at work.

b. Are there any *somewhat multicultural* small towns in Canada?

The emerging generalization on CN-based adjectives is stated below:

(29) **Last resort measurement** (with CN-based adjectives): in the positive form, which allows both counting and measuring, CN-based adjectives prefer counting (24); non-discrete "measuring" only takes place in environments like degree modifiers or comparatives that select for a non-discrete semantics.

3 The use of the 'count-to-mass' mapping

In view of 'massified' readings of CNs as in section 2, previous works proposed various operators that map countable denotations to uncountable denotations. Here we make the following claims on the count-to-mass mapping:

1. *Measurement requires density*: Only non-discrete readings of CNs can undergo non-cardinal measurement.
2. *Last Resort*: Deriving non-discrete (hence measurable) denotations

[3] An anonymous EISS reviewer points out that degree effects also appear with adjectives like *pregnant* or *Republican*, which are not CN-based but are nevertheless interpreted categorically in the positive, e.g. *very pregnant* (cf. (26),(28)) or *Alabama is more Republican than California* (cf. (27)).

for CNs is a last resort operation, which can be activated by a syntactic 'mass' environment (e.g. 'grinding' in English *à la* Cheng et al.), but also by semantic pressures in syntactically 'count' environments.

3. *Only one count-to-mass mapping*: Unlike Rothstein's proposal, both non-discreteness and measurement phenomena with CNs are treated using the same count-to-mass mapping. There is no evidence for Rothstein's claim that the mass/count alternation in cases like *carpeting*/*carpets* is emblematic of a separate count-to-mass mapping.

This section elaborates on the first two claims, which concern the circumstances in which count-to-mass mappings are used. Section 4 concerns the semantics of the count-to-mass strategy, hence the number of operators that must be involved in its definition.

3.1 Measurement requires density

Although we claim that non-discrete readings and measurement phenomena with CNs are related, we should note that semantically they are not the same: a non-discrete reading does not have to involve any measure phrase, and measuring may in principle apply to discrete entities. With this point in mind, let us summarize the interpretative effects we have seen:

(i) *Discreteness*, with or without explicit counting, is common with CNs, e.g. with 'a' indefinites, numerals and plurals, including comparatives with one or two CNs (*Sue has more ropes than Dan/rocks*), as well as in environments that are unspecified for the mass/count distinction (Mandarin (11b)).

(ii) *Non-discreteness* of CNs appears in English when they are in a singular mass environment. The non-discrete nature of the CN meaning is often interpreted as 'grinding', but it can also manifest itself in other ways, as in (17) above.

(iii) *Measurement* is observed with plural CNs and CN-based adjectives in English when the semantics requires it: in pseudo-partitives with nominals, mixed nominal comparatives, and degree environments like adjectival comparatives.

Countability is a hallmark of discrete sets. However, the linguistic property that we intuitively call 'discreteness' may also appear without any counting expression, e.g. in the Mandarin sentence (11b) or its plural English translation ("there are dogs all over the wall"). Since discreteness and countability are so common with CNs, they are standardly considered as the key for analyzing their semantics. Nonetheless, in syntactic 'mass' environments CNs may get a non-discrete ('ground') reading. Similarly, in environments that unambiguously require measuring, CN denotations can be easily measured. There are two ways to look at these effects. One is to see them as related to one another: to be measured on a dense scale a CN has to receive a non-discrete interpretation.[4] Another way is to disconnect non-discreteness from measurement and allow discrete denotations of CNs to be measured directly. A priori we cannot rule out any of these two options, but there is reason to prefer the former. First, both non-discrete interpretations and measuring appear as last resort options with CNs. In environments that allow both discrete and non-discrete interpretations, CNs receive a discrete reading; in environments that allow both counting and measurement, CN denotations are counted. As summarized above, it is only in environments where non-discreteness and/or measuring are required that these phenomena show up with CNs. Another piece of circumstantial evidence comes from Rothstein's examples (20a-b). These examples illustrate that the distribution of pseudo-partitives like *20kg of books* is similar to that of MNs. This suggests that the CN interpretation is non-discrete: it is straightforward to treat the measure phrase in such pseudo-partitives as a simple modifier of non-discrete denotations. The alternative treatment would be more complex: a function that assigns non-discrete meanings to denotations that may be discrete or non-discrete. An additional piece of evidence comes from denominal forms like *more bilingual*. If measuring in such cases were to be dissociated from density, we might expect them to lead to the same odd effect we get in comparatives like #*more double*.

While these arguments are inconclusive, they support a clear picture about count-to-mass mappings in semantics: in any case where we find a measurement effect or a non-discrete interpretation involving a CN, we assume that a count-to-mass mapping has been at work. Environments like pseudo-partitives, denominal adjectival comparatives and mixed comparatives require measurement, hence we say that they *semantically select* for

[4] Fox & Hackl (2007) propose the more radical thesis, where even cardinal numerals operate on dense scales.

a non-discrete, 'mass' interpretation. Like Rothstein, I consider this to be a plausible null hypothesis, which will be used in the analysis that follows.

3.2 Last resort: lexical, syntactic and semantic information

With this assumption, the following examples all require a count-to-mass mapping of a discrete CN meaning:

(30) pseudo-partitives: *20kg of books*
mixed comparatives: *more money than friends*
denominal comparatives: *more bilingual*

As said above, the idea that certain semantic environments select for a mass reading of CNs meshes well with familiar syntactic and lexical influences on mass/count readings. As representative examples for these effects in English, we consider (31) and (32) below. The English bare singular in (31a) triggers a non-discrete interpretation of the CN (involving 'grinding', i.e. bicycle parts) whereas the bare plural in (31b) involves the common discrete interpretation of the noun. Conversely, sentence (32a) supports a non-discrete interpretation of the MN (i.e. beer liquid) while the bare plural in (32b) sanctions a discrete interpretation that involves 'packaging' beer liquid into containers (bottles, cans, etc.).[5] The 'packaging' mapping will be discussed later in this section.

(31) a. There is bicycle all over the floor. (=(10))
b. There are bicycles all over the floor.

(32) a. There is beer all over the floor.
b. There are beers all over the floor.

As Borer (2005: p.103-4) points out, such syntactic influences on the mass/count distinction should be separated from our tendency to interpret the noun *bicycle* as referring to discrete entities and *beer* as referring to non-discrete stuff. At the same time, while there are certainly nouns that are lexically quite neutral between mass and count readings (e.g. *paper, pizza*), many nouns show a strong lexical preference between mass and count (e.g.

[5] Another discrete reading of (32b) involves *sorts* of beer. This kind of reading appears with MNs and CNs alike (cf. reference to car brands in: *these are the top 10 luxury cars that should be on your bucket list*), hence it is orthogonal to our purposes here.

dust vs. *boy*; see Rothstein 2017,ch.7; Cheng & Doetjes & Sybesma 2008).

We propose that the lexical, syntactic and (formal) semantic influences on the mass/count distinction work operationally as a cascaded decision procedure. A decision at a certain linguistic level may trigger semantic coercion, thus effacing effects of decisions made at previous levels in the meaning derivation. Figure 1 depicts the proposed synthesis. In words:

(i) *Semantic selection*: A 'mass' (*m*) or 'count' (*c*) semantic environment determines the discreteness of the noun's interpretation, independently of lexical preferences and syntactic selection (nodes I and II in Figure 1, respectively).

(ii) *Syntactic selection*: If the semantic environment is neutral, then a 'mass'/'count' syntactic environment determines the discreteness of the noun's interpretation independently of lexical preferences (nodes III and IV).

(iii) *Lexical selection*: If the nominal's environment is semantically and syntactically neutral, then the lexical preference of the noun is manifested (nodes V and VI).

Node VII represents a thoroughly neutral situation, where no level dictates any mass/count distinction (see below).

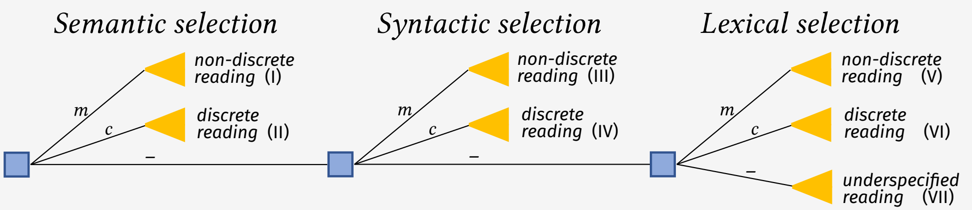

Figure 1 mass/count decision – semantic, syntactic and lexical selection

Suppose that the meaning of a nominal derived by its lexical preference and syntactic environment is discrete (non-discrete). If that meaning does not match the semantic environment, case (i) dictates its coercion into a non-discrete meaning (discrete meaning, respectively). When the nominal's lexical meaning is discrete (non-discrete), case (ii) entails a similar coercion into a non-discrete (discrete) meaning in any syntactic environment that is specified as 'mass' ('count', respectively). To summarize:

(33) **Mass-count coercion**: The meaning of any nominal that is lexically (syntactically) assigned a discrete/non-discrete denotation can be coerced into a non-discrete/discrete meaning if the syntactic environment (semantic environment, respectively) requires that.

According to this principle, mass-count coercions may occur in both directions for syntactic or semantic reasons. We already reviewed some examples for three out of these four coercions, as subsumed by Cases I, III and IV in Figure 1. Under Case I, coercion occurs when the semantic environment is 'mass' but the noun's lexical-syntactic interpretation is 'count'. This is the case with pseudo-partitives like *five kilos of books* as in (18a), with CN-based adjectives in semantic environments that require a degree interpretation (section 2.4), and with most mixed comparatives (6). Coercion in Case III happens when the semantic environment is neutral to the mass/count distinction, the syntactic environment selects for a mass interpretation, but the noun shows a lexical preference for 'count'. This is the case with English grinding as in (31a). Determiners with singular nouns similarly lead to non-discrete interpretations in English, Dutch and Hebrew, as discussed in section 2.2, e.g. in relation to example (17). Coercion in Case IV is a result of a neutral semantic environment with a 'count' syntax of a noun with a lexical 'mass' preference. In English examples like (32b) this results in 'packaging', which is further discussed below.

Cases V and VI are situations where a noun that is lexically specified as either 'mass' or 'count' appears in a semantically and syntactically neutral environment. That such cases are attested in Mandarin is the gist of Cheng et al.'s argument regarding the absence of a 'grinding' effect in (11b). Case VII is illustrated by the following Hebrew example:

(34) *yesh neyar al ha-shulxan*
exists paper on the-table
'There is (a) paper on the table'.

Unlike Mandarin, Brazilian Portuguese and Gungbe, Hebrew does not have number-neutral nouns. However, unlike English, it allows bare singular CNs in argument position. Accordingly, sentence (34) is ambiguous (or vague) between a mass interpretation (paper material) and a count interpretation (a piece of paper). Thus, the sentence can be true if there is a pack of print paper on the table or if there is one piece of written paper there. This ambiguity vanishes when a quantifier disambiguates the noun as mass (e.g. *kcat neyar* 'some paper') or count (e.g. *neyar exad* 'one paper'). We conclude that in (34), the lexical CN/MN status of *neyar* leads to indeterminacy. Replacing *neyar* by an unambiguous MN (Case V, e.g. *avak* 'dust') or unambiguous CN (Case VI, e.g. *xatul* 'cat') removes the indeterminacy.

As said above, the 'packaging' effect in cases like (32b) is described by Case IV of Figure 1 using syntactically-driven coercion. Can semantic 'count' environments similarly coerce a non-discrete meaning into a semantically-driven discrete meaning? There are indications that the answer is positive, which is what Case II in Figure 1 implicitly assumes. Let us consider the following example from (Bale & Barner 2009):

(35) Seymour counted the sugar but not the water.

As Bale and Barner point out, this sentence can be used to describe a situation with sugar packets and bottles of water, where Seymour counted the former but not the latter. In this case the semantic environment of the verb *to count* semantically coerces the non-discrete interpretation of the two MNs into a discrete interpretation, leading to a 'packaging' effect. Bale and Barner argue that this does not necessarily suggest that the denotation of the nouns (or noun phrases) in (35) becomes discrete. It is conceivable that the definite *the sugar* is 'counted' as a whole.[6] However, this logical possibility is less viable when it comes to sentences like the following:

(36) Seymour counted sugar but not water.

In sentence (36) the morpho-syntactic form of the bare singulars requires a non-discrete interpretation. The fact that counting can take place in the same way it does in (35) suggests that the semantic environment coerces the mass noun denotations into countable, discrete denotations.

If indeed the mass-to-count coercion works symmetrically to the count-to-mass coercion, we find ourselves facing an interesting puzzle concerning

[6]It is conceivable, though questionable. We can't say #*Seymour counted the chessboard* when what Seymour did was to count the squares. Bale and Barner's line entails that we might have to make an unprincipled distinction between 'portion counting' with *sugar* (possible) and 'part counting' with *chessboard* (impossible).

mixed comparatives as in (6b) and (9b) from section 1, restated below:

(37) Pirates' treasures usually contained *more gold than diamonds*.

(38) He had *more hair than teeth*, and his hairs totalled three.

In (37) a count-to-mass mapping is prominent, except for contexts where the gold loot is arranged in discrete units (coins, bars etc.). Sentence (38) illustrates the opposite effect: the noun *hair*, whose primary mass use is as a substance MN (note 2), is used for counting in a mixed comparative when the context makes clear that this is what we need in order to make sense of the utterance. A similar effect was illustrated in (8) above. Is there a general rule for comparing CNs and MNs in mixed comparatives? My proposed answer to this question is fairly simple: if the context of the sentence triggers 'packaging' of the MN, as in (36) and (38) above, we apply the mass-to-count mapping. If the context does not contribute any 'salient' packaging of the MN, we must compare quantities using some common measurement (volume, mass, value etc.), which is available independently of context. Thus, the count-to-mass mapping is the default semantic strategy, while the packaging criteria for the mass-to-count mapping must be provided by the context. This idea is supported by the facts on English, German and Icelandic that are covered in (Wiese & Maling 2005). Wiese and Maling observe that 'packaging' effects with MNs are common with certain nouns (e.g. *beers*=sorts of beer or containers with beer) and hardly appear with others (*liquids*=predominantly sorts of liquid).[7]

4 The formal semantics of mixed comparatives

As proposed above, the analysis of mixed comparatives should involve a count-to-mass operator. The semantic details of such an operator depend on how we distinguish 'mass' meanings from 'count' meanings. Here I develop ideas by Rothstein (2017: ch.4) and others: while MNs denote simple lattices over semantic atoms, CN denotations involve a *contextual partition* of the corresponding mass domain. I propose that unlike what Rothstein suggested, this mass/count distinction only supports one 'count-to-mass' operation. That operation is at work whenever the semantic environment selects for a lattice structure. This structure is present with MNs and plural

[7] See (Acquaviva 2004) for related cross-linguistic facts about plural mass terms.

CNs in English and similar languages, as well as with all nouns in languages without marking like Mandarin. However, there is no lattice structure with singular CNs. ‘Grinding’ effects with singular nouns stem from this distinction: it is only triggered by non-lattices, hence only with singular CNs. This account works in a similar fashion with mixed comparatives and the other phenomena that were reviewed above.

4.1 Noun denotations: mass vs. count, singular vs. plural

We standardly assume that any model contains an arbitrary discrete set E of entities. Elements from E are used as the ‘semantic atoms’ of mass denotations. We follow Chierchia (1998) in treating any MN as denoting an atomic join semi-lattice generated from a subset of E. For example, suppose that in a given model, $S \subseteq E$ is the set of ‘atoms’ associated with the concept STONE: the minimal elements that are perceived as instances of STONE in the given model. The mass denotation of the noun *stone* is then the lattice generated by S, which we standardly denote ‘$*S$’.[8] For example, suppose that in a given model the set S of stone atoms includes the elements a, b and c of E. The mass reading of the noun *stone* has the following denotation:[9]

(39) $$[[\text{stone}]]_{\text{mass}} = *S = *\{a,b,c\}$$
$$= \{a,\ b,\ c,\ a+b,\ b+c,\ a+c,\ a+b+c\}$$

According to Rothstein, mass meanings as in (39) are associated with the root of *any* noun. However, a singular CN entry must denote a contextual selection of mutually disjoint sets from its root’s mass meaning. Thus, in a model where the mass denotation of *stone* is as in (39) above, Rothstein proposes that the ‘count’ denotation is some subset of this collection with mutually disjoint elements, as determined by the context.[10] For example, below we illustrate CN denotations of *stone* in two different contexts, ‘1’

[8] Equivalently, without Link’s (1983) metaphysical bias against powersets we can think of $*S$ as the collection $\wp(S)-\{\varnothing\}$: the powerset of ‘stone atoms’ excluding the empty set.

[9] We standardly use ‘x’ for singletons $\{x\}$ in a lattice L. Set union on L is denoted using summation, hence a set $\{a,b,\ldots\}$ from L is denoted ‘$a+b+\ldots$’.

[10] This is a simplification of Rothstein’s proposal. In fact Rothstein (2017:110-112) includes contexts in her ontology. This is not necessary in the proposal below, which follows Rothstein’s ‘context-based’ treatment of CNs, but adapts it to Chierchia’s treatment of the mass/count distinction without explicit contextual entities in the model.

and ‘2’, both of which are based on the mass denotation in (39):

(40) $[[\text{stone}]]^1_{\text{count}} = \{a, b+c\}$

$[[\text{stone}]]^2_{\text{count}} = \{c, a+b\}$

In context 1 there are two discrete stones: one stone is made of the ‘stone atom’ a, and the other is the sum of the atoms b and c. In context 2, one stone is the ‘stone atom’ c and another stone is made out of a and b.

We summarize Rothstein’s proposal as follows:

(41) **CN denotation – *stone*** (Rothstein):

For any set of stone atoms $S \subseteq E$, the CN denotation of *stone* in a context k is a collection $\mathcal{S}^k$ of mutually disjoint subsets of S. Formally:

$[[\text{stone}]]^k_{\text{count}} = \mathcal{S}^k \subseteq {*S}$, s.t. for any $A, B \in \mathcal{S}^k$: $A \cap B = \varnothing$.

A welcome result of definition (41) is that different contexts may lead to different interpretations of the count noun *stone* without any change in the stone material. This comes in handy when we want to describe a situation where one stone is broken into two, or where two fences may also be conceived of as one. However, definition (41) allows the contextual collection $\mathcal{S}^k$ to exclude atoms from S, which is counterintuitive. For instance, (41) allows a context where $\mathcal{S}^k = \{a+b\}$, with the atom c excluded. In such a context the only discrete stone would be $a+b$. This situation is quite problematic, as it makes the following mixed comparative true, in case Matilda owns all the stone in $\{a, b, c\}$:

(42) #Matilda owns more stone than stones.

Sentence (42) is unnatural: how could anyone own stone material that is not perceived as somehow divided into individual stones? Similar problems appear with other ‘flexible’ nouns like *pizza, hair, paper* etc.

The motivation that Rothstein gives for her method in (41) comes from English noun pairs like *carpet-carpeting* and *fence-fencing*. According to Rothstein’s judgement, the quantity of carpeting material may exceed the material in full-blown carpets. Consider for example a situation where the denotation of *carpeting* is made out of five atoms: a, b, c, d and e. Suppose that we only have two carpets: one carpet made of the sum a+b, and another made of the sum $c+d$. In such a context k we would have:

$$[\![\text{carpeting}]\!]^k_{\text{mass}} = *\{a,b,c,d,e\}$$

$$[\![\text{carpet}]\!]^k_{\text{count}} = \{a+b,c+d\}$$

A mixed comparative sentence like *there is more carpeting than carpets* might correctly describe such a situation.[11]

The mass/count alternation in the case of ‘flexible’ nouns like *stone* is by far more common than the *carpet*/*carpeting* alternation. Thus, instead of viewing *carpet*/*carpeting* as representative of a general count/mass ambiguity, I revise Rothstein’s definition (41) as follows:

(43) **CN denotation – *stone*** (revised version):

For any set of stone atoms $S \subseteq E$, the CN denotation of *stone* in a context k is a partition $\mathcal{S}^k$ of S using mutually disjoint sets. Formally:

$$[\![\text{stone}]\!]^k_{\text{count}} = \mathcal{S}^k \subseteq *S \text{ s.t. } \biguplus \mathcal{S}^k = S.$$

This definition is similar to Rothstein’s definition (41), but it eliminates the aforementioned problem: in all contexts, the union of the members in the count denotation of *stone* equals the union of members of the mass denotation. In formula:

(44) $\bigcup[\![\text{stone}]\!]^k_{\text{count}} = \bigcup[\![\text{stone}]\!]_{\text{mass}}$

Our treatment of plural CNs follows Chierchia’s account of plural CNs and employs Link’s (1983) plurality operator ‘$\circledast$’: [12]

(45) $[\![\text{stones}]\!]^k_{\text{count}} = \circledast[\![\text{stone}]\!]^k_{\text{count}}$

For example, let us consider context 1 in (40), where the countable denotation of *stone* is $\{a,b+c\}$. Here we see another limitation of Rothstein’s definitions. Applying the $\circledast$-operator to the set $\{a,b+c\}$ would result in set

[11] Two English speakers that I consulted thought that whole carpets may be excluded from the denotation of *carpeting*. That might raise problems for Rothstein’s account of the *carpet*/*ing* alternation, which I do not address here.

[12] The ‘$\circledast$’ operator is Link’s plural version (Chierchia’s ‘PL’) of his $*$-operator. For any set $X \neq \varnothing$ and $\mathcal{S} \subseteq *X$, the set $\circledast\mathcal{S}$ is the closure of $\mathcal{S}$ under union, excluding singletons. Formally: $\circledast\mathcal{S}$ is the smallest subset of $*X$ s.t. for any $A,B \in \mathcal{S}\cup\circledast\mathcal{S}$ s.t. $|A\cup B| \geq 2$: $A\cup B \in \circledast\mathcal{S}$.

$\{b+c, a+b+c\}$. This is an odd result: as the sum $b+c$ is conceived of as one unit we should expect the $\circledast$-operator to ignore the fact that it is made of two atoms, thus exclude it from the plural denotation similarly to the element a. By letting sums play the role of single countable units, Rothstein's account does not allow the $\circledast$-operator to ignore their internal structure. The same holds for numeral modifiers, which have to be relativised to the contextual partition of CN denotations (Rothstein 2017: p.112).

Instead, we introduce into Rothstein's system the idea that the elements of a CN's denotation in a given context are 'impure atoms' (Link 1984) or 'groups' (Landman 1989) – objects that are ontologically complex but viewed as atoms by the counting system. To avoid confusion, I refer to 'impure atoms' as semantic *molecules*. For any given set $A \subseteq E$ with at least two members, we say that $\uparrow A$ is the *molecule constructed from A*. Formally:

(46) **Molecules**: Let A be a non empty set. We define the 'molecule' $\uparrow A$ made of A to be A itself if A is a singleton, and an element outside A if A is not a singleton.

In the opposite direction we define $\downarrow(\uparrow A) = A$, i.e. the atoms that make up a 'molecule' $\uparrow A$ are simply A's elements.[13] Using the $\uparrow$ operator, CNs are treated as follows:

(47) **CN denotation – *stone*** (final version):

For any set of stone atoms $S \subseteq E$, the denotation of the count noun *stone* is a collection of the atoms and molecules made of a partition $\mathcal{S}^k$ of S. Formally:

$[[\text{stone}]]^k_{\text{count}} = \{\uparrow A : A \in \mathcal{S}^k\}$, where $\mathcal{S}^k \subseteq {*S}$ s.t. $\dot{\bigcup}\mathcal{S}^k = S$.

The count readings of *stone* of (40) are now modified in (48):

(48)
$$[[\text{stone}]]^1_{\text{count}} = \{a, \uparrow(b+c)\}$$
$$[[\text{stone}]]^2_{\text{count}} = \{c, \uparrow(a+b)\}$$

Using the $\circledast$-operator, we get in context 1:

[13] More precisely: when $|E| = n$ and M a set of 'molecules' disjoint from E s.t. $|M| = 2^n - n - 1$, we define $\uparrow$ as a bijection mapping any singleton in $*E$ to itself and any non-singleton in $*E$ to an element of M. The $\downarrow$ operator is the inverse function of that bijection.

(49) $[[\text{stones}]]^1_{\text{count}} = \circledast\{a, \uparrow(b+c)\} = \{a + \uparrow(b+c)\}$

In words, when a and $\uparrow(b+c)$ are the individuated stones, the denotation of *stones* is only made of the *sum* of a and the molecule $\uparrow(b+c)$, and it does not contain $\uparrow(b+c)$ itself.

As a more complex example we consider a model with four stone atoms: a, b, c and d. Figure 2 gives the mass denotation of *stone* in this model, as well as the singular and plural count denotations of *stone*(*s*) in context '3', which amalgamates b and c into a molecule.

mass: $a, b, c, d, a+b, a+c, a+d, b+c, b+d, c+d,$
$a+b+c, a+b+d, b+c+d, a+c+d, a+b+c+d$

atoms: a, b, c, d

count^3 **singular**: a, $\uparrow(b{+}c)$, d

count^3 **plural**: $a+d$, $a{+}\uparrow(b{+}c)$, $d{+}\uparrow(b{+}c)$, $a{+}\uparrow(b{+}c){+}\,d$

Figure 2 from four atoms to a mass denotation; and to singular and plural count denotations in context 3

As in Chierchia (1998), MNs and plural CNs both denote lattices. Countability of plural CNs follows from the assumption that their denotations (perhaps counterintuitively) contain no singular entities, while MN denotations do. Formally:

(50) **Countability**: Let E be a finite set of entities. A join semi-lattice $L \subseteq {*E}$ is called *countable* if the following holds:

$$\bigcup L = ({*}\bigcup L) - L.$$

In words, a lattice L is countable if $\bigcup L$ consists of all elements in the uncountable lattice ${*}\bigcup L$ except the members of L itself. For instance, the lattice for plural *stones* in context 3 (figure 2) does not contain any of the elements $a, \uparrow(b{+}c)$ or d, hence it is countable. We refer to these elements as the *counting units* of that countable lattice. In general, any plural CN denotes a countable lattice L whose minimal elements are doubleton sums $x{+}y$, where x and y are the counting units: atoms or molecules. By contrast, any MN denotes an uncountable lattice since that lattice contains all the (atomic) units that make it up.

4.2 The semantics of the ‘count-to-mass’ mapping

According to Rothstein’s line, what distinguishes plural CNs from MNs is the contextual index that is attached to elements of CN denotations. According to Chierchia the distinction lies in the lattice structure of the denotations: countable with plural CNs, uncountable with MNs. The current proposal combines the two lines: on the one hand we incorporate contextual influences on CNs by introducing molecules that are contextually constructed by the ↑ operator into CN denotations. On the other hand we rely on Chierchia’s distinction and not on an explicit encoding of contextual indices inside denotations. When it comes to the ‘count-to-mass’ mapping, we treat it as an operator that makes sure that the denotation of a noun has a lattice structure, whether countable or uncountable. Grinding is only a possible by-product of this mapping. We refer to this ‘grinding’ operation as *massification*, which is defined below:

(51) **Massification**: Let E be a finite set of entities, and let X be some set disjoint of E containing all molecules over E. For any set $A \subseteq *(E \uplus X)$, we define the *massification* of A as the following set:

$$mass(A) = \\ \quad * \left(\{x \in E : x \in E \cap \bigcup A \text{ or there is } y \in X \cap \bigcup A \text{ s.t. } x \in\downarrow y\}\right).$$

In words: to ‘massify’ a set A we collect the atoms making up A’s members, including atoms that make up molecules among A’s members. For example, suppose that A is the singular CN denotation from figure 2:

$$A = [[\text{stone}]]^3_{\text{count}} = \{a, \uparrow(b+c), d\}$$

The union set $\bigcup A$ is A itself, where the atoms are a and d, and the atoms from A’s single molecule are b and c. Massification leads to the mass denotation of *stone* in figure 2: the lattice made up of a, b, c and d.

Using massification we define ‘count-to-mass’ mapping *c2m* as follows:

(52) Let E be a finite set of entities, and let X be some set disjoint of E containing molecules over E. For any set $A \subseteq *(E \uplus X)$:

$$c2m(A) = \begin{cases} A & \text{if } A \text{ is an uncountable lattice over } E \cup X \\ A \cup \bigcup A & \text{if } A \text{ is a countable lattice over } E \cup X \\ mass(A) & \text{otherwise} \end{cases}$$

The *c2m* operator leaves MN denotations intact. Plural CN denotations have their units added. By contrast, singular CN denotations are mapped to the 'ground' meaning, which is also the denotation of the corresponding MN. More explicitly, for any context k we have:

$$c2m([[\text{stones}]]^k_{\text{count}}) = [[\text{stones}]]^k_{\text{count}} \cup \bigcup[[\text{stones}]]^k_{\text{count}}$$

$$c2m([[\text{stone}]]^k_{\text{count}}) = mass([[\text{stone}]]_{\text{count}})$$

In words: the *c2m* denotation of the plural *stones* has a mass-like structure of an uncountable lattice, with the difference from the mass denotation being that minimal elements in that lattice may be molecules. For example, in the model and context of figure 2 we have for plural *stones*:

$$c2m([[\text{stones}]]^3_{\text{count}}) = \{a, \uparrow(b+c), d, a+d, \ a+\uparrow(b+c), \ d+\uparrow(b+c), \ a+\uparrow(b+c)+d\}$$

By contrast, the *c2m* denotation of the count reading of *stone* is 'ground', i.e. identical to the mass reading of the noun.

4.3 The semantics of mixed comparatives

With this semantic background we now get back to mixed comparatives as in the following simple examples:

(53) There is more gold than stone(s).

(54) There is more gold than bicycle(s).

(55) There are more bicycles than stones.

To analyze these examples we adopt the following principles:

P1. Nominal comparatives semantically select for lattices, i.e. denotations of MNs and plural CNs.
P2. With countable lattices comparison must be performed by counting.
P3. With uncountable lattices comparison must be performed using a *measure function* (μ), which maps lattice elements to real numbers.

Using these consensual principles we account for the semantic effects in (53)-(55) as follows. In (53) the comparison requires lattice denotations of the nouns (P1). The singular noun *stone* is lexically ambiguous between mass and count. The mass reading entails comparison using a measure function μ as in (56a) below. If the count reading is selected it must be massified using the *c2m* operator to become a lattice (last resort application, section 3). In this case 'grinding' by the *c2m* operator leads to the same result as with the mass reading. With plural *stones* in (53) principles (P2) and (P3) clash with each other: a countable lattice (*stones*) cannot be compared to an uncountable lattice (*gold*). The resolution is by last resort application of *c2m*, which maps the denotation of *stones* to its mass correlate but without any grinding of molecules.[14] This leads to the analysis in (56b) below.

(56) a. $\mu([[\text{gold}]]_{\text{mass}}) > \mu([[\text{stone}]]_{\text{mass}})$
$\mu([[\text{gold}]]_{\text{mass}}) > \mu(c2m([[\text{stone}]]^{k}_{\text{count}})) = \mu([[\text{stone}]]_{\text{mass}})$
b. $\mu([[\text{gold}]]_{\text{mass}}) > \mu(c2m([[\text{stones}]]^{k}_{\text{count}}))$

The analyses (56a) and (56b) are not necessarily equivalent: that depends on whether the measure function μ is also a measure function at the sub-molecular level. For a weight function μ, it is reasonable to assume that a molecule $\uparrow(a+b)$ weighs the same as the two atoms a and b together, in which case it is a measure function for these atoms. By contrast, the value of a precious stone might be greater than the combined value of its parts, hence value is not a measure function at the sub-molecular level. Such a possible difference between (56a) and (56b) may be attested in cases like *more gold than diamond*(*s*). It seems possible that a comparison of values might lead to truth with singular *diamond* but to falsity with plural *diamonds*, while a comparison of weights does not lead to such a contrast.

Sentence (54) is treated similarly to (53), as in (57) below. The difference from *stone*(*s*) is that *bicycle* is unambiguously a CN. Thus, only one analysis of the singular is obtained, using griding by the *c2m* operator.

(57) a. $\mu([[\text{gold}]]_{\text{mass}}) > \mu(c2m([[\text{bicycle}]]^{k}_{\text{count}})) = \mu([[\text{bicycle}]]_{\text{mass}})$
b. $\mu([[\text{gold}]]_{\text{mass}}) > \mu(c2m([[\text{bicycles}]]^{k}_{\text{count}}))$

Sentence (55) involves two countable lattice denotations of the plural CNs. Accordingly, the analysis is standardly in terms of cardinality (P2):

(58) $|\bigcup[[\text{bicycles}]]^{k}_{\text{count}}| > |\bigcup[[\text{stones}]]^{k}_{\text{count}}|$

[14] Another resolution (see section 3) is when the context provides a salient 'packaging' of *gold*. This allows this MN to be interpreted like the count nominal *chunks of gold*.

In words: the cardinality of the maximal element in the *bicycles* lattice is greater than the corresponding cardinality with *stones*. Now let us consider the following example (cf. (21)):

(59) There is more gold than these few trinkets.

Standardly, the denotation of *these few trinkets* is a the (singleton made of) the sum $t_1 + \ldots + t_n$ where $t_1, \ldots, t_n$ are all trinkets. This is not a lattice, hence it triggers the *c2m* operator. Each of the trinkets $t_1, \ldots, t_n$ (possibly) denotes a molecule with some minimal gold elements. For instance, suppose we have three trinkets t_1, t_2 and t_3, which are made out of atoms as follows:

$$t_1 = a \qquad t_2 = \uparrow(b + c) \qquad t_3 = d$$

Thus, t_1 and t_3 are the 'gold atoms' a and d, respectively, and t_2 is the molecule made of the 'gold atoms' b and c. Applying the *c2m* operator leads to massification, i.e. an uncountable lattice corresponding to the gold within the trinkets, where a, b, c and d are all minimal elements. This is the mass denotation in figure 2. The result is that the gold referred to in (59) is compared to the amount of gold in the trinkets: the atoms a, b, c and d.

A similar analysis applies to (60) and (61a-b) below:

(60) 100 kilos of bicycle(s)

(61) a. There is bicycle all over the place.
b. There are bicycles all over the place.

Pseudopartitives like (60) semantically select for a lattice denotation of the noun. If it is not a lattice, as in the singular case, applying *c2m* derives a 'grinding' effect. If the noun is already a lattice as with plural *bicycles*, we do not get such an effect. Sentences (61a-b) are similarly analyzed: the adverbial *all over the place* semantically selects for a lattice. The singular noun is therefore 'ground' by *c2m* whereas the plural is not. CNs as in Mandarin (11b) do not require plural marking in order to have a lattice denotation, hence there is no griding effect, similarly to (61b).

5 Conclusion

Mixed comparisons between mass nouns and count nouns provide a unique window into their semantics, where the meaning of one of the nouns, usually the count noun, is coerced into a meaning of the same kind as the other's. To study this phenomenon we have expanded our view to other cases where count nouns are 'massified'. We have seen how the same last resort principle accounts for cases where lexical preferences are overridden by syntax and where syntactic requirements are overridden by semantic selection. For both cases we have proposed one count-to-mass operator. In that operator, 'grinding' is only a result of the lack of lattice denotations with singular count nouns, rather than a general operation. When a lattice structure is available, as with plural count nouns, the count-to-mass operator is only responsible for shifting that countable lattice into an uncountable one. Our technique combines Chierchia's denotational difference between mass nouns and count nouns with Rothstein's context-driven individuation. Unlike Rothstein's account, the contextual procedure is the well-established process that forms 'impure atoms' out of pluralities. Under this treatment of count nouns Chierchia's elimination of singular elements from their denotation is no longer obligatory: massified, uncountable denotations contain them. It is only *countable* denotations that do not. Further work may use this feature of our proposal to retain interpretations where singularities are necessary with plural count nouns, as in the case of *both Sue and Dan have children* where Sue only has one child.

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References

Acquaviva, Paolo. 2004. Plural mass nouns and the compositionality of number. *Verbum* 26(4). 387–401.

Bale, Alan C. & Barner, David. 2009. The interpretation of functional heads: using comparatives to explore the mass/count distinction. *Journal of Semantics* 26(3). 217–252.

Barner, David & Snedeker, Jesse. 2005. Quantity judgments and individuation: evidence that mass nouns count. *Cognition* 97(1). 41–66.

Borer, Hagit. 2005. *Structuring sense: in name only*. Vol. 1. Oxford University Press.

Cheng, Lisa L. S. & Doetjes, Jenny & Sybesma, Rint. 2008. How universal is the Universal Grinder? *Linguistics in the Netherlands* 25(1). 50–62.

Chierchia, Gennaro. 1998. Plurality of mass nouns and the notion of 'semantic parameter'. In Rothstein, S. (ed.), *Events and grammar*. Dordrecht: Kluwer.

Erbach, Kurt. 2021. *Object mass nouns: a frame based analysis*. Heinrich Heine University Düsseldorf dissertation.

Fox, Danny & Hackl, Martin. 2007. The universal density of measurement. *Linguistics and philosophy* 29(5). 537–586.

Gleason, Henry Allan. 1965. *Linguistics and English grammar*. Holt, Rinehart & Winston.

Grimm, Scott & Levin, Beth. 2012. Who has more furniture? An exploration of the bases for comparison. Paper presented at the *Mass/Count in Linguistics, Philosophy and Cognitive Science Conference*, École Normale Supérieure, Paris, France.

Landman, Fred. 1989. Groups I & II. *Linguistics and Philosophy* 12. 559–605, 723–744.

Landman, Fred. 2011. Count nouns, mass nouns, neat nouns, mess nouns. In *The Baltic international yearbook of cognition*, vol. 6, 1–67.

Link, G. 1983. The logical analysis of plurals and mass terms: a lattice theoretical approach. In Bauerle, R. & Schwarze, C. & von Stechow, A. (eds.), *Meaning, use and interpretation of language*. Berlin: De Gruyter.

Link, G. 1984. Hydras. On the logic of relative constructions with multiple heads. In Landman, F. & Veltman, F. (eds.), *Varieties of formal semantics*. Dordrecht: Foris.

McCawley, James D. 1975. Lexicography and the count-mass distinction. In *Annual meeting of the Berkeley Linguistics Society*, vol. 1, 314–321.

Pelletier, Francis Jeffry. 1975. Non-singular reference: some preliminaries. *Philosophia* 5(4). 451–465.

Rothstein, Susan. 2017. *Semantics for counting and measuring*. Cambridge University Press.

Stickney, Helen. 2009. *The emergence of DP in the partitive structure*. University of Massachusetts Amherst dissertation.

Wellwood, Alexis. 2019. *The meaning of 'more'*. Oxford University Press.

Wiese, Heike & Maling, Joan. 2005. Beers, kaffi, and schnaps: different grammatical options for restaurant talk coercions in three Germanic languages. *Journal of Germanic Linguistics* 17(1). 1–38.