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Monotonicity in a numeral classifier language

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While many languages require an obligatory plural morpheme to make reference to plural individuals, numeral classifier languages generally do not (Greenberg 1972; Sanches & Slobin 1973; Doetjes 2012: a.o.). This led some researchers to conclude that noun denotations in numeral classifier languages are inherently plural. In this paper, I show that one can find a syntactic environment which requires a plural reading or a mass reading of a noun phrase in a numeral classifier language. The core empirical finding is that the postnominal measurement construction in Japanese (i) does not allow a singular reading, and (ii) sometimes triggers count-to-mass coercion. This suggests that the constraint that measure phrases select a non-quantised denotation (Krifka 1989) is non-trivially satisfied in Japanese even though Japanese is argued to have inherently cumulative common noun denotations. To solve this, I propose two possible analyses. The first option is to assume the *stratified measurement reference* (Champollion 2017) and the second option is to assume that Japanese distinguishes singular count nouns, plural nouns and mass nouns in its syntax (Watanabe 2006; 2017). I discuss the implications of these options in light of the previous literature and provide further data which may suggest that Japanese makes an atomicity distinction both in its lexicon and its syntax.

1 Introduction

The opposition between singular noun phrases and plural noun phrases has been a matter of extensive discussion in the literature on natural language semantics. While some languages resort to an obligatory plural morpheme, some languages do not. For example, English is classified in the former class of languages, e.g., *cats* is the plural counterpart of a singular noun *cat*. This singular-plural distinction is often tied with a count-mass distinction. For example, (1) and (2) exemplify how English differentiates count nouns from mass nouns (Barner & Snedeker 2005).

(1) Count nouns, e.g., *cat*, *table*,
   a. have a singular form and a plural form,
   b. their singular forms usually require a determiner,
   c. allow cardinal numbers to modify them, and
   d. allow quasi-cardinal determiners, e.g., *several*, *many*, *these*, *those*.

(2) Mass nouns, e.g., *milk*, *sand*
   a. have no plural form,
   b. do not require determiners,
   c. allow neither cardinal numbers nor quasi cardinal determiners,[1] and
   d. allow *much* or *little*.

On the other hand, some languages do not resort to an obligatory plural morpheme. There has been claimed to be an implicational universal that numeral classifier languages do not utilise an obligatory plural morpheme (Greenberg 1972; Sanches & Slobin 1973).[2] For example, Japanese is a numeral classifier language: numerals in Japanese cannot be combined with a noun without a classifier as shown in (3a) and (3b).[3,4] In both cases, omission of classifiers leads to ungrammaticality[5]

(3) a. san*(-nin)-no gakusei
   3-CL_{Person}-no student
   'three students'

[1] If a mass noun comes with a conventional unit of individuation, it can be counted based on the unit, e.g., *three beers* can count three bottles, glasses or cans of beer. However, if a conventional unit of individuation is not available, such readings are harder to obtain, e.g., *three dirts*. The operation responsible for it is often called *universal packager* (Bach 1989; Jackendoff 1991; Landman 1991; Rothstein 2017).

[2] See Doetjes (2012) for discussion and some potential counterexamples. She calls this generalisation the *Sanches-Greenberg-Slobin generalisation*.

[3] The categorical status of *no* is controversial. This can be the genitive case marker, a morphological linker, a predicative head or something else. To be neutral, I just gloss it as 'no'.

[4] Acceptability judgement on Japanese examples are mine unless they are cited from previous literature.

[5] There are some instances of bare numerals, e.g., prenominal modifiers which express approximate amount (Sudo 2016). I do not discuss those cases in this paper.

b. san*(-bon)-no biiru
3-CL$_{Bottle}$-no beer
'three bottles of beer'

Note that a classifier needs to co-occur with a numeral, regardless of the type of nouns. *Biiru* (beer) refers to a liquid and thus seems to lack a mode of individuation, while *gakusei* (student) refers to a certain kind of person and seems to have its inherent mode of individuation. This notional difference in individuation does not affect the obligatory presence of a classifier after a numeral.

On the top of that, Japanese has no obligatory plural morpheme and its bare nouns are neither marked for singular nor plural. Also, Japanese has no articles and is often argued to lack the category D^0.[6] For example, the bare noun *gakusei* (student) occurs in a sentence as shown in (4). Moreover, (4) involves the overt distributor "sorezore" at the adverbial/floating position. The proper name "Ken" cannot be associated with "sorezore" while the bare noun "gakusei" can: it induces a reading in which the students each read two books.[7] This shows that bare nouns can refer to plural individuals in Japanese without resorting to a plural morpheme.

(4) {*Ken / Gakusei}-ga kinoo **sorezore** hon-o ni-satsu ka-tta.
{Ken / student}-NOM yesterday each book-ACC 2-CL$_{book}$ buy-PAST
'{Ken / The students} each bought two books yesterday.'

These observations seem to suggest that (i) Japanese noun denotations are inherently plural, and (ii) Japanese lacks a count-mass distinction. Indeed, it has been disputed whether Japanese has a count-mass distinction (Barner & Snedeker 2005; Inagaki & Barner 2009; Watanabe 2006; 2017; Sudo 2016; Erbach et al. 2018; 2021: among others).

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[6] See Fukui (1995) for the classical argument against the category D^0 in Japanese that modification within the nominal domain is iterable, unlike languages with D^0.

[7] One of the reviewers points out that distributive determiners often select for singular count nouns in number marking languages and thus (4) may not suggest that "gakusei" is plural in this example. The reviewer suggested that an example with "both" would be more compelling. (i) shows an acceptable example in which "dochira-no NP-mo" (both NPs) at the prenominal position is combined with a bare noun. In addition, (ii) shows an acceptable example with "subete" (all), which is non-distributive since it is compatible with gather-type collective predicate. These examples strengthen the point that Japanese bare nouns can refer to plural individuals.

i Dochira-no gakusei-mo kinoo hon-o ni-satsu ka-tta.
both-no student-also yesterday book-ACC 2-CL$_{book}$ buy-PAST
'Both students bought two books yesterday.'

ii Subete-no gakusei-ga koodoo-ni atsuma-tta.
all-no student-NOM lecture hall gather-PAST
'All the students gathered at the lecture hall.'

In this paper, I aim to show that Japanese has a syntactic environment in which a plural reading or a mass reading of a noun phrase is forced. First of all, the combination of a numeral and a classifier can occur in at least three positions in Japanese as shown in (5).

(5) a. **San-nin**-no gakusei-ga hon-o yon-da. (PRENOMINAL)
3-CL$_{Person}$-no student-NOM book-ACC read-PAST

b. Gakusei **san-nin**-ga hon-o yon-da. (POSTNOMINAL)
Student 3-CL$_{Person}$-NOM book-ACC read-PAST

c. Gakusei-ga **san-nin** hon-o yon-da. (FLOATING)
Student-NOM 3-CL$_{Person}$ book-ACC read-PAST
"Three students read a book."

Second, classifiers are either *sortal* or *mensural* (Allan 1977; Aikhenvald 2000). Sortal classifiers specify a particular sort of individuals, e.g., *-nin* is a sortal classifier and it co-occurs with nouns which denote a set of human individuals. On the other hand, mensural classifiers measure the value of entities based on a certain dimension, e.g., *guramu* (gram) is a mensural classifier and it can co-occur with any nouns as long as it denotes a set of entities which have weight.

Now, I call the combinations of an NP, a numeral and a mensural classifier *measurement constructions*. If the unit of a numeral and a mensural classifier occurs prenominally, I call it the *prenominal measurement construction* and if it occurs postnominally, I call it the *postnominal measurement construction*. The contrast between these two constructions provides the core observations in this paper. (6) and (7) show that a notional count noun gives rise to different interpretations in the prenominal measurement construction and the postnominal measurement construction. *Go-hyaku-kiroguramu* (500 kilograms) consists of a numeral *go-hyaku* (five hundred) and a mensural classifier *kiroguramu* (kilogram). It occurs at the prenominal position in (6) and at the postnominal position in (7). (6) and (7) involve the same noun *uma* (horse), but they have different readings.[8]

(6) go-hyaku-kiroguramu-no uma
5-100-CL$_{Kilogram}$-no horse
a. 'a 500 kilogram horse'
b. ??'500 kilograms of horse meat'

[8] Throughout this paper, I mark an expression in an object language with *, ?? or # if it is deviant for some reason. I use * if an expression is not acceptable for native speakers of the language. In this sense, I do not distinguish ungrammaticality and semantic anomaly at the phenomenological level. I use ?? to indicate that an expression is acceptable with coercion, but the coercion is dispreferred. I use # to if an expression is infelicitous because of clash between the interpretation of this expression and common knowledge.

(7) uma go-hyaku-kiroguramu
horse 5-100-CL$_{Kilogram}$
a. *‘a 500 kilogram horse’
b. ‘500 kilograms of horse meat’

(6) can be used to refer to an individual horse. It can also refer to horse meat when uttered in a certain pragmatic context, e.g., the speaker is talking about a butcher in an area where people eat horse meat. On the other hand, (7) can only be used to refer to horse meat and it cannot be used to refer to an individual horse. I claim that this horse meat reading is an instance of a “mass” reading and this is forced due to the semantics associated with the postnominal measurement construction.

However, a notional mass noun does not exhibit this interpretive difference. (8) and (9) both involve *ni-juu-go-kiroguramu* (25-CL$_{Kilogram}$) and a notional mass noun *biiru* (beer). In principle, two types of readings are possible. In one reading, beer is individuated based on certain containers such as glasses, bottles or barrels and in the other reading, individuation of beer is underspecified. 25 kilograms include the weight of containers as well in cases of individuated readings, but it only includes the weight of beer in cases of non-individuated readings.[9] Unlike the minimal pair of (6) and (7), individuation does not affect the acceptability of (8) and (9): both can be used to refer to barrels of beer in a pub (individuated) or to beer stored in fermentation vessels in a brewery (non-individuated).[10]

(8) ni-juu-go-kiroguramu-no biiru
2-10-5-CL$_{Kilogram}$-no beer
a. ‘25 kilograms of beers’
b. ‘25 kilograms of beer’

(9) biiru ni-juu-go-kiroguramu
beer 3-CL$_{Gram}$
a. ‘25 kilograms of beers’
b. ‘25 kilograms of beer’

This contrasts with (6) and (7). First, (8) does not require a noun denotation to be individuated, unlike (6). Second, (9) does not require a noun denotation to be non-individuated, unlike (7).

[9] I thank to two anonymous reviewers for pointing out that the total weight should include the weight of containers if it is a reading with containers.

[10] In Section 3.1, I show that notional mass nouns also disallow a singular reading when they are individuated based on a container, but the main points of the observation are that (i) the prenominal measurement construction does not require a noun denotation to be individuated and (ii) when noun denotations are not individuated, the prenominal measurement construction and the postnominal measurement construction do not have an interpretive asymmetry.

Importantly, (6) and (7) respectively share the same syntactic environment with (8) and (9). Thus, the contrast between the pair (6)–(7) and the pair (8)–(9) should be attributed to difference in the semantics of common nouns.

I claim that this contrast follows from the general constraint on the semantics of measurement. For example, pseudo partitives in English select plural nouns or mass nouns as shown in (10a) and (10b), but not singular count nouns as shown in (10c).

(10) a. thirty pounds of **books**
b. thirty litres of **water**
c *thirty pounds of **book** (Champollion 2017: 61)

If the postnominal measurement construction in Japanese shares the same selectional restrictions as pseudo partitives in English, it nicely accounts for the fact that a singular count interpretation of *uma* (horse) is blocked in (7). However, this is unexpected if Japanese noun denotations are inherently plural: the selectional restriction on measurement would have been trivially satisfied. I propose two possible solutions to this problem. One is to adopt the semantics of pseudo partitives proposed in Champollion (2017) while maintaining the assumption that Japanese common noun denotations are inherently plural. The other is to assume that Japanese makes a syntactic distinction among singular count nouns, plural nouns and mass nouns (Watanabe 2006; 2017) while maintaining the semantics of pseudo partitives. Both approaches make non-trivial implications for the semantics of common noun denotations in Japanese, which I will discuss in Section 5.

The rest of this paper is organised as follows. Section 2 introduces the notion of *measurement monotonicity*. I argue that the postnominal measurement construction presupposes measurement monotonicity, just like English pseudo-partitives, but prenominal numeral quantifiers do not. Section 3 discusses the pattern of interpretations in the postnominal measurement construction. Section 4 proposes two possible approaches to account for the range of readings available in the postnominal measurement construction. These options differ in the precise domains of the Japanese grammar from which they derive the relevant distinction: one approach derives it from the semantics of monotonic measurement and the other derives it from a syntactic distinction among different noun classes. Section 5 discusses the implication of the two possible analyses in light of the accumulated work on a count-mass distinction in Japanese. I provide another set of observations which suggests that the postnominal measurement construction provides a piece of evidence for a syntactic atomicity distinction in Japanese.

2 Monotonicity and the syntax of measure phrases

This section discusses the interaction of syntactic structures and the semantics of measurement. Its upshot is that both in English and in Japanese, there are two different structures for measure

phrases, one of which involves monotonic measurement and the other involves non-monotonic measurement. This distinction is the source of the count-to-mass coercion. First of all, I introduce the basic properties of noun denotations in Section 2.1 to set up the background of the discussion. Based on it, Section 2.2 introduces the notion of monotonicity and show that this notion plays a crucial role in grammar of measurement.

2.1 Setting up a stage

In this section, I introduce the basic assumptions on the domain of individuals and the semantics of common noun denotations. First of all, I take the domain of entities D_e to be closed under the sum operation '+' and partially ordered based on the sub-part relation '$\sqsubseteq$' (Link 1983: *et seq*). When an individual has no sub-part other than itself, this individual is *atomic* or an *atom*.

(11) Atomic individuals (*Atom*): $\forall x[\text{Atom}(x) \Leftrightarrow \neg\exists y[y \sqsubseteq x \,\&\, y \neq x]]$

I call this notion of atomicity *mereological atomicity*, but I primarily use the term "atom" to refer to mereological atoms.

Two entities overlap if there is an entity which is a mutual part of these entities. I use the symbol $\circ$ to model the overlap relation following the convention.

(12) Overlap: $x \circ y \Leftrightarrow \exists z[z \sqsubseteq x \,\&\, z \sqsubseteq y]]$

I define the notion of generalised sum following Champollion (2017).

(13) Generalised Sum: $\bigoplus \text{P} = \iota x.\forall y[\text{P}(y) \rightarrow y \sqsubseteq x] \,\&\, \forall z\,[z \sqsubseteq x \rightarrow \exists z'\,[\text{P}(z') \,\&\, z' \circ z]]$

The closure of a property under sum is defined in (14) (Link 1983).

(14) Closure under sum: $^*\text{P} = \{x \mid \exists \text{P'} \subseteq \text{P} \,\&\, x = \bigoplus \text{P'}\}$

I assume that plural nouns denote sets of atoms which are closed under sum (Link 1983).

(15) a. $[\![\text{cat}]\!] = \{\text{cat}_1, \text{cat}_2, \text{cat}_3\}$
b. $[\![\text{cats}]\!] = {}^*[\![\text{cat}]\!] = \{\text{cat}_1, \text{cat}_2, \text{cat}_3, \text{cat}_1 + \text{cat}_2, \text{cat}_2 + \text{cat}_3, \text{cat}_1 + \text{cat}_3, \text{cat}_1 + \text{cat}_2 + \text{cat}_3\}$

In the original analysis of Link (1983), denotations of plural nouns lack the atoms, e.g., $[\![\text{cats}]\!] = \{\text{cat}_1 + \text{cat}_2, \text{cat}_2 + \text{cat}_3, \text{cat}_1 + \text{cat}_3, \text{cat}_1 + \text{cat}_2 + \text{cat}_3\}$. However, more recent analyses assume that denotations of plural nouns include atoms and the multiplicity inference comes from pragmatic inferences (Sauerland et al. 2005; Spector 2007; Zweig 2009; Križ 2017: to note a few). This choice does not matter for the purpose of this paper: I am only concerned with cases in which the multiplicity inference is obligatory and thus one can replicate the discussion based on the assumption that plural nouns do not include atomic parts.

Two higher-order properties, *cumulative reference* (Quine 1960) and *quantised reference* (Krifka 1989), distinguish denotations of singular nouns and denotations of plural nouns.

(16) a. Cumulative reference: $\mathrm{Cum(P)} \Leftrightarrow \forall x \forall y\ [[\mathrm{P}(x)\ \&\ \mathrm{P}(y)] \rightarrow \mathrm{P}(x+y)]$
b. Quantised reference: $\mathrm{Qua(P)} \Leftrightarrow \forall x \forall y\ [[\mathrm{P}(x)\ \&\ \mathrm{P}(y)] \rightarrow \neg\ (x \sqsubset y)]$ (Krifka 1989: 78)

Singular nouns are quantised, whereas plural nouns are cumulative. For example, *cat* is quantised and non-cumulative: $\mathrm{cat}_1 \in [\![\mathrm{cat}]\!]$ and $\mathrm{cat}_2 \in [\![\mathrm{cat}]\!]$, but $\mathrm{cat}_1 + \mathrm{cat}_2 \notin [\![\mathrm{cat}]\!]$ as shown in (15a), while *cats* is cumulative and non-quantised: $\mathrm{cat}_1 + \mathrm{cat}_2 \in [\![\mathrm{cats}]\!]$, $\mathrm{cat}_2 + \mathrm{cat}_3 \in [\![\mathrm{cats}]\!]$ and $\mathrm{cat}_1 + \mathrm{cat}_2 + \mathrm{cat}_3 \in [\![\mathrm{cats}]\!]$ as shown in (15b).

I assume that count nouns and mass nouns take their denotations in the same domain.[11] One can assume either a single non-atomic domain (Krifka 1989) or a single atomic domain (Gillon 1992; Chierchia 1998). Unless I explicitly mention it, I assume a single atomic domain of individuals. On this assumption, one can assume that singular count nouns and mass nouns are distinguished based on plurality: singular count nouns denote sets of atoms, whereas mass nouns denote sets of atoms which is closed under sum.[12] In this sense, mass nouns are inherently plural as exemplified in (17).

(17) $[\![\mathrm{water}]\!] = \{\mathrm{water}_1, \mathrm{water}_2, \mathrm{water}_3, \mathrm{water}_1 + \mathrm{water}_2, \mathrm{water}_2 + \mathrm{water}_3, \mathrm{water}_1 + \mathrm{water}_3, \mathrm{water}_1 + \mathrm{water}_2 + \mathrm{water}_3\}$

Mass nouns such as *water* have atomic parts, but their denotations are not related with a set of atomic parts, which serves as a counting unit (Chierchia 1998).

On this assumption, one cannot distinguish plural nouns and mass nouns.[13] To distinguish plural nouns and mass nouns, one can adopt another notion of atomicity. For example, the notion of P-atom (Krifka 1989) defines atoms relative to predicates.

(18) P-Atom: $\forall \mathrm{P} \forall x[\mathrm{P\text{-}Atom(P)}(x) \Leftrightarrow \mathrm{P}(x)\ \&\neg \exists y[y \sqsubseteq x\ \&\ y \neq x\ \&\ \mathrm{P}(y)]]$

(18) can distinguish plural nouns and mass nouns: the denotation of a plural noun includes P-atoms and the denotation of a mass nouns does not, while both are still sets of mereological

[11] Link (1983); Bach (1986) assume that the domain of atomic individuals and the domain of non-atomic individuals are separate. On this assumption, count nouns take their denotations in the atomic domain and mass nouns take their denotations in the non-atomic domain. However, this option presupposes that count nouns and mass nouns are semantically distinguished in a language under discussion. Since one of the research questions in this paper is whether Japanese exhibits this distinction, I do not adopt this double-domain analysis. Also, see Rothstein (2010) for a criticism for separating domains for count nouns and mass nouns.

[12] However, see Rothstein (2010); Chierchia (2010; 2015) for analyses which make distinction between mass nouns and plural nouns, while adopting a single atomic domain.

[13] In Chierchia (1998), denotations of plural nouns exclude atoms while denotations of mass nouns include atoms. However, this distinction is lost if one assumes that denotations of plural nouns include atoms. Note that more recent work of his (Chierchia 2010; 2015; 2021) takes the view that denotations of plural nouns include atoms and adopts a more elaborated notion of atomicity to distinguish count nouns and mass nouns.

atoms that are closed under sum. Note that this definition of P-atom is quite coarse-grained. Indeed, there are more elaborated versions of atomicity in the market (Rothstein 2010; Chierchia 2010; to note a few) and they are motivated to make more fine-grained distinctions among different types of nouns. However, it is beneficial for me to adopt a coarse-grained definition because my primary aim is to examine whether there is any indication of a count-mass distinction and/or a singular-plural distinction at all in Japanese. If it turns out that one needs at least a coarse-grained definition of atomicity to describe Japanese data, then one can proceed to the next step and ask if finer-grained definitions of atomicity are also motivated there.

Summing up, the two notions of atomicity make two different distinctions. The mereological atomicity distinguishes singular count nouns from plural nouns and mass nouns. The P-atomicity distinguishes singular count nouns and plural nouns from mass nouns. These two notions become relevant at different sections in this article. The mereological atomicity plays the central role in §4 and the P-atomicity plays the central role in §5.

2.2 Monotonicity in measurement

In this section, I introduce the notion of measurement monotonicity and show that this semantic property plays a crucial role in restricting the syntactic distribution of measure phrases in English. Monotonicity is defined as a property of measurement such that it traces the part-whole structure of noun denotations (Krifka 1989; 1992; Schwarzschild 2002; 2006; Nakanishi 2008; Wellwood 2015). '$\sqsubset$' is a proper part relation, '$<$' is a total order relation relative to the measurement dimension and μ is a function from individuals to degrees.

(19) Monotonicity (*to be revised*): $\mathrm{Mon}(\mu) \Leftrightarrow \forall x \forall y [y \sqsubset x \rightarrow \mu(y) < \mu(x)]]$

For example, litre-measurement is monotonic: part of an entity necessarily has a smaller volumes in litres than the whole. However, temperature-measurement is non-monotonic: part of an entity need not have a lower temperature than the whole. Schwarzschild (2002; 2006) shows that this property correlates with the syntactic distribution of measure phrases in English: pseudo partitives allow only monotonic measure phrases as shown in (20), but measure attributives[14] only allow non-monotonic measure phrases as shown in (21).[15]

(20) Pseudo-partitives:
  a. two **litres** of oil (Monotonic)
  b. *sixty **degrees** of oil (Non-monotonic)

[14] Schwarzschild (2006) calls them *attributives*.

[15] Monotonic measure functions and non-monotonic measure functions are also called *extensive* measure functions and *intensive* measure functions in the literature, e.g., Krifka (1989).

(21) Measure attributives:
a. *two **litre** oil (Monotonic)
b. sixty **degree** oil (Non-monotonic)

Pseudo partitives are sensitive to noun denotations as well: plural nouns and mass nouns can occur in a pseudo partitive structure as repeated in (22a) and (22b), but singular count nouns cannot as shown in (22c). This suggests that monotonic measure phrases select non-quantised noun denotations (Krifka 1989; Filip & Sutton 2017).

(22) a. thirty pounds of **books**
b. thirty litres of **water**
c. *thirty pounds of **book** (Champollion 2017: 61)

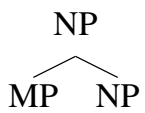
However, note that (22c) may allow a reading in which "book" is coerced to a mass noun. Champollion (2017) notes that (22c) can be used in a situation in which the books are sold by weight or five pounds of pulp that results from shredding books.

On the other hand, measure attributives allow singular count or mass nouns, but disallow plural nouns. For example, "seven pound babies" has two theoretically possible ways of parsing as shown in (23a) and (23b).

(23) a. [[[seven pound] baby] **-s**]
b. [[seven pound] [baby **-s**]]

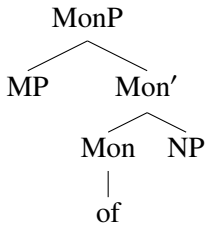
The structure (23a) offers a reading in which there are multiple babies each of who weighs 7 pounds. On the other hand, the structure (23b) offers a reading in which there are babies that collectively weigh 7 pounds. However, the reading associated with the structure (23b) is not attested, suggesting that measure attributives cannot attach to plural NPs.[16] Schwarzschild (2002; 2006) concludes that measure modifiers are lexical modifiers which occur inside an NP as shown in (24a), but pseudo partitives are functional modifiers which occur at the specifier of a functional head Mon^0, which occurs at the middle field of nominal functional projection as shown in (24b).

(24) a. Measure Attributives



[16] Morphologically, the plural morpheme *-s* need to be attached to the noun *baby*, not to the NP *7-pound baby*. This morphology-semantics mismatch is reminiscent of *bracketing paradox*. Though PF-lowering or LF-raising of of the plural morpheme is, in principle, possible, the position of the plural morpheme is higher than that of measure attributives in both account. So, I will not go into further detail.

b. Pseudo Partitives



This Mon^0 is responsible for the monotonicity constraint and the selectional constraint.

Despite its typological distance from English, Japanese also exhibits syntax-monotonicity correlation. Nakanishi (2008) notes that the postnominal measurement construction requires monotonic measurement, but prenominal numeral quantifiers are ambiguous as exemplified in (25) and (26).[17]

(25) Postnominal measurement construction
a. wain-san-**rittoru** (Monotonic)
wine-3-CL$_{Litre}$
'three litres of wine'
b. *abura-gojuu-**do** (Non-monotonic)
oil-50-CL$_{Temperature}$
'50°C oil'

(26) Prenominal measurement construction
a. san-**rittoru**-no wain (Monotonic)
3-CL$_{Litre}$-no wine
'three litres of wine'
b. gojuu-**do**-no abura (Non-monotonic)
50-CL$_{Temperature}$-no oil
'50°C oil'

These data suggest that Japanese postnominal measurement constructions impose a monotonicity constraint, just like English pseudo partitives. It raises a question of whether the postnominal measurement construction has a selectional constraint on noun denotations which is analogous to the one with English pseudo partitives. I will tackle this question in the next section.

[17] Note that Nakanishi (2008) takes the ambiguity in the prenominal measurement construction to suggest that the rigid syntax-monotonicity correlation is not maintained in Japanese.

3 The postnominal measurement construction in Japanese

In this section, I show that the postnominal measurement construction in Japanese imposes a similar selectional constraint on noun denotations to pseudo partitives in English. Since Japanese overtly marks neither a singular-plural distinction nor a count-mass distinction, this constraint is not visible from the choice of nominal predicate. However, this is detectable from the range of readings which are available in the postominal measurement construction. More specifically, a reading which asserts a singular individual is not allowed in the postnominal measurement construction. In some cases, this prohibition on a singular reading forces count-to-mass coercion. This is not expected if Japanese common noun denotations are all cumulative, as assumed under the existing view that common nouns in Japanese are not marked for either singular or plural.

3.1 Individual readings and substance readings

In this section, I discuss the range of readings that are allowed in Japanese measurement constructions. First of all, I introduce the terminology for the relevant readings. As a disclaimer, I primarily describe them in a theory-neutral way to avoid committing to any particular notion of atomicity.

An *individual reading* entails existence of discrete individuals.[18] There are two types of individual readings: *singular readings* entail existence of one individual and *plural readings* entail existence of more than one individual. Plural readings are furthre classified into two types: *distributive plural readings* attribute the measure phrase to each individual and *cumulative plural readings* attribute the measure phrase to the sum of individuals.[19] One may group up singular readings and distributive plural readings: if one pluralises the whole NP under a singular reading, one can obtain a distributive plural reading. In contrast, a *substance reading* entails absence of discrete individuals.[20] If one adopts P-atoms, this means that a substance reading entails absence of P-atoms. On the other hand, if one does not adopt P-atoms, this means that a substance reading entails existence of more than one atom and these atoms are different from those involved in plural readings.

Let me exemplify these readings with some examples. (27) and (28) contain a numeral *ni* (2), a mensural classifier *kiroguramu* ($CL_{Kilogram}$) and a notional count noun *ringo* (apple). While (27) allows all the four readings, (28) only allows a cumulative plural reading and a substance reading.[21]

[18] At this point, one may take these discrete individuals as mareological atoms or P-atoms. However, see §5.2 for the discussion that suggests that these discrete individuals should not be taken as P-atoms.

[19] I thank to anonymous reviewers for discussion on these terms.

[20] For example, one may use (28) to refer to a portion of pureed apple which is made from a 2 kilogram apple. However, one cannot use it to refer to the 2 kilogram apple.

[21] Some native speakers including the author accept all the four readings of (27). However, a few Japanese native speakers report that they prefer a singular reading in (27). As long as this is a matter of preference, the proposed account correctly predicts that all the four readings are, in principle, available for (27). I leave this issue of preference for future research.

(27) ni-kiroguramu-no ringo
2-CL$_{Kilogram}$-no apple
a. ‘a 2 kilogram apple’ (SINGULAR READING)
b. ‘2 kilogram apples’ (DISTRIBUTIVE PLURAL READING)
c. ‘2 kilograms of apples’ (CUMULATIVE PLURAL READING)
d. ‘2 kilograms of apple’ (SUBSTANCE READING)

(28) ringo ni-kiroguramu
apple 2-CL$_{Kilogram}$
a. * ‘a 2 kilogram apple’ (SINGULAR READING)
b. *‘2 kilogram apples’ (DISTRIBUTIVE PLURAL READING)
c. ‘2 kilograms of apples’ (CUMULATIVE PLURAL READING)
d. ‘2 kilograms of apple’ (SUBSTANCE READING)

Cumulative plural readings are not always available. If the relevant discrete individuals are not small enough relative to the measurement degree, a cumulative plural reading is blocked. In such cases, some nouns resort to count-to-mass coercion.[22] (29) and (30) use the same noun as (27) and (28), but use a measure phrase with a smaller degree. In (29) and (30), cumulative plural readings are not available: 100 grams is too light for multiple apples.

(29) hyaku-guramu-no ringo
100-CL$_{Gram}$-no apple
a. ‘a 100 gram apple’ (SINGULAR READING)
b. ‘100 gram apples’ (DISTRIBUTIVE PLURAL READING)
c. #’100 grams of apples’ (CUMULATIVE PLURAL READING)
d. ‘100 grams of apple’ (SUBSTANCE READING)

(30) ringo hyaku-guramu
apple 100-CL$_{Gram}$
a. *‘a 100 gram apple’ (SINGULAR READING)
b. *‘100 gram apples’ (DISTRIBUTIVE PLURAL READING)
c. #‘100 grams of apples’ (CUMULATIVE PLURAL READING)
d. ‘100 grams of apple’ (SUBSTANCE READING)

Now, recall the contrast between the prenominal measurement construction and the postnominal measurement construction with respect to the notional count noun *uma* (horse) as repeated in (31) and (32). Here, the singular reading and the distributive plural reading require there to

[22] Note that I use the term “count-to-mass coercion” in a purely descriptive way. One may posit a general sort-shifter that turns a count noun into a mass noun or one may assume that some nouns are polysemous. My main point is that the environments such as (30) require substance readings whatever mechanism is responsible for the coercion process.

be one or more than one horse individual each of which weighs 500 kilograms. In contrast, the cumulative plural reading requires there to be some horse individuals which collectively weigh 500 kilograms and the substance reading requires there to be a portion of horse meat which weighs 500 kilograms.

(31) go-hyaku-kiroguramu-no uma
5-100 $CL_{Kilogram}$-no horse
a. 'a 500 kilogram horse' (SINGULAR READING)
b. '500 kilogram horses' (DISTRIBUTIVE PLURAL READING)
c. #'500 kilograms of horses' (CUMULATIVE PLURAL READING)
d. ??'500 kilograms of horse meat' (SUBSTANCE READING)

(32) uma go-hyaku-kiroguramu
horse 5-100 $CL_{Kilogram}$
a. *'a 500 kilogram horse' (SINGULAR READING)
b. *'500 kilogram horses' (DISTRIBUTIVE PLURAL READING)
c. #'500 kilograms of horses' (CUMULATIVE PLURAL READING)
d. '500 kilograms of horse meat' (SUBSTANCE READING)

(33) shows that (31) can be used to express that one or more than one horses run, but (32) cannot be, i.e. it can only describe a strange situation in which horse meat runs in a horse race.

(33) {Go-hyaku-kiroguramu-no uma / *uma go-hyaku-kiroguramu}-ga kyoo-no reesu-de
{5-100 $CL_{Kilogram}$-no horse / horse 5-100 $CL_{Kilogram}$}-NOM today-no race-at
hashi-ru-rasii.
run-PRES-seems
"It seems that {(a) 500 kilogram horse(s) / 500 kilograms of horse} are running in today's race."

On the other hand, (34) shows that (32) can be used to express that a butcher sold some amount of horse meat in a month while (31) is degraded.

(34) Ano-nikuya-wa i-kkagetsu-de {?? go-hyaku-kiroguramu-no uma / uma
that-butcher-TOP 1-month-in { 5-100 $CL_{Kilogram}$-no horse / horse
go-hyaku-kiroguramu}-o u-tta.
5-100 $CL_{Kilogram}$}-ACC sell-PAST
"That butcher sold { (a) 500 kilogram horse(s) / 500 kilograms of horse} in a month."

Thus, the individual readings and the substance reading in (31) and (32) describe different types of entities: *uma* (horse) denotes a set of individual animate entities in the former, whereas it denotes inanimate non-individuated stuff in the latter. The contrast between (31) and (32) suggests that the postnominal measurement construction selects the latter in these cases. The

same contrast can be reproduced with smaller animals, e.g., *hamusutaa* (hamster). Count-to-mass coercion is more surprising in this case, considering that it is even less conventional to eat hamster meat.[23]

(35) go-juu-guramu-no hamusutaa
5-10 CL_{Gram}-no hamster
a. 'a 50 gram hamster' (SINGULAR READING)
b. '50 gram hamsters' (DISTRIBUTIVE PLURAL READING)
c. #'50 grams of hamsters' (CUMULATIVE PLURAL READING)
d. ??'50 grams of hamster meat' (SUBSTANCE READING)

(36) hamusutaa go-juu-guramu
hamster 5-10 CL_{Gram}
a. *'a 50 gram hamster' (SINGULAR READING)
b. *'50 kilogram hamsters' (DISTRIBUTIVE PLURAL READING)
c. #'50 grams of hamsters' (CUMULATIVE PLURAL READING)
d. '50 grams of hamster meat' (SUBSTANCE READING)

In both cases, a cumulative plural reading is available if the measurement degree is large enough as shown in (37a) and in (37b).[24]

(37) a. {Go-ton-no uma / Uma go-ton}-o nose-ta yusousen-ga tyakkan-sita.
{5-CL_{Ton}-no horse / horse 5-CL_{Ton}}-ACC load-PAST ship-NOM land-PAST
"A transport ship loaded with 5 tons of horses has landed."

b. {Go-kiroguramu-no hamusutaa / Hamusutaa go-kiroguramu}-o nose-ta
{5-$CL_{Kilogram}$-no hamster / hamster 5-$CL_{Kilogram}$}-ACC load-PAST
ookina kago-o mitsuke-ta.
large basket-ACC find-PAST
"(I) found a large basket which loads 5 kilograms of hamsters."

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[23] An anonymous reviewer reported that (36) sounds a bit far-fetched and the same thing applies to (32) to some extent. They suggest that "uma" (horse) is dispreferred when horse meat is meant due to some Gricean reasoning: the speaker can use the more appropriate expression "ba-niku" (horse meat). Still, they can use "buta" (pig) to refer to pork despite the presence of a separate expression "buta-niku" (pork). Though I do not examine if count-to-mass coercion is due to general sort-shifting or polysemy, this lexical variation of meat interpretations may favour a polysemy approach.

[24] Animacy may affect the acceptability of a cumulative plural reading: a cumulative plural reading with a human denoting noun is harder in measurement constructions. I thank an anonymous reviewer for pointing it out. I leave this effect of animacy for future research.

i {?? Go-hyaku-kiroguramu-no otona / ?? Otona go-hyaku-kiroguramu}-o nose-ta erebeetaa-ga
{ 5-100-$CL_{Kilogram}$-no adult / adult 5-100-$CL_{Kilogram}$}-ACC load-PAST lift-NOM
kosyoo-sita.
break-PAST
"A lift loaded with 500 kilograms of adults broke."

As shown above, easiness of count-to-mass coercion differs across nouns. For example, *ringo* (apple) easily allows a substance reading, whereas *uma* (horse) and *hamusutaa* (hamster) do not. Count-to-mass coercion is much harder with nouns that denote highly individual objects, e.g., *kuruma* (car). In (39), a cumulative plural reading is predicted to be unavailable because 2 kilograms is too light for multiple cars. Thus, if count-to-mass coercion is available, (39) should only allow a substance reading. The fact that (39) is degraded suggests that this coercion is quite hard or not possible with *kuruma* (car).

(38) ni-kiroguramu-no kuruma
2-CL$_{Kilogram}$-no car
a. ‘a 2 kilogram car’ (SINGULAR READING)
b. ‘2 kilogram cars’ (DISTRIBUTIVE PLURAL READING)
c. # ‘2 kilograms of cars’ (CUMULATIVE PLURAL READING)
d. *‘2 kilograms of car’ (SUBSTANCE READING)

(39) *kuruma ni-kiroguramu
car 2-CL$_{Kilogram}$
a. *‘a 2 kilogram car’ (SINGULAR READING)
b. *‘2 kilogram cars’ (DISTRIBUTIVE PLURAL READING)
c. #‘2 kilograms of cars’ (CUMULATIVE PLURAL READING)
d. *‘2 kilograms of car’ (SUBSTANCE READING)

A cumulative plural reading is fine with *kuruma* (car) when the measure is large enough to make this pragmatically plausible as shown in (40).

(40) {Go-ton-no kuruma / Kuruma go-ton}-o nose-ta yusousen-ga tyakkan-sita.
{5-CL$_{Ton}$-no car / car 5-CL$_{Ton}$}-ACC load-PAST ship-NOM land-PAST
“A transport ship which loaded 5 tons of cars has landed.”

Summing up, a singular reading and a distributive plural reading of a notional count noun are blocked in the postnominal measurement construction, whereas not in the prenominal measurement construction. If a measurement degree is too small to make a cumulative plural reading available, a count-to-mass coercion is triggered.

3.2 Notional mass nouns

In this section, I discuss notional mass nouns. Firstly, the postnominal measurement construction is not sensitive to individuation as repeated in (41) and (42). In this case, the singular reading and the distributive plural reading entail that stuff is individuated based on one type of container and the cumulative plural reading entail that this individuation is done based on possibly multiple types of containers. In contrast, substance readings do not entail presence of containers. Both (41) and (42) can be used regardless of presence of a container in a given context.

(41) ni-juu-go-kiroguramu-no biiru
2-10-5-$CL_{Kilogram}$-no beer
a. ‘a 25 kilogram beer’ (SINGULAR READING)
b. ‘25 kilogram beers’ (DISTRIBUTIVE PLURAL READING)
c. ‘25 kilograms of beers’ (CUMULATIVE PLURAL READING)
d. ‘25 kilograms of beer’ (SUBSTANCE READING)

(42) biiru ni-juu-go-kiroguramu
beer 2-10-5-$CL_{Kilogram}$
a. *‘a 25 kilogram beer’ (SINGULAR READING)
b. *‘25 kilogram beers’ (DISTRIBUTIVE PLURAL READING)
c. ‘25 kilograms of beers’ (CUMULATIVE PLURAL READING)
d. ‘25 kilograms of beer’ (SUBSTANCE READING)

In (43), a cooler contains several bottles of beer and the speaker report the total weight of those bottles of beer. Thus, beer is individuated based on bottles. In this context, the prenominal measurement construction and the postnominal measurement construction are both acceptable.

(43) Ima, biiru-o suu-hon ire-ta-node, kono kuuraa bokkusu-ni-wa
now beer-ACC some-CL_{Bottle} put-PAST-because, this cooler-at-TOP
{san-kiloguramu-no biiru / biiru san-kiroguramu}-ga hai-tte-iru.
{3-$CL_{Kilograms}$-no beer / beer 3-$CL_{Kilograms}$}-NOM put-PROG-PRES
“Now that I put several bottles of beer in it, this cooler contains three kilograms of beer.”

On the other hand, beer is not individuated based on containers in (44) and the speaker reports the total weight of beer produced in a brewery in one day. In this context, the prenominal measurement construction and the postnominal measurement construction are both acceptable.

(44) Kono jooryuujo-wa ich-nichi-atari {ni-hyaku-kiloguramu-no biiru / biiru
this brewery-TOP 1-day-per {2-100-$CL_{Kilograms}$-no beer / beer
ni-hyaku-kiroguramu}-o seizou-site-iru.
2-100-$CL_{Kilograms}$}-ACC produce-PROG-PRES
“This brewery produces two hundreds kilograms of beer per day.”

This suggests that the postnominal measurement construction does not require nouns to have non-individuated denotations and the prenominal measurement construction does not require nouns to have individuated denotations. Note that a singular reading is degraded in (42). This reinforces the main point of the observation: the selectional constraint of the postnominal measurement construction is visible in the range of readings available in this environment.

3.3 Interim summary

In this section, I have shown the range of readings available in the postnominal measurement construction in Japanese. The observed pattern is summarised in **Table 1**. The availability of substance readings with notional count nouns depends on the availability of count-to-mass coercion.

Classes of common nouns	singular	distributive plural	cumulative plural	substance
Notional count	*	*	ok	%
Notional (substance) mass	*	*	ok	ok

Table 1: The pattern of interpretations in the postnominal measurement construction.

The upshot is that the postnominal measurement construction in Japanese seems to impose some semantic restriction on noun phrases it selects. Although it is not visible in the type of nouns it selects, it is visible in the range of readings it allows. In the next section, I argue that this raises a puzzle and discuss two possible solutions to it.

4 Analyses of the postnominal measurement construction

So far, I have shown that the selectional constraint of monotonic measure phrases can be observed in the range of possible readings of nouns in the postnominal measurement construction in Japanese. In this section, I discuss its implications for the semantics of monotonic measurement. Recall that pseudo partitives in English impose measurement monotonicity and a selectional constraint on noun denotation. This can be informally stated as (45).

(45) ⟦Num-MP-of-NP⟧ is defined only if Mon(⟦MP⟧) & ¬Qua(⟦NP⟧).

If this is directly applied to Japanese, the semantics of the postnominal measurement construction is informally stated as (46).

(46) ⟦NP-Num-MP⟧ is defined only if Mon (⟦MP⟧) & ¬Qua (⟦NP⟧).

However, (46) does not explain why a singular reading is not available in the postnominal measurement construction in Japanese: (46) is stated as a constraint on predicates and thus it is trivially satisfied if common noun denotations in Japanese is closed under sum, i.e. cumulative. To solve this issue, one has to modify either the non-quantisation requirement or the NP denotation in (46). In the rest of this section, I examine these two options. In Section 4.1, I pursue an approach which modifies the semantics of monotonic measurement

while maintaining the assumption that common noun denotations in Japanese are inherently cumulative. In Section 4.2, I pursue another approach which modifies the semantics of Japanese common nouns so that Japanese has a covert singular-plural distinction, while maintaining the non-quantisation requirement. In both analyses, a distributive plural reading is not derived because one cannot pluralise the entire postnominal measurement construction. Section 4.3 shows how distributive plural readings are derived in the prenominal measurement construction in both approaches.

Note that I only talk about mereological atomicity in this section. P-atomicity is compatible with the analyses presented in the following sections, but it is not required. See §5 for the relevant data and discussions that motivate application of P-atoms to the semantics of Japanese common nouns.

4.1 Partition-based Monotonicity

In this section, I discuss a way to modify the definition of measurement monotonicity so that it can predict the range of readings available in the postnominal measurement construction in Japanese.

Champollion (2017) proposes a higher-order property *stratified reference*, which is a general constraint which applies to pseudo partitives, *for*-adverbials and the adverbial *each*. Since the main focus of this paper is on the semantics of monotonic measurement, I adopt a particular version of stratified reference for pseudo partitives which is defined in (47).

(47) Stratified measurement reference (SMR):
$\text{SMR}_{\mu}(P)(x) \Leftrightarrow x \in {}^{*}\lambda y[P(y) \,\&\, \mu(y) < \mu(x)]$
"A predicate P over entities has *stratified measurement reference* with respect to a function μ and a substance x iff x can be exhaustively divided into parts ("strata") that are each in P and whose μ-values are smaller than the μ-value of x." (Champollion 2017: 92)

The stratified measurement reference plays the role of measurement monotonicity and non-quantisation requirement at the same time. Moreover, it restricts an entity x so that it can be sub-divisible into smaller pieces each of which has a smaller degree with respect to the measure function μ. Putting aside the compositional details for now, I will show how it accounts for the unavailability of a singular reading in the postnominal measurement construction.

Firstly, (47) correctly predicts that pseudo partitives select nouns with non-quantised denotations. (48) and (49) exemplify the denotations of pseudo partitives with mass nouns or plural nouns.

(48) a. thirty pounds of **water**
b. λx: $\text{SMR}_{\text{WEIGHT}}(\text{water})(x).[\text{water}(x) \,\&\, \text{pounds}(\text{WEIGHT}(x)) = 30]$
c. $\text{SMR}_{\text{WEIGHT}}(\text{water})(x) \Leftrightarrow x \in {}^{*}\lambda y[\text{water}(y) \,\&\, \text{WEIGHT}(y) < \text{WEIGHT}(x)]$

(49) thirty pounds of **books**

a. λx: $\text{SMR}_{\text{WEIGHT}}(*\text{book})(x).[*\text{book}(x) \,\&\, \text{pounds}(\text{WEIGHT}(x)) = 30]$

b. $\text{SMR}_{\text{WEIGHT}}(*\text{book})(x) \Leftrightarrow x \in *\lambda y[*\text{book}(y) \,\&\, \text{WEIGHT}(y) < \text{WEIGHT}(x)]$

(48) denotes a set of stuff which is water and weighs 30 pounds, on the presupposition that those amounts of water satisfy the stratified measurement reference with respect to ⟦water⟧ and WEIGHT. Thus, for $x \in$ ⟦thirty pounds of water⟧ to hold, x has to be sub-divisible into smaller entities y such that y is still water and is lighter than x. Otherwise, it results in presupposition failure. Similarly, (49) requires that x is sub-divisible into smaller entities y such that y is still books and is lighter than x. Since denotations of plural nouns and mass nouns are closed under sum (see Section 2.1), this sub-divisibility requirement is satisfied in these cases. Thus, it correctly predicts that plural nouns and mass nouns are felicitous in pseudo partitives.

The stratified measurement reference correctly predicts that singular count nouns cannot occur in pseudo partitives, too. Take (50) as an example.

(50) *thirty pounds of **book**

a. λx: $\text{SMR}_{\text{WEIGHT}}(\text{book})(x).[\text{book}(x) \,\&\, \text{pounds}\ (\text{WEIGHT}(x)) = 30]$

b. $\text{SMR}_{\text{WEIGHT}}(\text{book})(x) \Leftrightarrow x \in \underline{*\lambda y[\text{book}(y) \,\&\, \text{WEIGHT}(y) < \text{WEIGHT}(x)]}$

The underlined part says that x is partitioned into parts each of which is a book and lighter than x. However, ⟦book⟧ is a set of atoms. Thus, this sub-divisibility requirement is not satisfied, i.e. a book is an atom and cannot be sub-divided further. Thus, it correctly predicts that singular count nouns are infelicitous in pseudo partitives.

Now, let's see if the stratified measurement reference can correctly block a singular reading in the postnominal measurement construction. The point is that the stratified measurement reference can block a singular reading even if Japanese common noun denotations are inherently cumulative. I start with a case with a substance reading.

(51) a. biiru 2-kiroguramu (2 kilograms of beer)

b. λx: $\text{SMR}_{\text{WEIGHT}}(\text{beer})(x).[\text{beer}(x) \,\&\, \text{kilograms}(\text{WEIGHT}(x)) = 2]$

c. $\text{SMR}_{\text{WEIGHT}}(\text{beer})(x) \Leftrightarrow x \in *\lambda y[\text{beer}(y) \,\&\, \text{WEIGHT}(y) < \text{WEIGHT}(x)]$

(51c) requires that x is sub-divisible into smaller entities y such that y is still beer and is lighter than x. Since Japanese common noun denotations are inherently cumulative by assumption, this sub-divisibility requirement is satisfied. In this case, the stratified measurement reference makes the same prediction for pseudo partitives in English and the postnominal measurement construction in Japanese. Note that the same result can be obtained with the non-quantisation requirement.

Difference between the stratified measurement reference and non-quantised reference becomes visible when a notional count noun occurs in the postnominal measurement construction.

Note that the denotation of *ringo* (apple) is closed under sum by assumption, i.e. ⟦ringo⟧ = λx[*apple(x)].

(52) a. ringo 2-kiroguramu (2 kilograms of apples)
b. λx: $\text{SMR}_{\text{WEIGHT}}$(*apple)($x$).[*apple($x$) & kilograms(WEIGHT($x$)) = 2]
c. $\text{SMR}_{\text{WEIGHT}}$(*apple)($x$) ⇔ $x \in$ *λy[*apple(y) & WEIGHT(y) < WEIGHT(x)]

In this case, (52c) is stronger than the non-quantised reference: it requires that each member of ⟦ringo 2-kiroguramu⟧ can be sub-divisible into smaller pieces so that those pieces are still members of ⟦ringo⟧. This precludes a singular reading: if x is an atom, it violates (52c), i.e. the set of x which satisfies (52c) is equivalent to the exclusive plural reading of ⟦ringo⟧.[25] Thus, the stratified measurement reference correctly rules out a singular reading in the postnominal measurement construction.[26]

On this point, note that the proposed semantics does not derive a distributive plural reading. While ⟦ringo⟧ is cumulative, (52b) is not cumulative: it is a set of apple-sums each of whose member is 2 kilograms. For example, 2 kilograms of apples is a member of this set, but 4 kilograms of apples is not. This correctly predicts that (52) does not have a distributive plural reading.[27]

Count-to-mass coercion is triggered due to an interaction between the stratified measurement reference and the common knowledge. (53) shows the denotation of the postnominal measurement construction with the notional count noun *uma* (horse).

(53) a. uma 500-kiroguramu (500 kilograms of horse) (INDIVIDUAL READING)
b. λx: $\text{SMR}_{\text{WEIGHT}}$(*horse)($x$). [*horse($x$) & kilograms(WEIGHT($x$)) = 500]
c. $\text{SMR}_{\text{WEIGHT}}$(*horse)($x$) ⇔ $x \in$ <u>*λy [*horse(y) & WEIGHT(y) < WEIGHT(x)]</u>

The underlined part requires that x is sub-divisible into horses each of which is lighter than x. However, this clashes with common knowledge: 500 kilograms is too light for multiple horses.

[25] I thank to an anonymous reviewer for this paraphrase.

[26] One of the anonymous reviewers pointed out the possibility that English pseudo partitives with plural nouns sometimes allow reference to a singular individual. The example the reviewer provides is given in (i): it does not exclude the possibility that the addressee uses one big carrot.

i. Use 50g of carrots.

At this point, I do not have an analysis of it. However, it is worth pointing out that (i) describes a situation that has not taken place yet in the actual world. Thus, one possibility is that pseudo partitives with a plural noun may allow reference to a singular individual if it occurs under sentences that are *non-veridical*, or *non-actual*. I thank to Émile Enguehard (p.c.) for pointing out this possibility. This predicts that pseudo partitives with a plural noun allow reference to a singular individual under non-veridical environment, but not under veridical environment. Furthermore, it is worth checking whether bare plurals exhibit a similar pattern under these environments. I leave this investigation for future research.

[27] One can still derive a distributive plural reading of (52) by pluralising (52). Although this option is not empirically motivated, it is compatible with the proposed account, in principle.

Thus, one cannot satisfy the presupposition without making it contradict with the common knowledge. As a result, (53) is infelicitous. To avoid it, one has to coerce ⟦uma⟧ so that it denotes a set of horse meat so that common knowledge about an individual horse does not matter.[28] On this point, one can either assume that (i) some nouns are polysemous, e.g., *uma* denotes a set of horses in one sense and a set of horse meat in the other sense, or (ii) a general operation of *universal grinder* shifts the denotation of *uma* (horse) from a set of horses into a set of horse meat.[29]

Indeed, Champollion (2017) discusses a similar phenomenon in English: *apples* is degraded with a sufficiently small measurement degree while *apple* is felicitous under a substance reading.[30]

(54) a. Give me 500 grams of {apple / apples}.
b. Give me 100 grams of {apple / ?apples}.
c. Give me one gram of {apple / ??apples}. (Champollion 2017: 152)

This is expected from the sub-divisibility requirement of the stratified measurement reference: apples cannot be divided into apples which are smaller than 100 grams or one gram. In this sense, I am not the first one who claims that the interplay of the stratified measurement reference and common knowledge makes a cumulative plural reading infelicitous.

Lastly, notional substance mass nouns with mass-to-count coercion block a singular reading: the stratified measurement reference forces an individual portion of stuff to be sub-divisible. For example, imagine a situation in which there is a glass of beer which weighs 500 grams. (55) shows how the stratified measurement reference works in this case.

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[28] When embedded under the complement clause of an attitude verb, the postnominal measurement construction can have a cumulative plural reading which is infelicitous in the extensional context: the canonical weight of horse atoms is evaluated relative to the attitude holder's belief. The verb *tsukamaer-u* (catch) requires its internal argument to be a seizable object and thus it is incompatible with a coerced substance reading of *uma* (horse). And yet, (ii) has a natural reading in which Sean believes that Rob caught plural individual horses.

i. Scenario: Sean, 5 years old, believes that a horse weighs less than 20kg.
ii. Sean-wa [Rob-ga uma go-hyaku-kiroguramu-o tsukamae-ta to] omo-tte-iru.
Sean-NOM [Rob-NOM horse 5-100-$CL_{Kilogram}$-ACC catch-PAST that] think-PROG-PRES.
a. # "Sean thinks that Rob caught 500 kilograms of horse." (SUBSTANCE READING)
b. "Sean thinks that Rob caught 500 kilograms of horses." (CUMULATIVE PLURAL READING)

Although some native Japanese speakers including, me accept (ii) in the context (i), an anonymous reviewer pointed out that (ii) is unacceptable for them because it sounds funny to express the weight of the horses caught. I suspect that this is the effect of animacy. In this sense, my argument goes through as long as there are speakers who (i) accept a plural reading of *uma* (horse) with *ni-ton* (2-CL_{Ton}) and not with *go-hyaku-kirogmuramu* (5-100-$CL_{Kilogram}$), but (ii) accept a plural reading of *uma* (horse) with *go-hyaku-kirogmuramu* (5-100-$CL_{Kilogram}$) with respect to Sean's belief.

[29] See Rothstein (2017) for a definition of universal grinder.

[30] See also Bale (2009) for the relevant discussion.

For the notational convenience, I put "*glass of beer" as the product of mass-to-count coercion of ⟦biiru⟧ in (55).[31]

(55) a. biiru 500-guramu (500 grams of beer) (SINGULAR READING)
b. λx: SMR_{WEIGHT}(*glass-of-beer)(x). [*glass-of-beer(x) & pounds(WEIGHT(x)) = 30]
c. SMR_{WEIGHT}(*glass-of-beer)(x) $\Leftrightarrow$ $x \in {}^*\lambda y$[*glass-of-beer(y) & WEIGHT(y) $<$ WEIGHT(x)]

(55c) requires that each member of ⟦biiru 500-guramu⟧ can be sub-divisible into smaller pieces so that those pieces are still members of *⟦glass-of-beer⟧. As a result, ⟦biiru 500-guramu⟧ does not include individuals which are singular glasses of beer. Thus, the stratified measurement reference blocks a singular reading when stuff is portioned into containers.

For a compositional implementation, I adopt some assumptions on the semantics of numerals and measure phrases. My assumption is essentially the same as the assumptions adopted in Champollion (2017), but this choice is not essential to the main point of this paper. Following Krifka (2008); Rothstein (2013); Sudo (2016; to appear), I assume a numeral of referential type.[32]

(56) ⟦Num⟧ = n

I assume that mensural classifiers denote predicates of type $\langle n,\langle dt\rangle\rangle$. For example *kiroguramu* ($CL_{Kilogram}$) is defined as shown in (57).

(57) ⟦kiroguramu⟧ = $\lambda n \lambda d$[kilograms(d) = n]

The mapping from individuals to degrees is achieved by a covert measurement function. For example, μ_{WEIGHT} maps an individual to a degree.

(58) $\llbracket \mu_{WEIGHT} \rrbracket = \lambda x_e \lambda d$[WEIGHT($x$) = d]

I assume that the postnominal measurement construction involves Mon^0 which takes an NP as its complement and the Num-CL complex as its specifier as shown in (59). I assume that the covert mapping operator occurs in the middle field following Champollion (2017). As he notes, this choice does not matter. I assume that case particles are realisations of a nominal functional head $Case^0$ and the NP-Num-CL word order is derived by an NP-raising to Spec, CaseP (Watanabe 2006).

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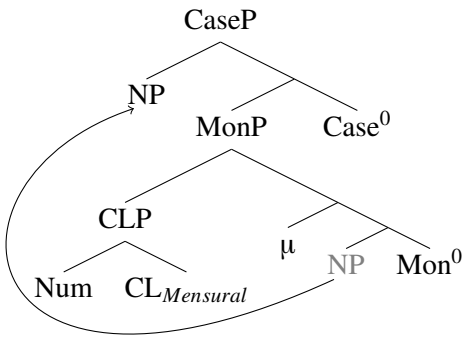
[31] See Rothstein (2017) for a definition of mass-to-count coercion, i.e. universal packager, and the relevant discussion.

[32] Rothstein (2013) proposes that numerals go back and forth between the referential-type and the predicative-type. Sudo (2016) proposes that sortal classifiers in Japanese are overt manifestation of type-shifting operation for numbers from referential type to predicative type. This blocks free application of shifting operation from the referential numeral to the predicative number, explaining why bare numerals are, in general, not allowed in Japanese.

(59)

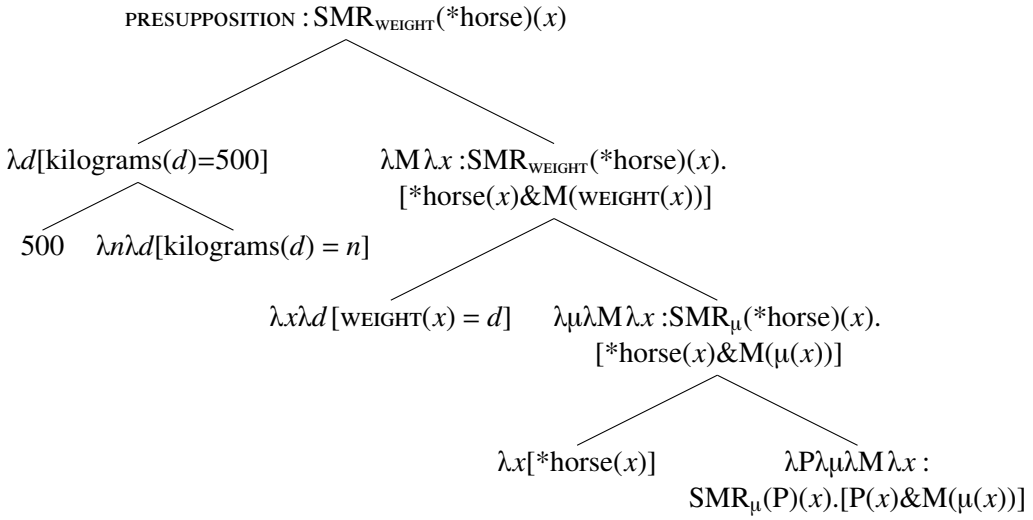


I assume that Mon^0 introduces the stratified measurement reference as presupposition. The denotations of terminal nodes are given in (60).[33]

(60) a. $[\![\text{uma}]\!] = \lambda x[*\text{horse}(x)]$
b. $[\![\text{Mon}^0]\!] = \lambda P_{\langle et\rangle}\lambda\mu_{\langle ed\rangle}\lambda M_{\langle dt\rangle}\lambda x$: $\text{SMR}_\mu(P)(x)$. $[P(x) \,\&\, M(\mu(x))]$
c. $[\![\text{go-hyaku-kiroguramu}]\!] = \lambda d\,[\text{kilograms}(d) = 500]$

Now, the denotation of the postnominal measurement construction is compositionally obtained as shown in (61). I ignore the semantics of Case^0 and the semantic repercussion of the NP raising.[34]

(61) $\lambda x.[*\text{horse}(x)\&\text{kilograms}(\text{WEIGHT}(x)) = 500]$



[33] Although I do not discuss the composition of complex numbers in this paper, Rothstein (2013) proposes that $^\cap$-operator turns a predicative denotation of numeral into a type *n* entity. If this analysis is on the right track, one does not need to complicate the composition of a mensural classifier and a complex numeral. See also Ionin & Matushansky (2006) for analyses of numerals.

[34] One can assume that Case^0 denotes an identity function of type $\langle\langle et\rangle,\langle et\rangle\rangle$ and the NP raising leaves a trace of type $\langle et\rangle$. This ensures $[\![\text{MonP}]\!] = [\![\text{CaseP}]\!]$.

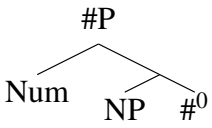
Summing up, this section described the first option to explain the range of possible readings in the postnominal measurement construction in Japanese. I showed that the stratified measurement reference (Champollion 2017) correctly predicts that a singular reading results presupposition failure. This explains why a singular reading is blocked in the postnominal measurement construction in Japanese even though common nouns in Japanese are neither marked for singular nor plural. With this option, one can maintain the hypothesis that Japanese common noun denotations are inherently cumulative.

4.2 Covert distinction among singular, plural and mass

In this section, I discuss a way to modify the common noun denotations of Japanese so that the non-quantisation requirement applies non-trivially.

In a series of papers (Watanabe 2006; 2010; 2017: a.o.), Akira Watanabe proposes that Japanese has $\#^0$ which is the locus of number specification. In this sense, he commits to the view that Japanese has a syntactic count-mass distinction: common nouns in Japanese are sorted based on number specification and they sometimes enter in an agreement relation with $\#^0$. Watanabe (2006) proposes that $\#^0$ hosts an NP in its complement and a numeral on its specifier as shown in (62).[35]

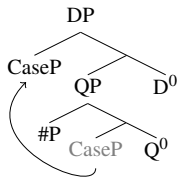
(62)



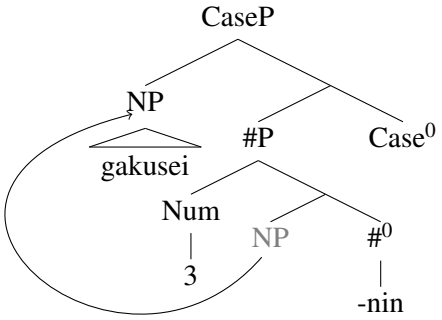
Watanabe (2006) assumes nominal functional heads $Case^0$, Q^0 and D^0 above $\#^0$ and proposes that sortal classifiers occupy the $\#^0$ position. Now, the distributional patterns of the unit of a numeral and a classifier are derived with massive DP-internal remnant movements. (63a) and (63b) respectively show the structures associated with the NP-Num-CL order and the Num-CL-no-NP order.[36]

[35] To the best of my knowledge, Watanabe (2006) is the first work which proposes that an NP and a classifier form a constituent in Japanese, though this idea is found in earlier literature in Mandarin (Cheng & Sybesma 1999; Li 1999).

[36] Floating numerals are derived by the remnant CaseP raising to Spec, DP.

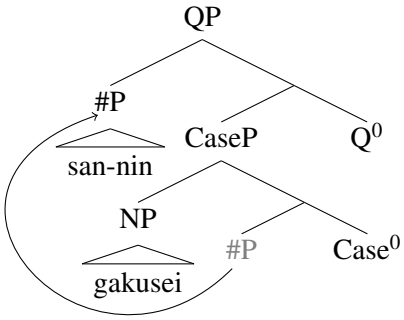
i.  ⇒ *gakusei-ga san-nin*

(63) a.



⇒ *gakusei san-nin*

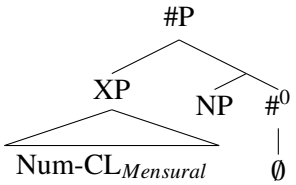
b.



⇒ *san-nin (no) gakusei*[37]

Crucially, Watanabe (2006) makes a syntactic distinction between sortal classifiers and mensural classifiers: sortal classifiers are realisations of $\#^0$, whereas mensural classifiers are not. Accordingly, $\#^0$ is covert in the latter case.[38] The structure for mensural classifiers are given in (64).

(64)



This structural distinction corresponds to a count-mass distinction: (62) accepts count nouns, whereas (64) accepts mass nouns.[39] Watanabe (2006) states it as *Mass/Count Universal* (65).

---

[37] Watanabe (2006) argues that no is not the genitive case marker, but a morphological linker which is post-syntactically inserted (Kitagawa & Ross 1982).

[38] Watanabe (2006) also proposes that $\#^0$ has another realisation *bun*, but I do not discuss it in this paper. See Watanabe (2006) for data and relevant discussions.

[39] Note that Watanabe (2006) discusses cases in which container classifiers, e.g., *hai* (CL_{Glass}), occur with $\#_{[-number]}$.

(65) Mass/Count Universal: The # head is [+number] in the case of count nouns, whereas it is [-number] in the case of mass nouns. (Watanabe 2006: 271)

Watanabe (2017) further argues for a singular-plural distinction in Japanese based on contrast between partitives and *reverse partitives*.[40] Partitives allow both a singular reading and a plural reading as shown in (66a), whereas reverses only allow a plural reading as shown in (66b).

(66) a. Ringo-no ichibu-ga kusa-tte-iru.
apple-no part-NOM rotten-PROG-PRES
i. 'Part of the apple is rotten.' (SINGULAR READING)
ii. 'Some of the apples are rotten.' (PLURAL READING)

b. Ichibu-no ringo-ga kusa-tte-iru.
part-no apple-NOM rotten-PROG-PRES
i. *'Part of the apple is rotten.' (SINGULAR READING)
ii. 'Some of the apples are rotten.' (PLURAL READING) (Watanabe 2017: 2)

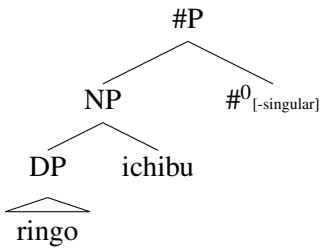
Moreover, Watanabe (2017) shows that reverse partitives trigger mass-to-count coercion as shown in (67b): contaminated water is required to be partitioned based on a contextually salient unit.[41]

(67) a. Osensui-no ichibu-ga moredashi-ta.
contaminated water-no part-NOM leak out-PAST
'Part of the contaminated water leaked out.'

b. Ichibu-no osensui-ga moredashi-ta.
part-no contaminated water-NOM leak out-PAST
'Part of the portions of contaminated water leaked out.' (Watanabe 2017: 14)

Watanabe (2017) proposes that the reverse partitive structure is derived with an NP raising to Spec, #P driven by agreement based on [-singular] feature. He assumes the base structure given in (68).[42]

(68)



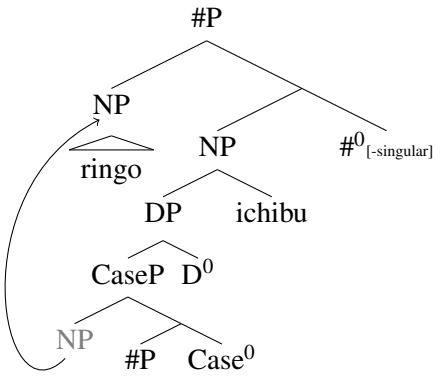
[40] This term comes from Sauerland & Yatsushiro (2004).

[41] He further discusses cases of plural masses. See Section 5.1 for discussion.

[42] He assume that this DP is predicate-denoting. This detail does not matter for the discussion here.

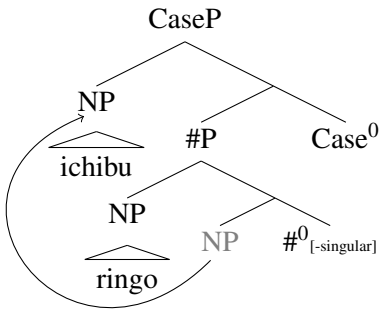
In the next step, the NP *ringo* (apple) within the DP is raised to Spec, #P, entering an agreement relation with $\#^0$.[43]

(69)



Lastly, the reverse partitive order is derived when *ichibu* (part) is raised to Spec, CaseP.[44]

(70)



In this analysis, the reverse partitive structure does not allow a singular reading because the NP has to agree with $\#^0$ in [–singular] feature.[45] Note that Watanabe (2017) assumes that bare NPs are marked with [±singular], i.e. their denotations include atomic as well as non-atomic individuals. In this sense, denotations of bare NPs are inherently cumulative, while denotations of #Ps are not.

Based on the discussion so far, one can suggest that the postnominal measurement construction in Japanese has the structure given in (71) and propose that Mon^0 takes #P as its complement.[46]

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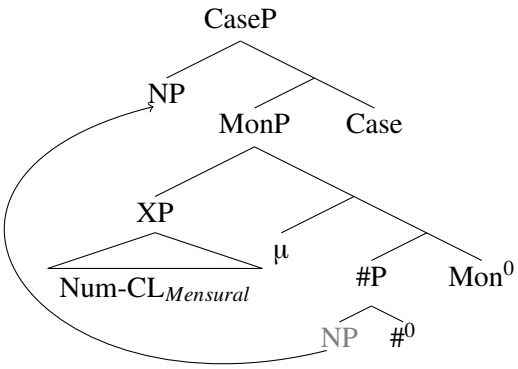
[43] Watanabe (2017) is inclined to think the QP is absent in the lower DP in (69) because it is semantically vacuous.

[44] *no* is post-syntactically inserted in the morphological component in these cases, too.

[45] Watanabe (2017) argues that if $\#^0$ is marked with [+singular], it contradicts with the semantics of partitive expressions such as *ichibu* (part). See Watanabe (2017) for the detail.

[46] One can go further and assume that $\#^0_{[-number]}$ plays the role of Mon^0. For this alternative, see Section 5.2.

(71)



Crucially, #P distinguishes singular denotations, plural denotations and mass denotations. On this point, I define the denotation #^{0} with a built-in (non-)atomicity condition.[47] Here, I sketch one possible implementation. First, I assume that a count noun denotes a set of atoms, whereas a mass noun denotes a set of atoms which is closed under sum. Count nouns are pluralised when it bears [–singular] feature, i.e. if $[\![\text{NP}_{[+singular]}]\!] = \text{P}$, then $[\![\text{NP}_{[-singular]}]\!] = {}^*\text{P}$. I assume that this pluralisation takes place "off-line" in the lexicon. Thus, the assumption that a bare NP is marked with [±singular] is maintained when an NP occurs in syntactic structures. Second, I assume that #^{0} has different semantics depending on its number specification. Under the assumption that mass nouns are inherently plural, there is no strong motivation to distinguish the semantics of $\#^0_{[-\text{number}]}$ and $\#^0_{[+\text{number},-\text{singular}]}$. Accordingly, a plural-mass distinction is only made in syntax: plural NPs agree with $\#^0_{[+\text{number},-\text{singular}]}$ and mass NPs agree with $\#^0_{[-\text{number}]}$. Importantly, this analysis distinguishes #P with [+number,+singular] and #P with [+number,–singular]. Accordingly, the denotation of #P with [+number,–singular] ends up including only non-atoms due to pragmatic enrichment in parallel with English plurals.[48]

(72) a. $[\![\#_{[+number,+singular]}]\!] = \lambda\text{P}\lambda x\text{: Atom}(x).\ [\text{P}(x)]$
b. $[\![\#_{[+number,-singular]}]\!] = [\![\#_{[-number]}]\!] = \lambda\text{P}\lambda x\text{: }{}^*\text{Atom}(x).[\text{P}(x)]$

In this analysis, the non-quantisation requirement of Mon^0 correctly rules out a singular reading simply because it is incompatible with a #P with [+number,+singular]. On the other hand, a #P with [+number,–singular] feature or [–number,–singular] feature is permitted in the postnominal measurement construction. For a compositional implementation, I assume the denotation of Mon^0 in (73), which minimally differs from Mon^0 defined in (60b) with respect to the presupposition.

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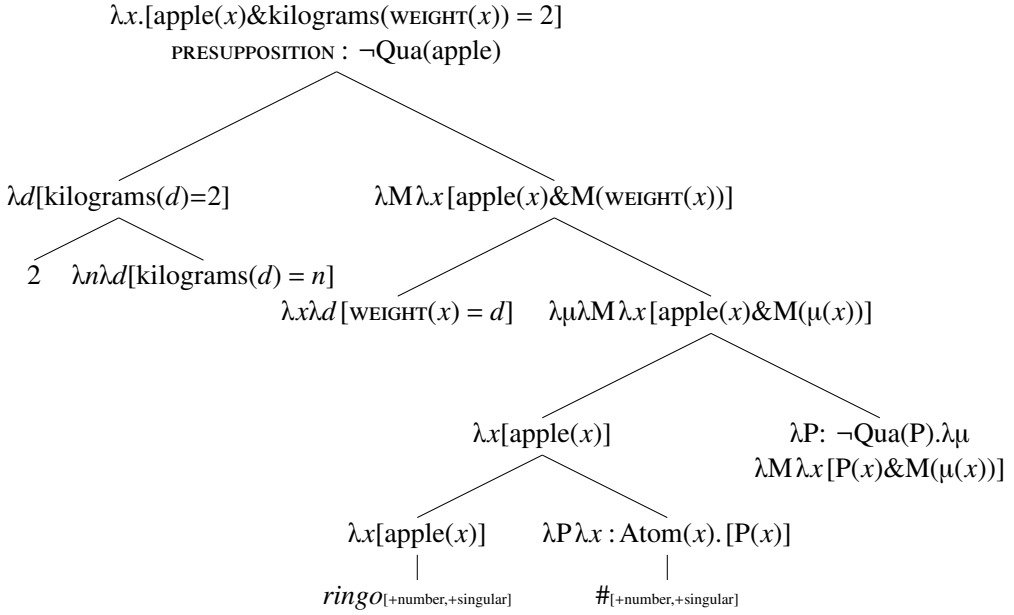
[47] This is different from the denotation of #^{0} originally suggested in Watanabe (2017).

[48] One may alternatively assume that the denotation of #P with [+number, +plural] semantically excludes atoms. The same result can be obtained with this alternative.

(73) $[\![\text{Mon}^0]\!] = \lambda P_{\langle et\rangle}: \neg\text{Qua}(P).\lambda\mu_{\langle ed\rangle}\lambda M_{\langle dt\rangle}\lambda x[P(x) \,\&\, M(\mu(x))]$

For example, the composition of the singular reading of *ringo ni-kiroguramu* (apple 2-$CL_{Kilogram}$) is given in (74). I ignore the composition above the CaseP layer here, too.

(74)



In this case, the #P bears [+number, +singular] feature and it results in presupposition failure: #P denotes a set of atoms and it is quantised by definition. Thus, a singular reading is blocked. If the #P bears [+number,–singular] feature or [–number] feature, it denotes a set of atoms which is closed under sum. Thus, it meets the non-quantisation presupposition. This explains why the postnominal measurement construction blocks a singular reading while allowing a cumulative plural reading and a substance reading. The unavailability of distributive plural readings follows in the same way as the analysis sketched in Section 4.1: even when [ringo] is cumulative, the denotation of the postnominal measurement construction itself is not cumulative.

This approach treats count-to-mass coercion in the same way as well. (75a) shows that the case in which *uma* (horse) is combined with $\#^0_{[+\text{number},-\text{singular}]}$. Crucially, since singular #Ps and plural #Ps are distinguished by assumption, the denotation of plural #Ps ends up including only non-atoms due to pragmatic enrichment.

(75) uma 500-kiroguramu (500 kilograms of horse)
  a. $\lambda x.[*\text{horse}(x)\&\text{kilograms}(\text{WEIGHT}(x)) = 500]$
  b. Presupposition: ¬Qua(*horse)

Now, (75a) clashes with common knowledge. (75a) requires there to be plural horses which collectively weigh 500 kilograms, but 500 kilograms is too light for plural horses. On the other hand, *uma* (horse) with $\#^0_{[-\text{number}]}$ can satisfy the non-quantisation presupposition without clashing with common knowledge. Thus, only the option with count-to-mass coercion can output a felicitous result with *uma 500-kiroguramu* (500 kilograms of horse).

Summing up, this section described the second option to explain the range of possible readings in the postnominal measurement construction in Japanese. If one wishes to maintain the hypothesis that the semantics of monotonic measurement imposes the non-quantisation requirement, one has to modify the semantics of common noun denotations in Japanese. I claimed that the syntax-semantics interface with $\#^0$ along with Watanabe (2006; 2017) correctly predicts that a #P with [+number, +singular] violates the non-quantisation presupposition.

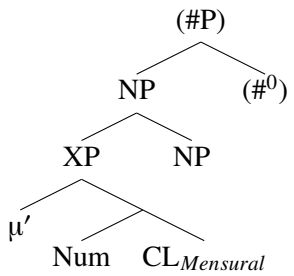
4.3 The prenominal measurement construction

So far, I have discussed two possible analyses of the postnominal measurement construction in Japanese. In this section I discuss ways to analyse the prenominal measurement construction.

As I discussed in Section 2.2, the prenominal measurement construction in Japanese allows both monotonic measure phrases and non-monotonic measure phrases. This suggests that either (i) the prenominal measurement construction is underspecified with respect to monotonicity and quantisation or (ii) it is structurally ambiguous between the monotonic structure and the non-monotonic structure. Starting with the underspecification approach, I point out that it has difficulty in deriving distributive plural readings and I argue for the structural ambiguity approach.

Following Schwarzschild (2002; 2006), I assume that the non-monotonic structure involves an NP adjunction as shown in (76).[49] If one assumes $\#^0$, it occurs above the NP.

(76)



I assume that *no* is a morphological linker which is post-syntactically inserted (Watanabe 2006).

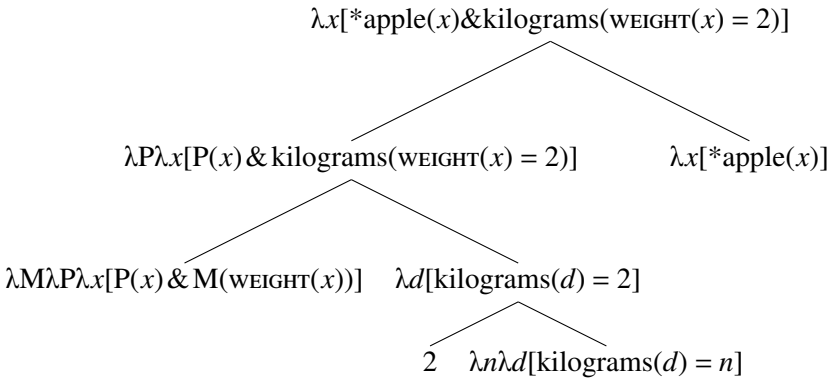
[49] See also Miyamoto (2009) for an analysis in which Num-CL is a predicate and the prenominal structure involves a relative clause.

I propose that the Num-CL unit in this structure functions as an intersective modifier. I assume a type variant of a covert mapping operator as defined in (77).[50]

(77) $[\![\mu'_{\text{WEIGHT}}]\!] = \lambda M_{\langle dt\rangle}\lambda P_{\langle et\rangle}\lambda x_e[P(x) \,\&\, M(\text{WEIGHT}(x))]$

The compositional detail of the prenominal measurement construction *ni-kiroguramu-no ringo* (2-$CL_{Kilograms}$-no apple) is given in (78).[51]

(78)



Since Mon^0 is absent in this structure, both a monotonic mensural classifier and a non-monotonic mensural classifier can occur in this structure. Furthermore, it does not impose any restriction on [[ringo]]: as long as the total weight of them is 2 kilograms, there can be any number of apples including one. Thus, a singular reading is not blocked in the prenominal measurement construction.

However, distributive plural readings pose a problem for this approach. In the end, I argue for the structural ambiguity approach. There are two options to derive a distributive plural reading: one is to let a measure phrase distributively apply to a noun denotation and the other is to apply pluralisation to the constituent [Num-CL NP]. In the first option, one can modify (77) as (79): this version of μ′ attributes the measure phrase to each atomic parts of an individual *x*.

---

[50] An anonymous reviewer pointed out that an overt expression signals a measurement dimension in (i).

i. **Taijuu** go-hyaku-kiroguramu-no uma
body weight 5-100-$CL_{Kilogram}$-no horse
"a horse that weighs 500kg"

Here, *taijuu* (body weight) overtly signals the measurement dimension. Although covert mapping operator in (77) is not usually assumed in the literature, (i) provides a piece of support for a covert material in the prenominal measurement construction. I leave further investigation on the semantic details of the expressions such as *taijuu* (body weight) for future research.

[51] One can alternatively assume the rule of Predicate Modification (Heim & Kratzer 1998) and define μ′ with type ⟨*dt*,*et*⟩.

(79) $[\![\mu'_{\text{WEIGHT}}]\!] = \lambda M_{\langle dt\rangle}\lambda P_{\langle et\rangle}\lambda x_e\,[P(x) \,\&\, \forall y\,[[\text{Atom}(y) \,\&\, y \sqsubseteq x] \rightarrow M(\text{WEIGHT}(y))]]$

The revised version of μ′ can also derive a singular reading when x is an atomic individual. However, (79) does not derive a reading in which the measurement degree is attributed to the sum of atoms. Thus, a cumulative plural reading and a substance reading are not obtained with (79).

The other option is dependent on the #P approach. One can modify the denotations of $\#^0_{[+\text{number},-\text{singular}]}$ and common nouns so that $\#^0_{[+\text{number},-\text{singular}]}$ pluralises a singular denotation and a common noun denotes a set of atoms. Now, distributive plural readings are obtained when (78) involves $\#_{[+\text{number},-\text{singular}]}$. An example with *ni-kilogramu-no ringo* (2-$\text{CL}_{\text{Kilograms}}$-no apple) is given in (80c).

(80) a. $[\![\#_{[+\text{number},-\text{singular}]}]\!] = \lambda P\lambda x{:}\,{}^*\text{atom}(x).\ [{}^*P(x)]$.
b. $[\![\text{ringo}]\!] = \lambda x\ [\text{apple}(x)]$
c. $\lambda x{:}\ {}^*\text{atom}(x).\ x \in {}^*\lambda y[\text{apple}(y) \,\&\, \text{kilograms}(\text{WEIGHT}(y)) = 2]$

Here, (80c) includes sums of atomic apples each of which weighs 2 kilograms.[52] On this point, it is crucial that the common noun denotation is inherently non-cumulative. Otherwise, it overgenerates. For example, *ni-kiroguramu-no ringo* (2-$\text{CL}_{\textit{Kilograms}}$-no apple) cannot be used to refer to seven apples which collectively weigh 4 kilograms. However, (81) includes such plural individuals, predicting non-attested readings. Thus, this option with the modified denotation of $\#_{[+\text{number},-\text{singular}]}$ requires the common noun denotations to be inherently non-cumulative.

(81) $\lambda x{:}\ {}^*\text{atom}(x).\ x \in {}^*\lambda y[{}^*\text{apple}(y) \,\&\, \text{kilograms}(\text{WEIGHT}(y)) = 2]$

Although this revised entry of $\#_{[+\text{number},-\text{singular}]}$ successfully derives a singular reading and a distributive plural reading, it cannot derive a cumulative plural reading: there is no way to pluralise a noun denotation before it is combined with a measure phrase.

---

[52] In both of these approaches, one can regard the Num-CL unit in the non-monotonic structure as an instance of *stubbornly distributive predicates* (Schwarzschild 2011). I thank to an anonymous reviewer for pointing it out. Adjectives such as *big* are incompatible with the mass *apple* as shown in (1a), but compatible with the singular *apple* as shown in (1b). When combined with the plural *apples* as in (1c), it means that each of the apples Jimmy ate was big.

i. *Jimmy ate big apple.
ii. Jimmy ate a big apple.
iii. Jimmy ate big apples. (Gil 1996)

In this sense, the distributivity of the non-monotonic Num-CL should be an instance of the general property of the attributive use of stubbornly distributive predicates. Although it is an interesting issue concerning the syntax-semantics interface with respect to attributive modification, I leave it for future research as the general consideration goes beyond the scope of this paper.

So far, I have shown two ways to derive a distributive plural reading in the prenominal measurement construction. However, both analyses do not predict that the non-monotonic structure derives cumulative plural readings and substance readings.[53] Here is a dilemma: if one wishes to include a distributive plural reading, then cumulative plural readings and substance readings are excluded. One can solve this dilemma if one assumes that the prenominal measurement construction is structurally ambiguous between the non-monotonic strtucture and the monotonic structure. Recall that the proposed structures for the postnominal measurement construction, i.e. (61) and (71), both involve an NP-movement. If this movement is optional, then the monotonic structure can also derive the Num-CL-no-NP order. This leads to a division of labour: the non-monotonic structure is responsible for a singular reading and a distributive plural reading, while the monotonic structure is responsible for a cumulative plural reading and a substance reading. Since the postnominal order can only be derived with the monotonic structure, it still explains why the postnominal measurement construction does not allow a singular reading nor a distributive plural reading.[54]

Summing up, I discussed the syntax and semantics of the prenominal measurement construction. I proposed that the Num-CL unit in the non-monotonic structure is an intersective modifier. Although this assumption can derive a singular reading, a cumulative plural reading and a substance reading, it cannot derive a distributive plural reading. It motivates some mechanism for distributive attribution of a measure phrase. However, addition of this mechanism wrongly filters out a cumulative plural reading and a substance reading. To solve this dilemma, I proposed that the prenominal measurement construction is structurally ambiguous between the non-monotonic structure and the monotonic structure. The former derives a singular reading and a distributive plural reading, while the latter derives a cumulative plural reading and a substance reading.

4.4 Interim summary

In this section, I discussed two possible ways to explain why a singular reading is blocked in the postnominal measurement construction in Japanese. Essentially, one has to choose to put burden on the theory of monotonic measurement or on the theory of common noun denotations in Japanese. The first option is to modify the analysis of monotonic measurement, while maintaining

[53] One may attempt to modify the semantics of μ′ so that it allows a cumulative plural reading and a substance reading. The challenge is that one has to avoid overgeneration of unattested readings, e.g., *ni-kiroguramu-no ringo* (2-$CL_{Kilogram}$-no apple) is read as 7 apples which collectively weigh 4 kilograms. Also, Section 5.2 provides another argument for the structural ambiguity, which is independent of the semantics of μ′. Thus, I do not pursue this option further here.

[54] Note that when $Case^0$ is added to (78), the NP may be raised to Spec, CaseP. However, this NP raising moves the whole sequence of Num-CL-no-NP because the XP is an NP adjunct. Thus, (78) does not derive the postnominal word-order even if additional functional layers are added.

the assumption that Japanese common noun denotations are inherently plural. I claimed that the stratified measurement reference in Champollion (2017) makes the right predictions even if Japanese noun denotations are inherently cumulative. The second option is to modify the analysis of common nouns in Japanese, while maintaining the assumption that the semantics of monotonic measurement requires a noun to have a non-quantised denotation. I claimed that the #P approach in Watanabe (2006; 2017) makes the right predictions even if the semantics of monotonic measurement just requires a noun to have a non-quantised denotation.

These two approaches roughly converge in the analysis of the prenominal measurement construction: the prenominal measurement construction is structurally ambiguous between the non-monotonic structure and the monotonic structure. In the non-monotonic structure, the Num-CL unit functions as a distributive attributive modifier and it derives a singular reading and a distributive plural reading. In the monotonic structure, it involves the same underlying semantics as the postnominal measurement construction and it derives a cumulative plural reading and a substance reading. This covers all the four possible readings for the prenominal measurement construction.

5 Implications for a count-mass distinction

So far, I have suggested two possible approaches to explain the behaviour of the postnominal measurement construction in Japanese. In this section, I discuss implications of these approaches on general issues of a count-mass distinction and the syntax-semantics of classifiers. Firstly, Section 5.1 discusses Chierchia (1998) and some challenges for it. Section 5.2 shows that a plural reading in the postnominal measurement construction does not involve semantics of counting and discuss its implication for the two approaches I discussed in the previous section.

5.1 Countability distinction in the lexicon

As I have discussed in Section 2.1, Chierchia (1998) assumes that both count nouns and mass nouns take their denotations in the atomic domain. Furthermore, he reduces a count-mass distinction to a singular-plural distinction: singular count noun denotations are not closed under sum, whereas mass noun denotations are closed under sum.[55] Based on this view, Chierchia (1998) proposes that denotations of numeral classifier languages are inherently plural and thus they lack a count-mass distinction. One of the advantages of this analysis is that it naturally captures the generalisation that bare arguments are generally used as a kind-denoting expression. Chierchia (1998) proposes a pair of operators $^{\cup}$ and $^{\cap}$ as defined in (82a) and (82b). I use k as variable for kinds.

[55] However, recall Footnote 13.

(82) a. $^{\cup}k = \lambda w \lambda x[x \sqsubseteq k_w]$ if k_w is defined. $^{\cup}k = \varnothing$, otherwise
b. $^{\cap}P = \lambda w \, \iota \, P_w$ if P is closed under sum. It is undefined, otherwise.

Based on this correspondence between kinds and plural properties, Chierchia (1998) proposes the *Nominal Mapping Parameter*: languages are parametrised based on two binary features, [±Arg(ument)] and [±Pred(icate)]. [+Arg] feature allows a noun to be mapped to an entity of type *e* and [+Pred] feature allows a noun to be mapped to a predicate of type ⟨*et*⟩. This nicely explains the cross-linguistic distribution of bare arguments and kind-denoting expressions.[56] See Chierchia (1998) for data and discussion. What is relevant for the discussion here is that Chierchia (1998) proposes that numeral classifier languages are specified with [+Arg, –Pred]. This explains why these languages generally allow bare arguments and lack an obligatory plural morpheme.

This analysis of numeral classifier languages also explains why classifiers are obligatory when a numeral is combined with a noun. In the analysis of Chierchia (1998), a noun denotation is countable if it is associated with a set of atoms. Count nouns are associated with a set of atoms because their denotation only include atoms, whereas mass nouns are not because they are already plural in the lexicon. Chierchia (1998) proposes that a set of atoms serves as a counting unit for numerals and mass nouns cannot be directly combined with numerals because they do not provide a counting unit. This explains the behaviour of numeral classifier languages. Noun denotations in those languages are inherently plural and do not provide a counting unit for numerals. Thus, a classifier is necessary to provide a counting unit for numerals. This makes a prediction that noun denotations in numeral classifier languages are uncountable without help of classifiers.

However, the previous literature has suggested that Japanese has several syntactic environments which only allow notional count nouns, but do not involve an overt classifier. First, Watanabe (2006) shows that distributive universal quantifiers require individuated noun denotations and *dono-NP-mo* (every NP) in Japanese is illicit with the notional mass noun *mizu* (water) as shown in (83).[57] This is unexpected if Japanese does not have a count-mass distinction.

(83) a. John-wa dono hon-mo yon-da.
John-TOP which book-MO read-PAST
'John read every book.'

[56] Note that there are several arguments against this generalisation. See Schmitt & Munn (1999); Sato (2008), for example. I thank to an anonymous reviewer for drawing my attention to this point. Although the proposed analysis is compatible with Chierchia's (1998) generalisation, I leave this general issue open.

[57] Universal Packaging or Universal Sorter is available with an appropriate pragmatic context. In those cases, *water* is individuated by containers or kinds. However, these are not specific to Japanese.

b. *John-wa dono mizu-mo non-da.
John-TOP which water-MO drink-PAST
'John drank every water.' (Watanabe 2006: 278)

Furthermore, Japanese has several quasi-cardinal modifiers which do not involve an overt classifier, but sensitive to notional count nouns. (84) shows that *nan-byaku-toiu* (hundreds of) and *tasuu-no* (many) require nouns with a specific mode of individuation.

(84) a. *Taro-wa [nan-byaku-toiu / tasuu-no] ase-o kai-ta.
Taro-TOP what-100-say / many-no sweat-ACC secreted-PAST
(intended) 'Taro sweated a lot.' (Sudo to appear: 5)

b. Taro-wa [nan-byaku-toiu / tasuu-no] syomotsu-o yon-da.
Taro-TOP what-100-say / many-no book-ACC read-PAST
'Taro read a lot of books.'

In addition to those count-sensitive quasi-cardinal modifiers, Sudo (to appear) shows that interpretations of proportional quantifiers are sensitive to countability. *Hotondo* (most) in Japanese is compatible with both notional count nouns and notional mass nouns.

(85) a. Taro-wa **hotondo**-no hon-o yon-da.
Taro-TOP most-no book-ACC read-PAST
'Taro read most of the books.'

b. Taro-wa **hotondo**-no mizu-o non-da.
Taro-TOP most-no water-ACC drink-PAST
'Taro drank most of the water(s).' (Sudo to appear: 7)

However, *hotondo* (most) allows different patterns of interpretations for notional count nouns and notional mass nouns. First, consider the situation (86). Sudo (to appear) shows that (85a) can be true only in the count-based situation (86a).

(86) There are 10 books, $Book_1$, $Book_2$, ..., $Book_{10}$. $Book_1$ is 500 pages long, $Book_2$ is 190 pages long, $Book_3$ is 100 pages long, and $Books_{4–10}$ are 30 pages long each.

a. Count-based scenario: Taro read all the short books, namely $Book_{4–10}$, i.e. he only read 210 pages out of 1000 pages. → (85a) is **true**

b. Quantity-based scenario: Taro read $Book_{1–3}$, i.e. he read 790 pages out of 1000 pages. → (85a) is **false**

The same is not true for notional mass nouns. Consider the situation (87).

(87) There are 10 glasses of water, $Glass_1$, $Glass_2$, ..., $Glass_{10}$. $Glass_1$ contains 500 ml of water, $Glass_2$ contains 190 ml, $Glass_3$ contains 100 ml, and $Glass_{4–10}$ contains 30 ml each.

a. Count-based scenario: Taro drank the water in $Glass_{4–10}$, i.e. he only drank 210 ml out of 1000 ml. → (85b) is **true**

b. Quantity-based scenario: Taro drank the water in $Glass_{1-3}$, i.e. he drank 790 ml out of 1000 ml. → (85b) is **true**

Since the same modifier is used, this difference must be attributed to the semantic difference between *hon* (book) and *mizu* (water). Thus, Sudo (to appear) proposes that common noun denotations are sorted into countable nouns and uncountable nouns, if not count nouns and mass nouns.[58]

In the more recent papers of his (Chierchia 2015; 2021), Chierchia abandons the claim that numeral classifier languages lack a count-mass distinction: nominal properties are sorted into atomic ones and non-atomic ones based on the notion of P-Atom.[59] However, he maintains the view that common nouns in numeral classifier languages are kind-denoting and thus their predicative denotations are inherently cumulative since $^{\cup}k$ is either closed under sum or undefined. In this sense, observations discussed so far in this section suggests that Japanese has at least a lexical atomicity distinction, but these are not enough to show that Japanese has a singular-plural distinction or a syntactic count-mass distinction.

The two analyses of the postnominal measurement construction I proposed have different implications in this regard. The first analysis with the stratified measurement reference does not presuppose a count-mass distinction, but it is compatible with it. In this sense, this analysis neither argues for nor against a lexical count-mass distinction in Japanese. On the other hand, the second analysis with #P acknowledges both a lexical count-mass distinction in NPs and a syntactic count-mass distinction in #Ps. In this sense, the implications of the second approach are stronger than the discussion in this section. Note that both analyses can be made compatible with an analysis in which Japanese common nouns are kind-denoting and thus their corresponding properties are inherently plural. The analysis with the stratified measurement reference is compatible with the assumption that Japanese noun denotations are inherently cumulative. The analysis with #P is conditionally compatible with the inherent cumulativity assumption. Recall that I laid out two possible analyses to derive a distributive plural reading: one with the distributive μ′ operator and the other with the modified version of $\#_{[+\text{number},-\text{singular}]}$. The former option is compatible with the inherent cumulativity assumption. However, the latter option requires common noun denotations to be non-cumulative in the lexicon. This is contradictory with the inherent cumulativity assumption. In this sense, both analyses can retain the Chierchia-style explanation for the typological correlation between lack of number specification and generalised bare argument, but it make the distributive μ′ operator the only option to derive distributive plural readings.

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[58] See also Inagaki & Barner (2009). They conducted an experiment on Japanese speakers based on the quantity judgement task used in Barner & Snedeker (2005). The result shows that Japanese speakers makes distinction between countable nouns and uncountable nouns.

[59] Note that he uses a more elaborated version of P-atom. See Chierchia (2010) for the detail.

5.2 Countability distinction in syntax

So far, I reviewed the analysis of Chierchia (1998) and challenges to his analysis. The tentative conclusion is that Japanese has a lexical atomicity distinction. Then, the next question is if Japanese has a syntactic count-mass distinction.

Watanabe (2017) argues that the distinction between countable nouns and uncountable nouns in Sudo (to appear) can be the one between object mass nouns, e.g., *furniture*, and substance mass nouns, e.g., *water*.[60] (88) shows that *furniture* does not require a determiner, disallows a cardinal modifier and allows *much*. Thus, *furniture* is syntactically mass.

(88) a. I bought furniture. (Chierchia 2010: 130)
b. I bought {*three furnitures / three pieces of furniture}.
c. I don't have {*many furnitures / much furniture}. (Chierchia 2010: 110)

However, *furniture* refers to a set of discrete entities unlike *water*, which refers to substance. Thus, the intuitive notion of individuation and a count-mass distinction do not always match.

Thus, Watanabe (2017) claims that one must check if Japanese makes distinction between count nouns and object mass nouns. Watanabe (2017) shows that counterparts of plural mass nouns *funds* and *assets* do not display an interpretive distinction in the reverse partitive structure.

(89) a. **Shikin**-no ichibu-ga saiken-shijou-ni nagarekon-da.
funds-no part-NOM bond-market-loc flow into-PAST
b. Ichibu-no **shikin**-ga saiken-shijou-ni nagarekonda.
part-no funds-NOM bond-market-loc flow into-PAST
'Some of the funds went into the bond market.' (Watanabe 2017: 15)

(90) a. **Shisan**-no ichibu-ga kokugai-ni mochidasare-ta.
assets-no part-NOM country out-loc is taken out-PAST
b. Ichibu-no **shisan**-ga kokugai-ni mochidasareta.
part-no assets-NOM country out-loc is taken out-PAST
'Some of the assets were taken out of the country.' (Watanabe 2017: 15)

[60] These terms are from Barner & Snedeker (2005). They conducted experiments that involve quantity judgement tasks on count nouns, object mass nouns and substance mass nouns. They used pictures with two sets of objects. These are designed so that the left-hand side objects are more than the right-hand side objects in terms of total amount, but the right-hand side objects are more than the left-hand side objects in terms of cardinality. With such stimuli, they ask participants which side has more. The result is that almost every participant made a cardinality-based judgement in cases with count nouns and object mass nouns, but almost every participant made an amount-based judgement in cases with substance mass nouns. This is expected if one assume that mass noun denotations have atoms. Note that this is not a knock-down argument against an approach in which mass nouns have non-atomic denotations. See Landman (2016) for an analysis with a non-atomic domain of entities and a more sophisticated semantic criterion for counting.

Watanabe (2017) concludes that they are always marked with [-singular]. On the top of it, Watanabe (2017) shows that count-sensitive modifiers do not allow *shikin* (funds).

(91) a. John-wa kazu ooku-no **hon**-o yon-da.
John-TOP number many-no book-ACC read-PAST
'John read a large number of books.'

b. *John-wa kazu ooku-no **mizu**-o non-da.
John-TOP number many-no water-ACC drink-PAST
'John drank a large number of water.'

c. *Kazu ooku-no **shikin**-ga saiken-shijou-ni nagarekon-da.
number many-no funds-NOM bond-market-loc flow into-PAST
'A large number of funds went into the bond market.' (Watanabe 2017: 15–6)

This suggests that *shisan* (funds) is semantically plural, but syntactically mass. This is a piece of evidence for a syntactic count-mass distinction for Watanabe (2017).[61]

Combining the discussions so far, there are reasons to believe that Japanese has a count-mass distinction both in its lexicon and in its syntax. On this point, one can wonder if it is necessary to encode a count-mass distinction in its lexicon for the first place. Borer (2005) proposes that that every noun root is universally mass and its count-mass status is determined by unambiguous functional structure provided in syntax. More specifically, the functional head (Div^0, CL^0 or $count^0$) is the locus of individuation. On this view, count nouns are those which acquire their mode of individuation from this functional head and mass nouns are obtained as a default due to the lack of the dividing feature in that head. The relevant functional head is realised either as a classifier or as an article/plural morpheme. In this sense, classifier systems and article systems are two sides of the same coin. One theoretical merit of this approach is that we can avoid redundancy between syntax and the lexicon. As there are different unambiguous functional structures above count nouns and mass nouns, further lexical specification of a count-mass distinction is redundant. This is close to the position taken in Cheng & Sybesma (1999) and Watanabe (2006).

[61] Erbach et al. (2021) conducted an experiment to check if Japanese has a class of object mass nouns opposed to count nouns and substance mass nouns. Erbach et al. (2018) employ three conceptual classes of nouns, namely (i) discrete individuals, e.g. *onna no hito* (woman), (ii) undifferentiated stuff, e.g. *yuki* (snow), and (iii) collections of discrete entities, e.g. *choorikigu* (kitchenware). Then, they ask participants if a given noun is felicitous under a count-sensitive modifier *nan-byaku-toiu* (hundreds of) (Sudo to appear). Erbach et al. (2018) report that four nouns in the third class are judged infelicitous (*hakimono* (footwear), *shinamono* (wares/articles), *kattamono* (shopped goods) and *choorikigu* (kitchenware)). Based on this result, they set up a quantity judgement task based on Barner & Snedeker (2005) for three consultants. However, they reported that a number of factors prevents them from making a strong claim on if these nouns show a behaviour of object mass nouns. Although they avoided drawing a strong claim, if Japanese indeed has the class of object mass nouns, it suggests that countability distinction is made both in the lexicon and the syntax in Japanese.

In this paper, I do not aim to make a strong claim on this issue, but let me point out that the postnominal measurement construction provides further material which merits the discussion on a syntactic count-mass distinction in Japanese. As I have shown in Section 3, cumulative plural readings and substance readings have different truth conditions with respect to individuation. However, I claim that those plural readings in the postnominal measurement construction show a 'mass-like' property in the sense that they do not make atoms salient for further grammatical operations. Recall that Japanese bare arguments are compatible with an overt distributor *sorezore* (each) as repeated in (92).

(92) Gakusei-ga **sorezore** hon-o ni-satsu ka-tta.
student-NOM each book-ACC 2-CL_{book} buy-PAST
'Students bought two books each.'

The floating *sorezore* (each) itself is sensitive to countability in the same way as other count-sensitive environments discussed in Section 5.1.

(93) *Mizu-ga **sorezore** hukounimo ni-satsu-no hon-o yomenaku-shi-ta.
water-NOM each unfortunately 2-CL_{Volume}-no book-ACC unreadable-make-PAST
(Intended)'Each portion of water unfortunately made two books unreadable.'

Imagine a situation in which a server is bringing several glasses of water to a table in which customers are reading books. Now, the server drops these glasses of water and each of these are spilled on two books. However, (93) is still infelicitous in this situation, suggesting that the floating *sorezore* (each) is sensitive to some notion of atomicity.

Now, let's see if the floating *sorezore* (each) is felicitous when it is combined with a cumulative plural reading of the postnominal measurement construction. As a baseline, consider (94).

(94) Kuruma-ga **sorezore** isogasisooni machi-o ourai-site-iru.
car-NOM each in a bustle city-ACC come and go-PROG-PRES
'The cars are each coming and going in a bustle in this city.'

Now compare it with the postnominal measurement construction as shown in (95): addition of the postnominal measurement construction leads to infelicity. In principle, one can consider a distributive plural reading and a cumulative plural reading in (95). Since a distributive plural reading is unavailable in the postnominal measurement construction, the infelicity of (95) suggests that cumulative plural readings are incompatible with the floating *sorezore* (each).

(95) *Kuruma go-ton-ga **sorezore** isogasisooni machi-o ourai-site-iru.
car 5-CL_{Ton}-NOM each in a bustle city-ACC come and go-PROG-PRES
a. 'The 5 tons of cars are each coming and going in a bustle in this city.'
b. 'The 5 ton cars are each coming and going in a bustle in this city.'

Note that the prenominal measurement construction is fine under a distributive plural reading, although it is a bit harder to imagine that several 5 ton cars are running.

(96) Go-ton-no kuruma-ga **sorezore** isogasisooni machi-o ourai-site-iru.
5-CL$_{Ton}$-no car-NOM each in a bustle city-ACC come and go-PROG-PRES
a. *‘The 5 tons of cars are each coming and going in a bustle in this city.’
b. ‘The 5 ton cars are each coming and going in a bustle in this city.’

Definiteness is orthogonal to this contrast: the contrast retains between (97a) and (97b).

(97) a. Korera-no kuruma-ga **sorezore** isogasisooni machi-o ourai-site-iru.
these-no car-NOM each in a bustle city-ACC come and go-PROG-PRES
‘These cars are each coming and going in a bustle in this city.’

b *Korera-no {kuruma go-ton / go-ton-no kuruma}-ga **sorezore** isogasisooni
these-no {car 5-CL$_{Ton}$ / 5-CL$_{Ton}$-no car}-NOM each in a bustle
machi-o ourai-site-iru.
city-ACC come and go-PROG-PRES
‘These 500 kilograms of cars are each coming and going in a bustle in this city.’

If cumulative plural readings in the measurement constructions make reference to the same type of plural individuals as *gakusei* (student) in (92) and *kuruma* (car) in (94), they should have been compatible with the floating *sorezore* (each). A similar behaviour is observed in English: Rothstein (2011) shows that pseudo partitives with plural nouns are compatible with *much*, but not with *many*.

(98) a. # I have read many of the twenty kilos of books that we sent.
b. I have (n’t) read much of the twenty kilos of books in our house.
(Rothstein 2011: 23)

Furthermore, Rothstein (2011) shows that they are incompatible with reciprocals.

(99) # The twenty kilos of books are standing next to each other in a row.
(Rothstein 2011: 24)

In Japanese, a reciprocal adverb *koogo ni* (alternately) can describe the same situation. Imagine that red books and blue books are standing next to each other. (100) is felicitously true in this context.

(100) Hon-ga **koogo ni** naran-de-iru.
book-NOM alternately standing in row-PROG-PRES
‘The books are standing next to each other.’

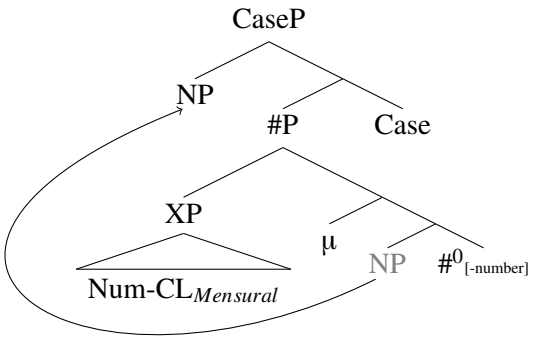
In contrast, cumulative plural readings of the measurement constructions are incompatible with *koogo ni* (alternately). (101) is infelicitous in the situation in which red books and blue books are standing next to each other.[62]

(101) *{Hon ni-ju-kkiro / Ni-ju-kkiro-no hon}-ga **koogo ni** naran-de-iru.
{book 2-10-CL$_{Kilo}$ / 2-10-CL$_{Kilo}$-no book}-NOM alternately standing in row-PROG-PRES
'The 20 kilos of books are standing next to each other.'

These observations may suggest that plural readings of the Japanese postnominal measurement construction are mass-like to the same extent as English pseudo partitives with plural nouns.

Rothstein (2011) proposes that (i) the counting structure and the measurement structure are syntactically distinguished, and (ii) count denotations and mass denotations are in one-to-one correspondence with the counting structure and the measurement structure.[63] Although more work is needed to make a precise assessment, the observations so far suggest that the same may apply to Japanese. I do not develop a full-fledged analysis in this paper, but let me describe a possible way to implement it with the ingredients discussed so far. First, I minimally modify the monotonic structure so that #^{0} plays the role of Mon^0 as shown in (102).

(102)



[62] Note that *koogo ni* (alternately) is compatible with distributive plural readings. Surprisingly, the distributive plural reading with the postnominal measurement construction becomes available in this environment. Imagine a situation in which several piles of books are standing next to each other and each pile weighs 20 kilograms.

i {Hon ni-ju-kkiro / Ni-ju-kkiro-no hon}-ga **koogo ni** naran-de-iru.
{book 2-10-CL$_{Kilo}$ / 2-10-CL$_{Kilo}$-no book}-NOM alternately standing in row-PROG-PRES
'The portions of 20 kilos of books are standing next to each other.'

This case is more complex than the previous cases. Here, *koogo ni* (alternately) quantifies over multiple piles each of which consists of multiple books. In this sense, a proper treatment of this phenomenon requires consideration of *structured pluralities*, pluralities of pluralities. As any full attempt for the reading in (i) requires a proper treatment of the semantics of *koogo ni* (alternately) and its interaction with structured pluralities, I leave this issue for future research.

[63] See also Borer (2005) for this type of approach.

Since both types of measurement constructions underspecify atoms, I assume that either (i) the NP-raising to Spec, CaseP is optional or (ii) the remnant #P can be raised to Spec, QP when Q^0 is introduced to the derivation. This is in line with the structural ambiguity discussed in Section 4.3.

Second, I refine the denotations of $\#^0$ based on P-atoms. I assume that P-atoms are underspecified in the lexical semantics of common nouns and $\#^0$ plays a role to specify P-atoms as shown in (103).

(103) a. $[\![\#_{[+number,+singular]}]\!] = \lambda P \lambda x{:}\text{P-atom}(x).[P(x)]$
b. $[\![\#_{[+number,-singular]}]\!] = \lambda P \lambda x{:}*\text{P-atom}(x).[P(x)]$
c. $[\![\#_{[-number]}]\!] = \lambda P \lambda x{:}\neg\exists y[y \sqsubseteq x \,\&\, \text{P-atom}(y)].[P(x)]$

Now, this analysis makes a distinction between a set of atoms and a set of P-atoms. If the notion of atomicity relevant for distributivity is P-atom, this correctly predicts that plural readings in the measurement constructions are compatible with neither *sorezore* (each) nor *koogo ni* (alternately).

If the discussion so far is on the right track, the fact that cumulative plural readings of the measurement constructions are compatible with neither an overt distributor nor a reciprocal adverb provides a piece of support for a syntactic atomicity distinction in Japanese: the #P layer is necessary to distinguish NP denotations with P-atoms and those without P-atoms. In addition, recall that notional count nouns are compatible with the floating *sorezore* (each) as shown in (92) and (94), while notional substance mass nouns are not as shown in (93). This suggests that P-atoms can be defined with notional count nouns, but not with notional substance mass nouns.[64] Note that this P-atom-based semantics of $\#_{[-number]}$ emulates the effect of the stratified

[64] If denotations of NPs are classified based on P-atoms and count-sensitive modifiers require P-atoms, the postnominal measurement construction offers yet another observation which merits further discussion. Filip & Sutton (2017) shows that non-quantised count nouns can occur under pseudo partitives. Indeed, the Japanese counterpart of *wall* shows an analogous behaviour. (i) suggests that *kabe* (wall) specifies P-atoms: it is compatible with count-sensitive modifiers. However, (ii) suggests that *kabe* (wall) does not specify P-atom: it can have a singular reading in the post-nominal measurement construction. Note that one native speaker of Japanese reported that this context is necessary to accept (ii), but the other speaker reported that this context is not necessary.

i. {kanari no kazu-no / nan-byaku-toiu} kabe
{a number of-no / what-100-toiu} wall
"{A number of / Hundreds of} walls"

ii. Context: In this game, a player tries to climb up a wall just with momentum of running. A player has cleared until 4.5 meters high.
Tsuini, kanojo-ga {go-meetoru-no kabe / Kabe go-meetoru}-ni tyoosen-suru.
finally, she-NOM {5-CL_{Meter}-no wall / wall 5-CL_{Meter}}-DAT challenge-PRES
"Finally, she is attempting {5 meter wall / 5 meters of wall}."

(i) and (ii) collectively suggest that *kabe* (wall) shows a flexible behaviour with respect to P-atoms, which is analogous to the behaviour of non-quantised count nouns in Filip & Sutton (2017). Filip & Sutton's (2017) analysis relies on a context-sensitive notion of counting (Rothstein 2010; Landman 2011) and if the discussion so far is on the right track, this behaviour of *kabe* (wall) may suggest that Japanese also resorts to a similar context-sensitive notion of atomicity.

measurement reference. Imagine that P(x) is true. $[\![\#_{[-number]}]\!]$ (P)(x) presupposes that there is no sub-part of x which is a P-atom. Crucially, x itself cannot be a P-atom. As a result, $\#^{0}_{[-number]}$ rules out any readings which imply P-atoms, i.e. singular readings and plural readings. In this sense, $\#_{[-number]}$ triggers count-to-mass coercion whether its complement induces a singular reading or a plural reading. See Rothstein (2011) for a more elaborated analysis of plural-to-mass coercion in pseudo partitives in English. Accordingly, the difference between a singular reading and a cumulative plural reading is attributed to a different notion of atomicity than P-atom nor mereological atomicity, e.g., *natural atomicity* (Rothstein 2010).[65] Although I leave the precise formalisation of the resultant system for future research, this offers a novel material for further discussion on a count-mass distinction in Japanese. The take-home message is that the measurement constructions provide further observations which may suggest that Japanese makes an atomicity distinction both in its lexicon and its syntax.

6 Conclusion

I started discussion with a typological generalisation that numeral classifier languages generally do not have an obligatory plural morpheme (Greenberg 1972; Sanches & Slobin 1973; Doetjes 2012). In this paper, I discussed the semantic properties of measurement constructions in Japanese, which is a numeral classifier language and lacks an obligatory plural morpheme. The main findings are, (i) the postnominal measurement construction disallows a singular reading, and (ii) notional count nouns sometimes trigger count-to-mass coercion in the postnominal measurement construction. This pattern is reminiscent of the selectional restriction of monotonic measure phrases in English: monotonic measure phrases select nouns with non-quantised denotations. This raises a question of why this restriction is not trivial if common noun denotations in Japanese are inherently cumulative.

I proposed two possible ways to derive the observed readings in the postnominal measurement construction. The first option is to adopt the stratified measurement reference (Champollion 2017) and require an entity to be sub-divisible if it is a member of the denotation of the postnominal measurement construction. In this option, one can retain the assumption that Japanese common noun denotations are inherently cumulative. The second option is to assume that Japanese has a syntactic number distinction at the #P level, following Watanabe (2006; 2017). In this option, one can retain the definition of measurement monotonicity and non-quantisation requirement.

I further showed that cumulative plural readings of Japanese measurement constructions are compatible with neither an overt distributor nor a reciprocal adverbial. This is in line with

[65] Rothstein (2010) distinguishes *formal atomicity*, *natural atomicity* and *semantic atomicity* from each other. Roughly speaking, formal atomicity concerns being atoms in the domain of entities, natural atomicity concerns individuation and semantic atomicity concerns the semantics of counting.

the observation in Rothstein (2011) that English pseudo partitives with plural nouns show mass-like behaviour. This suggests that the postnominal measurement construction is a syntactic environment which only selects NPs with mass denotations, which provide a new piece of support for a syntactic atomicity distinction in Japanese. Although I do not attempt to make a strong claim on it, I suggested that (i) the #P layer makes a distinction between denotations with P-atoms and those without P-atoms and (ii) overt distributors and reciprocal adverbs are sensitive to P-atoms.

Although I leave open which analysis is more desirable, each of the proposed analyses is compatible with the assumption that common noun denotations in Japanese are inherently cumulative. In this sense, the Chierchia-style analysis of kind-oriented languages can be maintained. If the discussion on the mass-like properties of plural readings in the measurement constructions is on the right track, the observations provided from the measurement constructions in Japanese possibly suggest that Japanese noun denotations are inherently cumulative, but an atomicity distinction is made in the denotations of #P. Also, to the extent that the diagnostics with the floating *sorezore* (each) tells, Japanese common noun denotations have to be classified into those which can specify P-atoms, e.g., *kuruma* (car) and those which cannot, e.g., *mizu* (water). This is the minimally required level of a lexical atomicity distinction based on the discussion in Section 5.2. The remaining question is how rich this lexical distinction is in Japanese. Discussion on mismatch between semantic countability and grammatical number is telling in this regard. Chierchia (2015; 2021) predict that numeral classifier languages lack object mass nouns, while they distinguish count nouns and mass nouns. However, Watanabe's (2017) claims that Japanese has plural mass nouns which are semantically plural, but syntactically mass, e.g., *shikin* (funds) and *shisan* (assets). If Japanese indeed has a class of object mass nouns or plural mass nouns, it suggests that Japanese also allows mismatch between semantic countability and syntactic number. Erbach et al. (2021) tackle this issue and propose an analysis of a count-mass distinction in Japanese which can distinguish count nouns, object mass nouns and substance mass nouns. Although they conclude that their experiment do not strongly suggest presence of object mass nouns in Japanese, their experiment suggests that a few of Japanese nouns fall into a gray zone between count nouns and substance mass nouns. More investigation in this regard would reveal how close the noun classification in in Japanese is to the noun classification in languages with an overt morphological number-marking.

Abbreviations

NOM = nominative case particle, ACC = accusative case particle, TOP = topic particle, CL = classifiers, PAST = past tense morpheme, PRES = present tense morpheme, PROG = progressive / stative aspectual morpheme

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Competing interests

The author has no competing interests to declare.

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