Object Mass as an Arbiter for the Mass-Count Category

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Introduction

Common view: Classifier languages have no grammaticized lexical mass/count distinction.

- All nouns are taken to be of the same semantic type.

Corollary: Classifier languages have no object mass Ns (Chierchia, 2010).

Main empirical data: There are quantifiers in Japanese that are sensitive to the inherent countability properties of Ns:

- e.g. *nan-byaku-to-iu* 'hundreds of'
  - felicitous with Ns like *onna no hito* 'woman', *isu* 'chair'
    - requires no classifier (Sudo, 2016)
  - infelicitous with Ns like *yuki* 'snow' and *chōri-kigu* 'kitchenware',
    - but only *chōri-kigu* 'kitchenware' denotes sets of individuated objects, therefore, it is plausible to assume that it has properties akin to object mass Ns like *kitchenware* in English.

Proposal: Japanese has (at least some reflexes of) a grammaticized lexical mass/count distinction, as also evidenced by Ns that exhibit properties of object mass Ns.

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Chierchia (2010)

- Fake mass Ns a.k.a. object mass Ns: Arbiter for the mass/count distinction

"What makes fake mass nouns interesting is that they constitute a fairly recurrent type of non canonical mass nouns, and yet they are subject to micro-variation among closely related languages. For all we know, the phenomenon of fake mass appears to be restricted to number marking languages. It is unclear that classifier languages like Mandarin and number neutral languages like Dëne display a class of cognitively count nouns with the morphosyntax of mass nouns. In view of this intricate behavior, **fake mass nouns arguably constitute a good testing ground for theories of the mass/count distinction**" (Chierchia, 2010, p. 111, emphasis added).

Object mass Ns

Two key properties

1. Denote objects, rather than substances, in the sense of Soja et al. (1991).
2. Do not grammatically pattern with count Ns:
   - infelicitous in direct combination with numericals:
     a. *three furniture(s)
   - infelicitous with count quantifiers, but felicitous with mass quantifiers:
     a. *every furniture
     b. *each furniture
     c. *many furniture(s)
     d. much furniture

Chierchia (2010)

Claim: Classifier languages cannot have object mass Ns.

"The idea, in other words, is that fake mass nouns arise as a 'copy cat' effect from the way in which number marking languages react to unstably atomic nouns. Since listing a potentially count noun as a singleton property is essentially a matter of lexical choice, we expect there to be variation, even across closely related languages or language families on this score, which has, in fact, been often observed in connection with fake mass nouns. Moreover, and more interestingly, this approach links the existence of fake mass nouns to the presence of (obligatory) number marking. The logic of this link is the following. **If a language lacks obligatory number marking, there is no need to turn its mass nouns into singleton properties. And hence, no copy cat effect can take place.** As we will see shortly, classifier languages might indeed be a case in point" (Chierchia, 2010, p. 139, emphasis added).

Analyses of classifier languages

All nouns are taken to be of the same semantic type:

- uniformly mass denoting
  - "I will show some other mass-like characteristics of J/K [(Japanese and Korean)] nouns to support the hypothesis that J/K bare nouns are mass" (Nemoto, 2005, p. 386).
  - "There is no evidence for a mass/count distinction in the nominal phrases in Chinese: in Chinese, all nouns are mass nouns denoting kinds" (Li, 2011, p. 1)
- uniformly kind denoting
  - "Common nouns are in a way assimilated to proper names in Chinese type languages. They are names of kinds." (Chierchia, 1998, p. 93)
  - "if in a language all nouns are kind denoting, by the time they combine with a number something must intervene... This is a way of understanding *why* there are generalized quantifier languages"(Chierchia, 2010, p. 141)
  - "in Mandarin, where bare nouns are kind-denoting terms" (Rothstein, 2017)
- A related view: Bare Ns have the same internal structure, "providing a basic mental space, denoting quality" (Muromatsu, 2003, p. 79).

Chierchia (1998)

- All Ns in classifier languages denote kinds—e.g. *zhuōozi* 'table' (Chinese)
- Ns become mass nominal predicates via the operation π (Chierchia, 1998)
- Ns become countable predicates by combining with classifiers—e.g. *zhāng* (CL)
- Numericals—e.g. *liǎng* 'two'—are quantifiers that can only take countable predicates

(1) liǎng zhāng zhuōozi (Chinese)
two CL table
'two tables'
liǎng(zhāng(π(zhuōzi))) (Chierchia, 1998, pp. 92-3)

Towards a more nuanced view of classifier languages

- "there is evidence in favor of a lexical mass/count distinction in a language such as Mandarin" (Doetjes, 2012, p. 2576).
- "nominal denotations in Japanese are not so different from those in non-classifier languages like English" (Sudo, 2016, p. 2).
- "Japanese has nouns with countable denotations" (Sudo, 2017, p. 8).

Reflexes of a mass/count distinction in Japanese

Japanese counting modifiers, proportional quantifiers, and large round numbers can directly compose with some Ns (Sudo, 2016, 2017):

(2) a. dono-ie-mo totemo furui
which-house-MO very old
'Every house is very old.'

b. #dono-ase-mo arainagashita
which-sweat-MO washed.off
Intended: '(I) washed off all the sweat.'

- Such data have mostly not been taken into account in the rest of the extant literature.
- Sudo (2016, 2017) concludes that there are Ns in Japanese with countable denotations, and that nominal denotations in Japanese, a classifier language, are not so different from those in non-classifier languages like English.

Analysis of the counting construction (Sudo, 2016)

- Classifiers are required by numericals rather than Ns (Krifka, 1995)
- Numericals are of type $\langle n \rangle$, classifiers are of type $\langle n, \langle e, t \rangle \rangle$, and together they form a predicate of type $\langle e, t \rangle$.

(3)
a. inu go-*(hiki)
dog five-CL$_{small.animal}$
'five dogs'(Muromatsu, 2003, p. 73)

b. mizu go-*(hon)
water five-CL$_{bottle}$
'five bottles of water'

c. kagu itsu-*(tsu)
furniture five-CL$_{general}$
'five pieces of furniture'

d. chōri-kigu itsu-*(tsu)
kitchenware five-CL$_{general}$
'five pieces of kitchenware'

Towards a lexical mass/count distinction in Japanese

Intermediary Conclusions

- Sudo (2016, 2017)'s key insight regarding Japanese Ns: There are Ns with countable denotations (Sudo, 2017, p. 8), and N denotations are not so different from those in non-classifier languages like English (Sudo, 2016, p. 2)
- Lacuna in Sudo (2016, 2017):
  - The observed compatibility constraints between quantifiers and Ns could be due to the inherent individuation properties of Ns, rather than their grammatical countability (mass/count) status.
- Object mass Ns as key evidence:
  - If a language has object mass Ns, then conceptual individuation alone cannot motivate the observed distributional patterns of quantifiers with Ns, and an alternative must be sought, namely, acknowledging that such patterns are indeed reflexes of the grammatical mass/count distinction.

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Empirical Study

An acceptability judgment task to test for object mass Ns in Japanese.

- Tested felicity with the quantifier *nan-byaku-to-iu* 'hundreds of':
  - A test for count Ns in Sudo (2016).
- Test items
  - 18 collective artifact Ns: e.g., *shokki* 'dishware'
  - 30 prototypical object Ns: e.g., *isu* 'chair'
  - 30 substance Ns for comparison: e.g., *abura* 'oil'
- Each sentence judged by 50 native speakers.
- Online survey on www.crowdworks.jp.
- 5 point Likert scale from 1 (*zenzen yokunai* 'not at all good') to 5 (*totemo yoi* 'very good').

Examples of Test Sentences

(4) toranpu-shi ga daitoryō ni na-tta ato,
Trump-president NOM president ACC become-PST after;
nan-byaku to iu onna.no.hito ga washinton de
what-hundred to say woman NOM Washington LOC
neriarui-ta
march-PST
'After Trump became president, hundreds of women marched in Washington DC.'

(5) kinō yuki ga fu-tta. **nan-byaku to iu yuki** wa
yesterday snow NOM fall-PST; what-hundred to say snow NOM
mō toke-te shima-tta
already melt-TE finish-PST
'It snowed yesterday. #Hundreds of snow melted already.'

Test Sentences (Continued)

(6) Atarashī ryōri no gakkō wa **nan-byaku to iu**
new cooking GEN school TOP what-hundred to say
chōrikigu o ka-tta. Dakara subete no seito ga
kitchenware ACC buy-PST therefore all GEN student NOM
benkyōsuru tame no potto to furaipan o mo-tta.
study for GEN pot and pan ACC hold-PST

'The new culinary school bought hundreds of kitchenware, so every student had pots and pans to work with.'

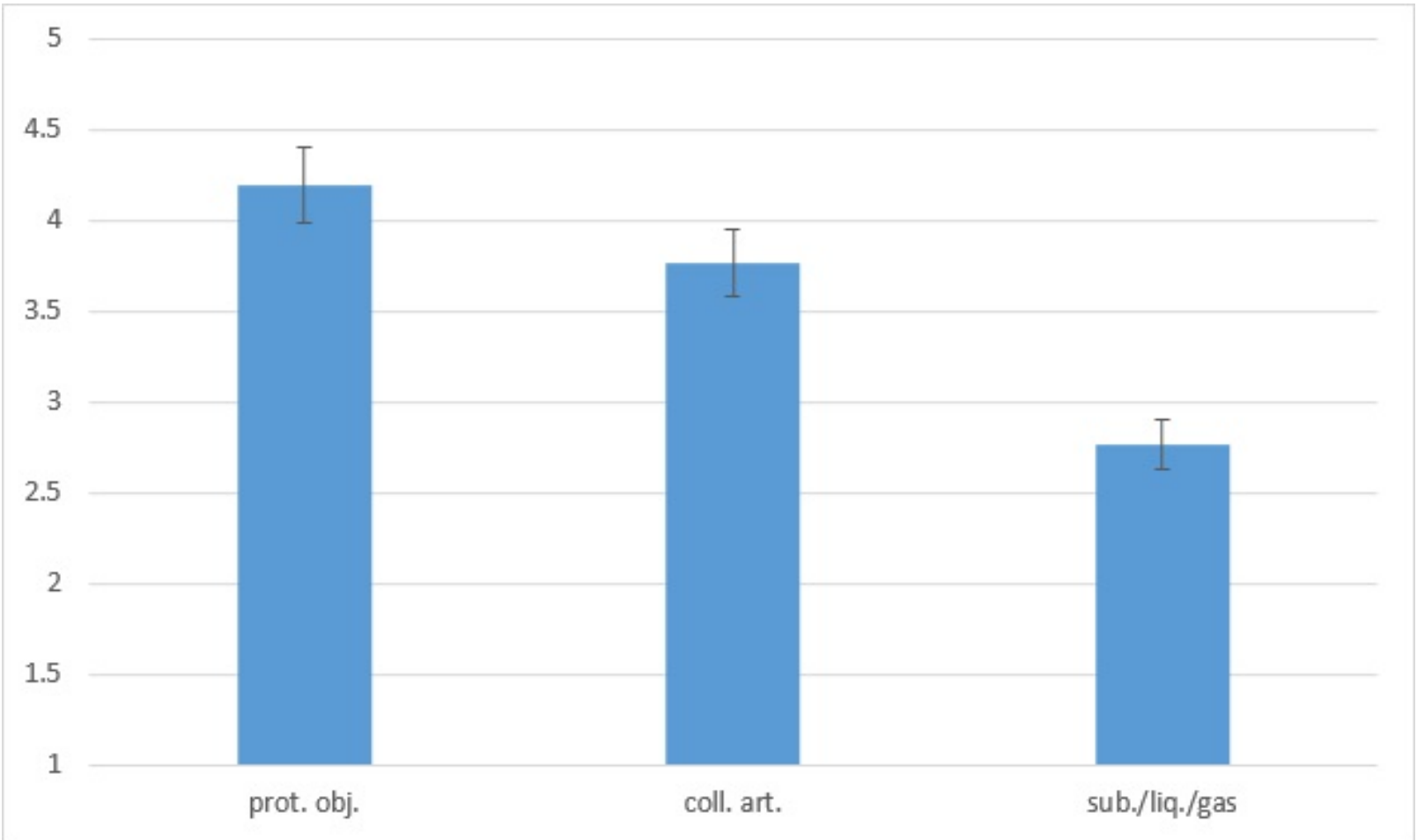
Results

Generalized linear mixed effects model

- lme4 package in R
- Random effects: item and participant
- Fixed effect: Notional class (prot. obj., coll. art., sub/liq/gas)
- Sentences with collective artifact Ns are less felicitous than those with object Ns ($p < 0.01$).
- Sentences with substance Ns are less felicitous than those with object Ns ($p < 0.001$).

Results (Continued)

- Prototypical object Ns have high average acceptability (4.20)
- Substance Ns have low average acceptability (2.76)
- Collective artifact Ns are in between (3.77)



Results (Continued)

Not all collective artifact nouns behave the same way.

There is a gradient in judgments of collective artifact Ns.

- This is common in acceptability judgments (Bresnan, 2007; Bresnan and Ford, 2010; Chomsky, 1964; Featherston, 2005; Keller, 2000; Newmeyer, 2007; Sorace and Keller, 2005; Sprouse, 2007)

Collective artifact Ns fall into three groups:

1. Collective artifact Ns that pattern with prototypical object Ns
   - $p = 0.567$, $\bar{x} = 4.22$, $n = 7$, trivial effect size (< 0.2)
2. Collective artifacts Ns that weakly do not pattern with object Ns
   - $p < 0.05$, $\bar{x} = 3.71$, $n = 7$, medium effect size (0.5–0.8)
3. Collective artifact Ns that strongly do not pattern with object Ns
   - $p < 0.001$, $\bar{x} = 3.21$, $n = 4$, large effect size (> 0.8)

Results: Average Judgments

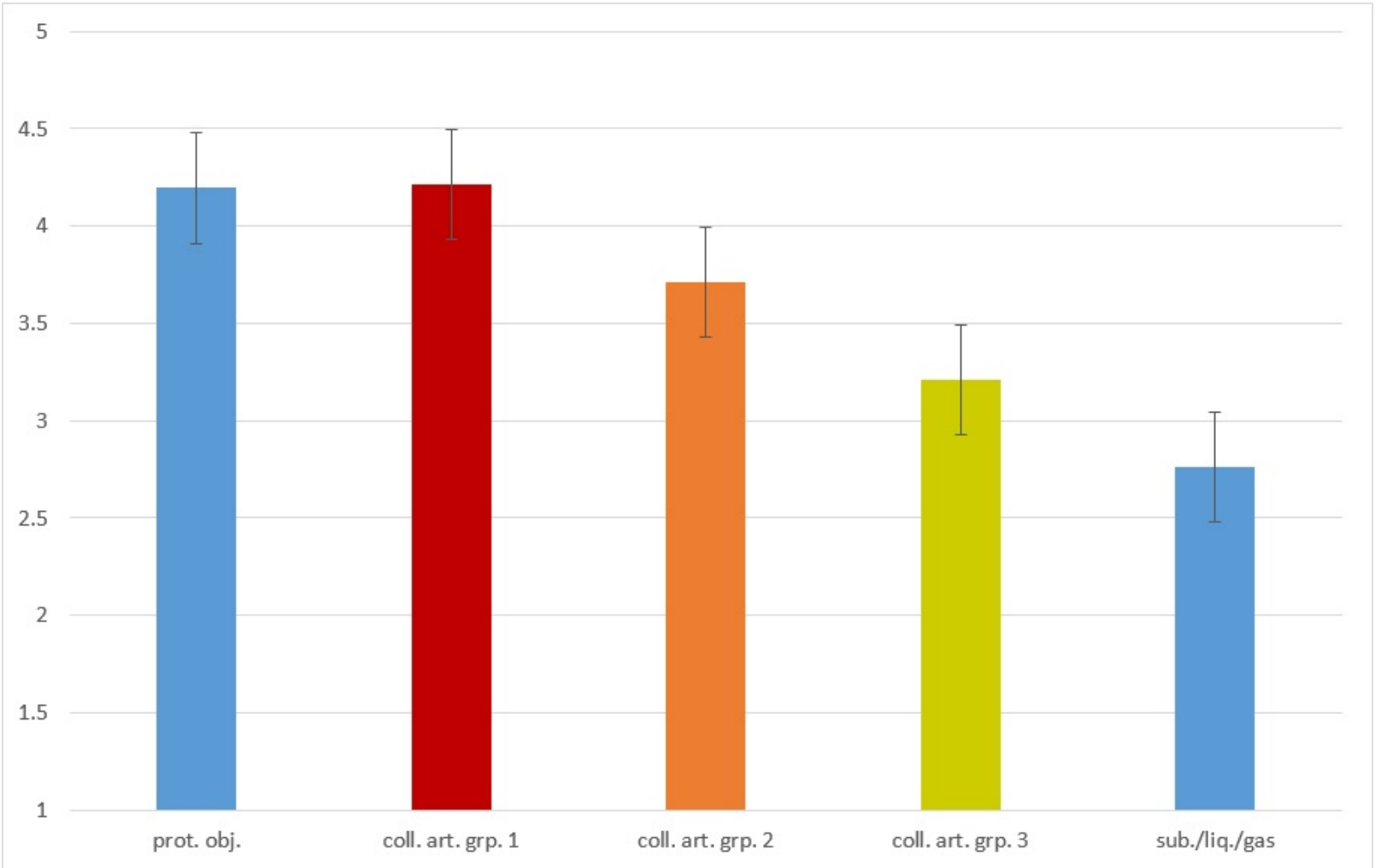


Fig.: Average judgment of Ns with *nan-byaku-to-iu* ('hundreds of')

Discussion

Nan-byaku-to-iu 'hundreds of' seems to tap into the grammaticized lexical mass/count distinction among Japanese Ns.

- There is a large effect size between prototypical object Ns and substance Ns

The three groups of collective artifact Ns have different acceptability with *nan-byaku-to-iu* 'hundreds of':

1. Collective artifact Ns that are felicitous with *nan-byaku-to-iu*
   - *haikibutsu* ('waste'), *kizai* ('equipment'), *yōfuku* ('western clothes'), *chōri-ki* ('kitchenware'), *yūbin* ('mail'), *daidokoro yōhin* ('kitchenware'), *kutsu* ('footwear')
2. Collective artifact Ns that are (in)felicitous, %, with *nan-byaku-to-iu*
   - *shōhin* ('goods/wares'), *kagu* ('furniture'), *shokki* ('dishware'), *sōbi* ('equipment'), *dōgu* ('tools'), *yūbinbutsu* ('mail'), *gomi* ('garbage')
3. Collective artifact Ns that are infelicitous, #, with *nan-byaku-to-iu*
   - *hakimono* ('footwear'), *shinamono* ('wares/articles'), *kattamono* ('shopped goods'), *chōri-kigu* ('kitchenware')

Discussion (Continued)

Showing that a collective artifact N is infelicitous with *nan-byaku-to-iu* 'hundreds of' and denotes sets of individuable entities amounts to showing that it has properties of an object mass N:

- Some examples: *hakimono* ('footwear'), *shinamono* ('wares/articles'), *kattamono* ('shopped goods'), *chōri-kigu* ('kitchenware').

Tested quantity comparison tasks in the style of Inagaki and Barner (2009):

- Participants compared the relevant quantities according to cardinality when prompted by questions about quantity that contained no classifiers or other cues for individuation.

Individuation in Japanese Ns (Inagaki and Barner, 2009)

Inagaki and Barner (2009) argue that Japanese Ns can individuate in the absence of count syntax, and generally individuation can be encoded by nouns cross-linguistically in absence of count syntax.

- Compatible with the common view
- Test: classifier-less 'more than' constructions
  - No cues about individuation, and yet
- Some Ns are compared according to cardinality
  - e.g. *kutsu* ('shoe'), *kagu* ('furniture')
- Some Ns are compared according to volume
  - e.g. *karashi* ('mustard')

(Inagaki and Barner, 2009, p. 124)

Informal Quantity Judgments

(7) Mayo no kago ni wa ookii mi-ttsu no men no
Mayo GEN basket LOC TOP big 3-CL GEN noodle GEN
fukuro to fatatsu no suika ga hai-tte iru. Ai
bag and 2-CL GEN watermelon NOM contain-TE IRU Ai
no kago ni wa chiisai yo-ttsu no men no fukuro
GEN basket LOC TOP small 4-CL GEN noodle GEN bag
to mi-ttsu no satsuma mikan ga hai-tte iru.
and 3-CL GEN satsuma mandarin NOM contain-TE IRU
"Mayo's basket has three large packs of noodles and two watermelons in it. Ai's basket has four small packs of noodles and three satsumas in it."

(8) Dochira no hito no kago ga yori ōku no
Who GEN person GEN basket NOM more much GEN
kattamono o motte irudeshou?
goods DIR carry stay
"Who's basket has more goods?"

Object Mass Ns in Japanese

Given contexts like (7) and classifier-less questions like (8), participants judged collective artifact nouns according to cardinality rather than volume.

Given that such collective artifact Ns

1. denote individuated objects, rather than substances, as seen via cardinality comparison,
2. do not grammatically pattern with count Ns, in so far as they are infelicitous with with *nan-byaku-to-iu* 'hundreds of'

It is reasonable to conclude that there are collective artifact Ns in Japanese that behave like object mass Ns.

Conclusion from the empirical study

Conclusion: There are collective artifact Ns in Japanese that behave like object mass Ns.

- consequence: If there are collective artifact Ns in Japanese that behave like object mass Ns, then the common view that Japanese, and classifier languages generally, have no grammaticized lexical mass/count distinction cannot be upheld.

Proposed analysis: based on the analysis of collective artifact Ns in Sutton and Filip (2016).

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Why Frame Semantics

Sources of inspiration:

- Type theory with records (TTR)
- Other frame semantics (Fillmore, 1976; Barsalou, 1992; Löbner, 2014)
- Landman's Iceberg Semantics ($\langle \mathbf{body}, \mathbf{base} \rangle$)

Why a different formalism:

- Much simpler than TTR
- Like TTR, retains Montague-style compositional semantics (other frame semantics lose this)
- Ability to represent richer lexical structures than Landman's Iceberg Semantics

Standard features:

- functional types formed from basic types e, t, w, n, d (n for numbers, d for dimensions (e.g. volume))
- typed variables and constants, λ-abstraction

Non-standard features:

- Propositions are frames (sets of (recursive) labelled fields)

  Example:

$$[\![\text{n}]\!] = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.P(y) \\ \text{ext} & = & {}^{*}P(x) \end{bmatrix}$$

  - Set of Ps or sums of Ps individuated in terms of the property $\lambda y.P(y)$.
  - Of type $\langle ef \rangle$ with f a basic type for *frame*

- Modification can be done on specific fields (parts of a frame)
  - Labels can be used to refer to properties or propositions in frames:

$$\text{cbase}([\![\text{n}]\!](x)) \leftrightarrow \lambda y.P(y)_{:\langle et \rangle}$$
$$\text{ext}([\![\text{n}]\!](x)) \leftrightarrow {}^{*}P(x)_{:t}$$

Sutton & Filip's account of the mass/count distinction

Expression	Type	Description
glass, wine, ...	$\langle et \rangle$	Predicates. Stand-ins for e.g., bundle of perceptual, functional, and topological properties
$\mathcal{O}$	$\langle et, et \rangle$	Object unit function: A function from predicates to predicate for entities that can count as 'one'
$\mathcal{S}_{i>0} \in \mathbb{S}$	$\langle et, et \rangle$	Individuation Schema: A function from predicates P to predicate with an extension that is a maximally disjoint wrt the extension of P
$\mathcal{S}_0 \in \mathbb{S}$	$\langle et, et \rangle$	The Null Individuation Schema: The identity function. More formally: $\mathcal{S}_0(P) = \bigcup_{\mathcal{S}_{i>0} \in \mathbb{S}} \mathcal{S}_i(P)$)

Inspirations and origins:

- $\mathcal{O}$: Landman's (2011) generator sets, Krifka's (1995) OU function
- $\mathcal{S}_{i>0}$: Landman's (2011) variants, Rothstein's (2010) default counting contexts
- $\mathcal{S}_0$: Landman's (2011) contexts for object mass nouns
- The context sensitivity of individuation: (Chierchia, 2010; Rothstein, 2010)
- (More in our work with TTR) mereotopological properties in a theory of individuation (Grimm, 2012)

Object and Substance denoting nouns

Expression	Type	Description
glass, wine, ...	$\langle et \rangle$	Predicates. Stand-ins for e.g., bundle of perceptual, functional, and topological properties
$\mathcal{O}$	$\langle et, et \rangle$	Object unit function: A function from predicates to predicate for entities that can count as 'one'
$\mathcal{S}_{i>0} \in \mathbb{S}$	$\langle et, et \rangle$	Individuation Schema: A function from predicates P to predicate with an extension that is maximally disjoint wrt the extension of P
$\mathcal{S}_0 \in \mathbb{S}$	$\langle et, et \rangle$	The Null Individuation Schema: The identity function. More formally: $\mathcal{S}_0(P) = \bigcup_{\mathcal{S}_{i>0} \in \mathbb{S}} \mathcal{S}_i(P)$)

Examples:

$$[\![\text{glasses}]\!]^{\mathcal{S}_i} = [\![\text{glasses}]\!](\mathcal{S}_i) = \lambda s.\lambda x.\left[\begin{array}{lcl} \text{cbase} & = & \lambda y.s(\mathcal{O}(\mathit{glass}))(y) \\ \text{ext} & = & {}^{*}s(\mathcal{O}(\mathit{glass}))(x) \end{array}\right](\mathcal{S}_i)$$

Set of individual glasses/sums of individual glasses under schema $\mathcal{S}_i$. Disjoint counting base. Cumulative extension.

$$[\![\text{wine}]\!]^{\mathcal{S}_i} = [\![\text{wine}]\!] = \lambda x.\left[\begin{array}{lcl} \text{cbase} & = & \lambda y.\mathcal{S}_0(\mathit{wine})(y) \\ \text{ext} & = & \mathcal{S}_0(\mathit{wine})(x) \end{array}\right]$$

Set of all possible partitions of wine. Overlapping and non-quantized counting base. Cumulative extension.

Collective Artifact Nouns

$$[\![\text{furniture}]\!]^{\mathcal{S}_i} = [\![\text{furniture}]\!] = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_0(\mathcal{O}(\textit{furniture}))(y) \\ \text{ext} & = & {}^*\mathcal{S}_0(\mathcal{O}(\textit{furniture}))(x) \end{bmatrix}$$

Set of pieces of furniture and sums thereof. Overlapping and non-quantized counting base. Cumulative extension.

Contrasts with *huonekalu(t)* ('[piece(s) of] furniture', Finnish):

$$[\![\text{huonekalut}]\!]^{\mathcal{S}_i} = \lambda s.\lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.s(\mathcal{O}(\textit{furniture}))(y) \\ \text{ext} & = & {}^*s(\mathcal{O}(\textit{furniture}))(x) \end{bmatrix}(\mathcal{S}_i)$$

$$= \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_i(\mathcal{O}(\textit{furniture}))(y) \\ \text{ext} & = & {}^*\mathcal{S}_i(\mathcal{O}(\textit{furniture}))(x) \end{bmatrix}$$

Set of pieces of furniture and sums thereof at schema $\mathcal{S}_i$. Disjoint and quantized counting base. Cumulative extension.

Nominal semantics in Japanese

Interpretations of Japanese Ns are number neutral, but otherwise just like Ns in number marking languages.

Noun	Translation	Countability	Disj Cbase	Cum Ext
isu	chair(s)	Count	Yes	Yes
kagu	[piece(s) of] furniture	Count	Yes	Yes
chōri-kigu	kitchenware	Mass	No	Yes
yuki	snow	Mass	No	Yes

$$[\![\text{isu}]\!]^{\mathcal{S}_i} = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_i(\mathcal{O}(\mathit{chair}))(y) \\ \text{ext} & = & {}^*\mathcal{S}_i(\mathcal{O}(\mathit{chair}))(x) \end{bmatrix} \quad (1a)$$

$$[\![\text{kagu}]\!]^{\mathcal{S}_i} = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_i(\mathcal{O}(\mathit{furniture}))(y) \\ \text{ext} & = & {}^*\mathcal{S}_i(\mathcal{O}(\mathit{furniture}))(x) \end{bmatrix} \quad (1b)$$

$$[\![\text{chōri-kigu}]\!]^{\mathcal{S}_i} = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_0(\mathcal{O}(\mathit{kitchenware}))(y) \\ \text{ext} & = & {}^*\mathcal{S}_0(\mathcal{O}(\mathit{kitchenware}))(x) \end{bmatrix} \quad (1c)$$

$$[\![\text{yuki}]\!]^{\mathcal{S}_i} = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_0(\mathit{snow})(y) \\ \text{ext} & = & {}^*\mathcal{S}_0(\mathit{snow})(x) \end{bmatrix} \quad (1d)$$

The quantifier *nan-byaku to iu* ('hundreds of')

Selects count Ns like *isu* ('chair') that have a countable, disjoint *cbase* property.

- Disjointness precondition stored in a *precon* field

$$[\![\text{nan-byaku-to-iu}]\!]^{\mathcal{S},n_c} = \lambda F.\lambda x.\begin{bmatrix} cbase & = cbase(F(x)) \\ ext & = ext(F(x)) \\ restr & = \mu_{card}(x, cbase(F(x)), \geq n_c) \\ precon & = \text{DISJ}(cbase(F(x))) \end{bmatrix} \tag{2a}$$

$$[\![\text{nan-byaku-to-iu isu}]\!]^{\mathcal{S},n_c} = \lambda x.\begin{bmatrix} cbase & = \lambda y.\mathcal{S}_i(\mathcal{O}(chair))(y) \\ ext & = {}^*\mathcal{S}_i(\mathcal{O}(chair))(x) \\ restr & = \mu_{card}(x, \lambda y.\mathcal{S}_i(\mathcal{O}(chair))(y), \geq n_c) \\ precon & = \text{DISJ}(\lambda y.\mathcal{S}_i(\mathcal{O}(chair))(y)) \end{bmatrix} \tag{2b}$$

Paraphrase: The set of sums of chairs that have a cardinality greater that the contextually specified standard n_c in terms of the counting base for individual chairs with the precondition that the counting base set of disjoint.

The quantifier *nan-byaku to iu* ('hundreds of') is infelicitous with mass nouns, including object mass nouns

Attempt to compose *#nan-byaku-to-iu chōri-kigu* (Int: 'hundreds of pieces of kitchenware')

$$[\![\text{nan-byaku-to-iu chōri-kigu}]\!]^{\mathcal{S},n_c} = \lambda x.\begin{bmatrix} cbase & = \lambda y.\mathcal{S}_0(\mathcal{O}(kitchenware))(y) \\ ext & = {}^*\mathcal{S}_0(\mathcal{O}(kitchenware))(x) \\ restr & = \mu_{card}(x, \lambda y.\mathcal{S}_0(\mathcal{O}(kitchenware))(y), \geq n_c) \\ precon & = \text{DISJ}(\lambda y.\mathcal{S}_0(\mathcal{O}(kitchenware))(y)) \end{bmatrix} \quad (3)$$

False precondition!!

- Object mass Ns like are interpreted at the null individuation schema, $\mathcal{S}_0$
- $\mathcal{S}_0$ does allows overlapping individuals to count as one simultaneously (Landman, 2011)
- *chōri-kigu* ('kitchenware') does not meet the disjointness precondition and is therefore infelicitous.

Counting Object Mass Ns

Object mass Ns can still be used in count syntax with an intervening sortal classifier:

- Classifiers convert numerals into noun modifiers (Krifka, 1995)
- They also introduce the disjoint individuation schema of evaluation ($\mathcal{S}_i$)
  - $\mathcal{S}_i(\mathcal{S}_0(P)) \leftrightarrow \mathcal{S}_i(P)$ A disjoint set

$$[\![\text{itsu}]\!]^{\mathcal{S}_i} = [\![\text{itsu}]\!] = 5 \tag{4a}$$

$$[\![\text{tsu}]\!]^{\mathcal{S}_i} = \lambda n.\lambda F.\lambda s.\lambda x.\begin{bmatrix} cbase & = \lambda y.s(cbase(F(x)))(y) \\ ext & = \lambda x.s(ext(F(x)))(x) \\ restr & = \mu_{card}(x, \lambda y.s(cbase(F(x)))(y), n) \\ precon & = \forall y.s(cbase(F(x)))(y) \\ & \quad \rightarrow inannimate(y) \end{bmatrix} \tag{4b}$$

$$[\![\text{chōri-kigu itsu-tsu}]\!]^{\mathcal{S}_i} = \lambda x.\begin{bmatrix} cbase & = \lambda y.\mathcal{S}_i(\mathcal{O}(kitchenware))(y) \\ ext & = \mathcal{S}_i(\mathcal{O}(kitchenware))(x) \\ restr & = \mu_{card}(x, \lambda y.\mathcal{S}_i(\mathcal{O}(kitchenware))(y), 5) \\ precon & = \forall y.[\mathcal{S}_i(\mathcal{O}(kitchenware))(y) \\ & \quad \rightarrow inannimate(y)] \end{bmatrix} \tag{4c}$$

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Conclusion

1. Observation: *Nan-byaku to iu* 'hundreds of' is
   - felicitous with prototypical object Ns ('woman'), which denote individuated objects;
   - infelicitous with substance Ns ('water');
   - infelicitous with certain collective artifact Ns, which denote individuated objects: e.g., *hakimono* 'footwear', *shinamono* 'wares/articles', *kattamono* 'shopped goods', and *chōri-kigu* 'kitchenware'.
   - **Therefore**, its selectional restrictions cannot be stated in terms of conceptual individuation inherent in lexical meanings of Ns, or the pre-linguistic substance/object distinction.
2. *Nan-byaku to iu* 'hundreds of' is sensitive to the grammaticized lexical mass/count distinction.
3. Japanese has object mass Ns.
   - Collective artifacts Ns (e.g., 'footwear') denoting individuated objects like prototypical object Ns ('woman'), but infelicitous with *nan-byaku to iu* 'hundreds of' like substance Ns ('water').
   - It is, therefore, reasonable to conclude that such Ns are akin to object mass Ns, as in English.

Conclusion (cont.)

Consequently, **Japanese has reflexes of a grammaticized lexical mass/count distinction**.

4. Ns are not of the same semantic type (e.g., uniformly kind- or mass-denoting), even if they exhibit the same behavior in counting syntax.
5. Evidence: Differences in the counting bases of Ns seem to motivate differences in felicity judgments of 'N+Quantifier' combinations.

Future Work

1. Re-test these constructions in an EEG study.
2. Investigate and account for the graded acceptability judgments of a variety of 'N+Quantifier' combinations.
3. Test combinations of putative object mass Ns with *nan-byaku to iu* ('hundreds of') in a broad range of contexts.
4. What is the internal structure and meaning of *nan-byaku to iu* 'hundreds of'? To what extent are our conclusions about the existence of putative object mass Ns in Japanese dependent on idiosyncratic properties of this quantifier?

   (9) nan-byaku to iu
   what-hundred to say
   'hundreds of'

5. Test the felicity of putative object mass Ns with other quantifiers:
   - e.g., *dono mo* 'whichever'/'every'/'all'

Thank you!

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Appendix: Quantity comparison tasks

hakimono ('footwear')

(10) 'Ronald MacDonald bought one enormous pair of shoes. Tsubasa bought his baby two pairs of shoes.'

shinamono ('wares/articles'), *kattamono* ('shopped goods')

(11) 'Mayo bought three large packs of noodles and two watermelons. Ai bought four small packs of noodles and three satsumas.'

chōri-kigu ('kitchenware')

(12) 'Keiichi bought 6 small plates to go with his tea cups. Mayuko bought 4 large dinner plates.'

Appendix: Judgment patterns by notional class

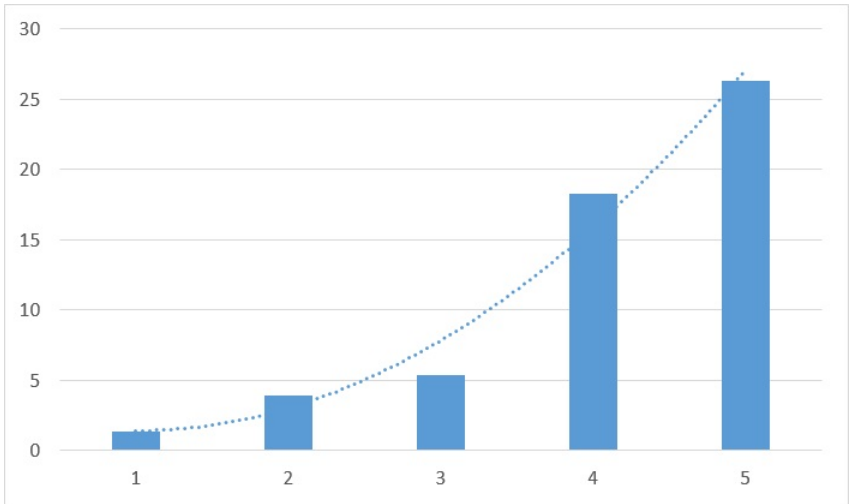

Fig.: Prototypical object Ns.

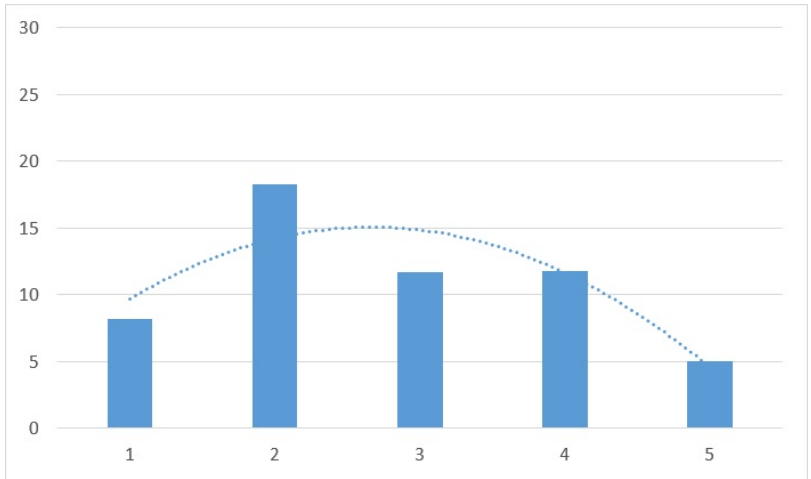

Fig.: Substance Ns.

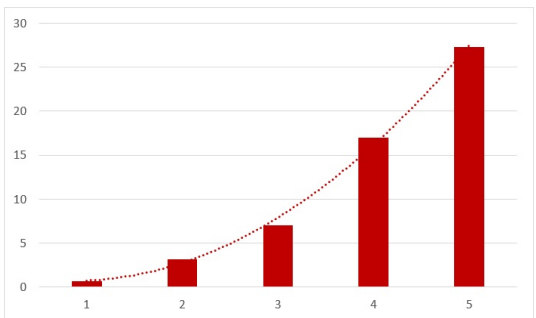

Fig.: Collective artifact Ns, group 1

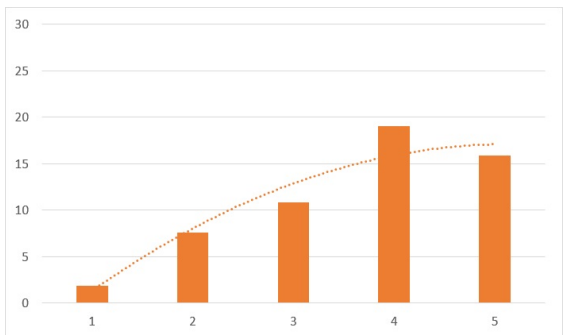

Fig.: Collective artifact Ns, group 2

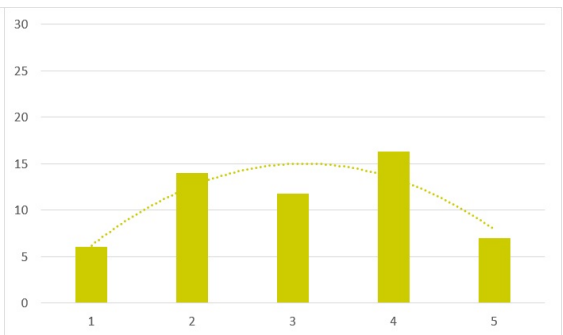

Fig.: Collective artifact Ns, group 3

Results: Effect Size

Effect size, the degree to which a phenomenon exists (Cohen, 1988)

- e.g. Effect size = $(\bar{x}_1\text{-}\bar{x}_2)/s$
- The measure of grammaticality is the size of the effect (Mahowald et al., 2016).
  - Trivial effect, <0.2
  - Small effect, 0.2-0.5
  - Medium effect, 0.5-0.8
  - Large effect, >0.8

Judgments of each participant were *z*-transformed.

- The average of all judgments divided by the standard deviation of all judgments was substracted from each judgment.
- This is done to partially reduce the effect of participants using the scale differently from each other (Sprouse et al., 2013; Mahowald et al., 2016; Langsford et al., 2018).

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