Non-Transitive Information Flow in Japanese Noun-Classifier Matching

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Abstract

In Japanese, as in other classifier languages like Chinese and Malay, numerals do not directly quantize nouns, but first combine with a classifier to form a *measure phrase* (MP; cf. Aikhenvald 2000). From the perspective of constraint-based approaches to syntax/semantics, the mutual selective restriction between classifiers and nouns can be stated in terms of information-sharing and featural identity, to some extent parallel to the treatment of gender/number agreement (between determiner and noun, for instance) (cf. Pollard and Sag 1994; Kathol 1999). There are, however, data that challenge this line of approach to noun-classifier matching. We demonstrate in this paper that it is possible that a single noun is associated with different types of classifier, and show why they are problematic for unification-based approaches, similar to the situation with case syncretism in European languages (Ingria 1990 and others). Later in the paper, we argue that information-sharing between noun, predicate and classifier is not completely transitive, and present a formal analysis which models multiple selectional requirements with sets.

1 Introduction

The long-standing problem of *polysemy* in natural language gained new importance with the advent of generative grammar. Whether two aspects of the meaning of a phonological string were simply pure homophony or rather different facets of a unified representation was no longer a pedantic issue; in transformational syntax it determined whether conditions were met for a variety of transformations covering ellipsis, pronominalization, conjunction, and relativization. Within constraint-based syntax the issue has not disappeared, but rather has broadened to include purely formal cases of phonological identity, called *syncretism* (Zaenen and Karttunen, 1984; Pullum and Zwicky, 1986). A variety of cases involving government or concord with syncretic items leads to the difficulty in a number of constraint-based theories that information sharing becomes *non-transitive*: if, for example verb A governs case X, verb B governs case Y, and noun N can be simultaneously governed by both verb A and verb B, it does not follow that X=Y. Similar cases in more semantic domains have also been identified; for example, one instance of the name of an author may be simultaneously be used to identify an individual in a matrix clause and that individual's literary output in a relative clause. These observations have stimulated a variety of approaches, ranging from the more pragmatically-based (Nunberg, 1979) to formal analyses more closely resembling treatments of syncretism (Pustejovsky, 1995).

In this paper we show that the same issues of polysemy arise in a superficially different domain, that of noun classifiers in Japanese. It is possible to use two distinct classifiers simultaneously to measure over a single noun, subject to an interacting host of syntactic and semantic constraints. We investigate the syntax and semantics of Japanese noun-classifier matching, showing how the problems and treatments of polysemy and syncretism apply. A major conclusion of this work is that in some cases, the semantic dimensions of measurement corresponding to

different classifiers for a single noun must be hierarchically organized, a result that can be shown much more clearly in Japanese than the syntax of a language like English would allow.

2 Basic facts

2.1 Syntax/semantics of measure phrases

In this section we briefly review the internal and external syntax of classifiers and measure phrases. A basic measure phrase consists internally of a numeral quantity followed immediately by a classifier:

(1)

3-*nin*	5-*hiki*	7-*satu*	9-*mai*
3-CL.human	5-CL.animal	7-CL.bound_object	9-CL.2D_object

Certain quantity modifiers optionally follow the classifier, as in 2-*hiki-zutu* 'two-CL.animal each', but these modifiers play no role in our analysis.

Following Gunji and Hasida (1998), we identify three distinct external environments where measure phrases occur: prenominal, postnominal, and adverbial, as seen in (2).

(2) 'Three monkeys came'

a. 3-biki-no saru-ga ki-ta. (prenominal)
3-CL.animal-Gen monkey-Nom come-Past

b. Saru 3-biki-ga ki-ta. (postnominal)
monkey 3-CL.animal-Nom come-Past

c. Saru-ga 3-biki ki-ta. (adverbial)
monkey-Nom 3-CL.animal come-Past

Both the prenominal and postnominal MPs can have either distributive or non-distributive readings, and generally seem to have little difference in their semantic import. In this paper we frequently group these two types as "intranominal". Adverbial MPs (so-called 'floating quantifiers'), in contrast, must be associated with either themes or agents and measure the extent of participation in the event denoted by the verb.[1]

(3) a. 3-nin-no gakusei-ga piano-o motiage-ta.
3-CL.human-Gen student-Nom piano-Acc lift-Past
'Three students lifted a piano.' (both the distributive and collective readings possible)

b. Gakusei-ga 3-nin piano-o motiage-ta.
student-Nom 3-CL.human piano-Acc lift-Past
'Three students lifted a piano.' (the distributive reading only)

[1]This is a slightly simpler stance than is taken by Gunji and Hasida (1998), who claim that adverbial MPs are strictly quantificational when associated with agents.

2.2 Multiple measuring

Semantically, the application of a measure phrase to a noun involves the *measurement* of the denotatum of the noun in dimensions roughly specified by the classifier. Since most denotata can potentially be measured in more than one dimension, there is generally more than one classifier applicable to a single noun. For example, 'beer' in Japanese can be measured with classifiers *meigara* 'brand', *syurui* 'kind', or any of a variety of volume-measuring classifiers, such as *garon* 'gallon' and *rittoru* 'liter'. (See Denny 1979; Downing 1996; Iida 2000; Paik and Bond 2002 for classifier taxonomies.)

Not only can a single noun be measured by more than one type of classifiers, in some cases a single noun token can be simultaneously measured by multiple classifiers. Multiple measuring of a single noun token can be classified into two types, depending on the type of the relation between classifiers: (i) type/token and (ii) alternative units on a single dimension:

(4) type-token

a. 3-syurui-no sakana-o 2-hiki-zutu tabe-ta.
3-CL.species-Gen fish-Acc 2-CL.animal-each eat-Past
'(I) ate two each of three species of fish.'

b. 2-satu-no hon-o gookei 10,000-bu zoosatu-si-ta.
2-CL.bound_object-Gen book-Acc in.total 10,000-CL.copy print-Past
'(The publisher) printed a total 10,000 copies of two books.'

c. 3-meigara-no biiru 2-syurui-zutu-o gookei 10-garon non-da.
3-CL.brand-Gen beer 2-CL.species-Acc in.total 10-CL.gallon drink-Past
'(We) drank two types each of three brands of beer, ten gallons in total.'

The type/token classifier relationship is reminiscent of but distinct from the well-known species/individual distinction in formal semantics (Carlson 1977 and others). We are concerned here with a *relationship* between classifiers: two classifiers are in a type/token relationship if the latter classifier measures units within a set of categories delimited by the former. This is clear in (4c), where kinds of beer (*syurui*) are tokens of different brands of beer (*meigara*), and gallons of beer (*garon*) are in turn tokens (albeit continuous rather than discrete) of different kinds of beer (*syurui*).

(5) alternative units

a. Mizu-o 3-bai, zenbu-de 2-rittoru non-da.
water-Acc 3-CL.cup in.total 2-CL.liter drink-Past
'(I) drank three glasses of water, two liters in total.'

b. Hon-o 5-hako, (gookei) 100-satu hakon-da.
book-Acc 5-CL.box in.sum 100-CL.bound_object transport-Past
'(I) moved five boxes of books, 100 books in total.'

Example (5) above illustrates cases of multiple measurements in a single dimension – volume in (5a), and physical quantity in (5b).

In cases of two distinct classifiers for a given noun in a single clause, there

are twelve logically possible combinations of environment and intra-environment linear order for the two classifiers. Four are ruled out, however, by the fact that Japanese syntax does not allow more than one prenominal MP or more than one postnominal MP in a single noun phrase. There also turn out to be further constraints on classifer positioning which we outline below; these are based on semantic considerations, and we take them up in the remainder of the paper.

Type-token classifier pairs permit the following arrangements: prenominal type plus postnominal token; adverbial type and adverbial token; or intranominal (either pre- or post-nominal) type plus adverbial token. These arrangements are exemplified in (6)-(8).

(6) intranominal/intranominal[2]

a. 2-syurui-no sakana 3-biki-zutu-o tabe-ta.
2-CL.species-Gen fish 3-CL.animal-each-Acc eat-Past
'I ate three each of two species of fish.'

b. *3-biki(-zutu)-no sakana 2-syurui-o tabe-ta.
3-CL.animal(-each)-Gen fish 2-CL.species-Acc eat-Past

(7) adverbial/adverbial

a. Sakana-o 2-syurui, gookei 10-piki tabe-ta.
fish-Acc 2-CL.species in.total 10-CL.animal eat-Past
'I ate two species of fish, ten fish in all.'

b. ?Sakana-o gookei 10-piki, 2-syurui tabe-ta.
fish-Acc in.total 10-CL.animal 2-CL.species eat-Past

(8) intranominal/adverbial

a. (i) 2-syurui-no sakana-o gookei 10-piki tabe-ta.
2-CL.species-Gen fish-Acc in.total 10-CL.animal eat-Past
'I ate a total of ten of two species of fish.'

(ii) Sakana 2-syurui-o gookei 10-piki tabe-ta.
fish 2-CL.species-Acc in.total 10-CL.animal eat-Past
'I ate a total of ten of two species of fish.'

b. (i) *(Gookei) 10-piki-no sakana-o 2-syurui tabe-ta.
in.total 10-CL.animal-Gen fish-Acc 2-CL.species eat-Past

(ii) *Sakana (gookei) 10-piki-o 2-syurui tabe-ta.
fish in.total 10-CL.animal-Acc 2-CL.species eat-Past

Alternative-unit combinations permit only multiple intranominal or multiple adverbial uses. These are illustrated in (9)-(11).

(9) intranominal/intranominal

a. 3-hako-no hon 100-satu-o hakon-da.
3-CL.box-Gen book 100-CL.bound_object-Acc transport-Past
'(I) moved three boxes of books, 100 books in all.'

[2]Some speakers do not accept multiple intranominal classifiers. As noted in the text above, we have found no speakers who accept more than one prenominal or more than one postnominal classifier in a single NP.

b. ?100-satu-no hon 3-hako-o hakon-da.
100-CL.bound_object-Gen book 3-CL.box-Acc transport-Past
'(I) moved three boxes of books, 100 books in all.'[3]

(10) adverbial/adverbial

a. Hon-o 3-hako, gookei 100-satu hakon-da.
book-Acc 3-CL.box in.total 100-CL.bound_object transport-Past
'(I) moved three boxes of books, 100 books in all.'

b. (?)Hon-o gookei 100-satu, 3-hako hakon-da.
book-Acc in.total 100-CL.bound_object 3-CL.box transport-Past
'(I) moved three boxes of books, 100 books in all.'

(11) intranominal/adverbial

a. (i) *3-hako-no hon-o 100-satu hakon-da.
3-CL.box-Gen book-Acc 100-CL.bound_object transport-Past

(ii) *Hon 3-hako-o 100-satu hakon-da.
book 3-CL.box-Acc 100-CL.bound_object transport-Past

b. (i) *100-satu-no hon-o 3-hako hakon-da.[4]
100-CL.bound_object-Gen book-Acc 3-CL.box transport-Past

(ii) *Hon 100-satu-o 3-hako hakon-da.
book 100-CL.bound_object-Acc 3-CL.box transport-Past

We can generalize the pattern of type-token multiple classifier arrangement more succinctly by taking advantage of the fact that the three possible measure phrase environments are totally ordered with respect to their *syntactic proximity* to the noun. Syntactic proximity has an intuitive explanation in terms of context-free trees as follows: Node A is closer than node B to node X iff the shortest path between B and X (not including B and X themselves) contains all the nodes in the shortest path from A to X, but not vice versa. Adverbial MPs are clearly farther than intranominal MPs from the modified noun; furthermore, constituency test by coordination confirms that prenominal MPs are closer to the noun than are postnominal MPs ('corr' is units of correspondence for letters):

(12) a. 20-tuu-no tegami-to 3-saku-no syoosetu 2,000-mai-o
20-CL.corr-Gen letter-Conj 3-CL.work-Gen novel 2,000-page-Acc
kai-ta.
write-Past
'(I) wrote 2,000 pages' worth of twenty letters and three novels.'

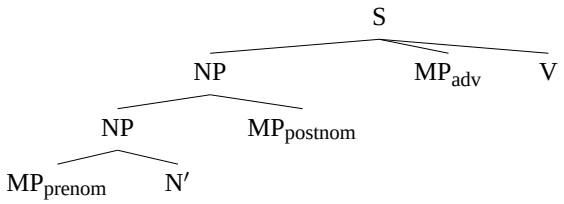
b. *6-syurui-no sakana 7-hiki-to tori 7-wa-o
6-CL.species-Gen fish 7-CL.ind_animal-Conj bird 7-CL.ind_bird-Acc
tabeta.
eat-Past
((I) ate five types of fish and bird, seven fish and seven birds.)

[3]There may be another, marginal reading of (9b) that involves three cases of 100 books each. This reading is discussed in Section 4.2.

[4]Example (11bi) also has another reading involving at least three hundred books. It will be discussed later.

The configuration of the three MP environments thus looks as follows:[5]

(13)



From the data above we can thus make the following generalizations about possible multiple-classifier arrangements in a single clause:

(14) in the "type-token" case:

a. The type MP must be at least as syntactically close to the measured as the token MP.

b. For multiple adverbial classifiers, it is preferred that the linear order of MPs conforms the order: type $>$ token.

(15) in the "alternative units" case:

a. The intranominal/adverbial combination is impossible.

b. Two intranominal classifiers are possible; it is preferred for the larger unit to occupy the (syntactically closer) prenominal position, and for the smaller unit to be postnominal.

c. The effect of linear order (bigger unit preceding smaller unit) for multiple adverbial classifiers is weaker than that of type preceding token, if not absent.

The next two sections of the paper will focus on the type-token case, which exhibits the clearest asymmetries of felicity judgements. We develop a constraint-based analysis of Japanese noun-classifier matching, properly capturing the syntactic-semantic relationships between noun, measure phrase, and verbs, which allows for multiple matchings and correctly predicts the asymmetries shown above. In Section 4.2 we briefly return to the issue of non-canonical arrangements of alternative-unit classifier combinations. The linear order asymmetry for type/token adverbial classifier pairs seems to us less categorical, and we leave its status as an open question.

3 Analysis

Our first task is to clarify our position on the syntactic versus semantic nature of noun-classifier concord in Japanese. In general there is strong semantic motivation for noun classification (Matsumoto, 1993; Iida, 2000), but we will take a somewhat vague and weak position on the syntactic versus semantic nature of noun classification as our main goal is to elucidate the interaction of varying dimensions of

[5] We do not take a strong position about the identity of categories labeled S and NP in (13); we use S on the assumption that Japanese clause is flat and has no VP.

measurement with Japanese syntax. We assume that an utterance of a noun (or a pronoun, overt or null) is associated with a *cognitive object*, which is *measurable* in a variety of dimensions. For a given type of cognitive object there is a one-to-one mapping between the set of measurable dimensions for the object and the set of classifiers compatible with the object.[6] The use of a particular classifier in an MP for a given noun invokes the dimension along which the cognitive object associated with the noun is measured. As we have seen, a cognitive object can be measurable in multiple dimensions in a single utterance.

3.1 Case syncretism and a set-based approach to noun-classifier matching

As stated thus far, the problem of multiple measurement is isomorphic to the (strictly formal) problem of case syncretism in European languages, where a single noun token may satisfy multiple distinct case requirements (Ingria, 1990; Bayer and Johnson, 1995; Bayer, 1996; Blevins, 2003; Dalrymple and Kaplan, 2000; Levy, 2001; Levy and Pollard, 2001; Daniels, 2001; Sag, 2002). Example (16) below illustrates the problem of case syncretism, where the syncretized noun *Frauen* 'women' satisfies both accusative and dative requirements.[7]

(16) Er findet und hilft Frauen.
He finds.Acc and helps.Dat women.Acc/Dat
'He finds and helps women.'

Most formal treatments of case syncretism treat the simpler instances with what is essentially a set-structured account, making a noun's case value a set and treating case government as a membership requirement (see Dalrymple and Kaplan 2000 for the clearest implementation of this idea):

(17) *Frauen* 'women': CASE = {ACC,DAT}
finden 'find': requires ACC ∈ CASE of its object
helfen 'help': requires DAT ∈ CASE of its object

In the case of Japanese classifiers, the issue is that a single noun can be measured by multiple classifiers. Like the syncretism problem, the classifier problem is amenable to a set-based analysis:

(18) classifier type (CLTYPE) specification for *hon* 'book:

$$\left[\text{CLTYPE}\left\{\text{COPY,BOUND\_OBJECT,}\ldots\right\}\right]$$

A classifier measuring a noun can be thought of as imposing a membership requirement on the CLTYPE value of the measured noun. Membership requirements

[6] We are *not* making a claim that there is a one-to-one mapping from classifiers to specific dimensions of cognitive objects in the language.

[7] *Frauen* is actually syncretized for all German cases, but we include only accusative and dative for narrative simplicity.

can also be formulated as non-empty intersection constraints on singleton CLTYPE values; we use that formulation in the remainder of the paper.

(19) a. 1-piki-no
1-CL.ind_animal-GEN:{IND_ANML}
sakana
fish:{IND_ANML,MASS_FOOD,SPECIES,...}
{IND_ANML} ∩ {IND_ANML,MASS_FOOD,SPECIES,...} ≠ ∅

b. *1-wa-no sakana
1-CL.ind_bird-GEN:{IND_BIRD} fish:{IND_ANML,SPECIES,...}
{IND_BIRD} ∩ {IND_ANML,SPECIES,...} = ∅

This analysis captures the non-transitive requirement of multiple classifiers to match the noun: each classifier individually needs to match the noun, but this does *not* mean that the classifiers must match each other, as shown below in (20).

(20) Tegami-o 2-tuu, gookei
letter-Acc:{CORR,2D_OBJECT,...} 2-CL.corr:{CORR}, in.sum
10-mai kai-ta.
10-CL.2D_object:{2D_OBJECT} write-Past
{CORR,2D_OBJECT,...} ∩ {CORR} ≠ ∅
{CORR,2D_OBJECT,...} ∩ {2D_OBJECT} ≠ ∅

3.2 Adverbial measure phrases and verbs as classification filters

The distribution of classifiers is not, however, determined only by the compatibility of nouns with classifiers. In particular, the governing verb acts as a *filter* on the compatibility of classifiers. The intuitive explanation for this is that an event denoted by a verb involves the participation of at least one aspect (measurable dimension) of each of its arguments, and some events pick out only a limited set of aspects of their cognitive objects valid for participation. An adverbial classifier is associated with the event denoted by the verb with which it is syntactically associated; it therefore can measure only in those dimensions of the associated argument which can validly participate in the event. (We take up the case of intranominal classifiers in Section 3.3.) We see this in (21)-(22) below, where the verb *kuguru* 'pass through' is incompatible with the 'flat object' aspect of a window picked out by the classifier *mai*, and the verb *makikomareru* 'get involved in' is incompatible with the 'scheduled event' aspect of a bus picked out by *hon*.

(21) a. Mado-o 1-tu/*mai kugut-ta.
window-Acc 1-CL.general/CL.2D_object pass.through-Past
'(I/you/he) went through a window.'

b. Mado-ga 1-??tu/mai ware-ta.
window-Acc 1-CL.general/CL.2D_object $\text{break}_{\text{intr}}$-Past
'A window has broken.'

(22) a. Basu-ga 1-dai/*pon ziko-ni
bus-Nom 1-CL.vehicle/CL.scheduled_event accident-Dat
makikom-are-ta.
involve.in-Pass-Past
'A bus was involved in a traffic accident.'

b. Basu-o 1-?dai/pon nogasi-ta.
bus-Acc 1-CL.vehicle/CL.scheduled_event miss-Past
'(I) missed a bus.'

When there is more than one verb involved, an adverbial classifier need be compatible only with the verb with which it is syntactically and semantically associated, and with the noun it measures. In (23c), the verb *eigaka-sare-ta* 'was made into a movie' is incompatible with the 'copy' aspect of a book picked out by the classifier *bu*, but the presence of the verb in a relative clause does not prevent the appearance of *bu* as an adverbial classifier in the matrix clause, associated with another verb.

(23) a. Hon-o 2-satu/*bu eigaka-sita.
book-Acc 2-CL.bound_object/*CL.copy make.into.movie-PAST
'(They) made two books into movies.'

b. Hon-o 2,000-satu/bu zoosatu-sita.
book-Acc 2,000-CL.bound_object/CL.copy print-PAST
'(They) printed two thousand books (resp. bound_objects or copies)'

c. Sono syuppansha-wa [eigaka-s-are-ta]
that publisher-Top [make.into.movie-Pass-Past]
hon-o 2,000-bu zoosatu-sita.
2-CL.bound_object-Gen book-Acc 2,000-CL.copy print-PAST
'That publisher printed 2,000 (additional) copies of books made into movies.'

(24) Mado-o 3-tu kugut-te, 2-mai wat-ta.
Window-Acc 3-CL.general passthrough-Conj, 2-CL.2D_object break$_{trans}$-Past
'(I) went through three windows and broke two.'

We formalize the filtering effect of a verb with the notion of *set intersection* between the CLTYPE set of the noun and the (argument-specific) set of *allowed* classifiers for the governing verb.

(25) a. Once again, classifier type (CLTYPE) specification for *hon* 'book:

$$\left[\text{CLTYPE} \quad \boxed{1}\left\{\text{COPY}, \text{BOUND\_OBJECT}, \ldots\right\}\right]$$

b. Allowed classifier type specification for object of *eigaka-suru* 'make into a movie':

$$\left[\text{CLTYPE} \quad \boxed{2}\left\{\text{BOUND\_OBJECT}, \ldots\right\}\right]$$

c. Resulting set of allowed adverbial classifiers for *hon-o eigaka-suru* 'make a book into a movie':

$$\left[\text{CLTYPE} \quad \boxed{1} \cap \boxed{2} = \left\{\text{BOUND\_OBJECT}\right\}\right]$$

d. For objects of *zoosatu-suru* 'print', the allowed classifier type specification includes both BOUND_OBJECT and COPY, so either adverbial classifier in (23b) is allowed.

In this example, a different filtered CLTYPE value must be represented for each verb. Therefore a *relation* must be specified between the CLTYPE value of a nominal argument and its filtered CLTYPE value as an argument of a particular verb. The controversial ARG-STR feature can be a means of doing this: we assume that the representation on the relevant subcategorization list (COMPS or SUBJ in recent versions of HPSG) contains the nominal argument itself, and in the ARG-STR representation of the corresponding argument, the intersection with the verb's set of acceptable dimensions is substituted.[8] This is shown in (26) for the verb *eigaka-suru* 'make into a movie'.

(26) Partial lexical entry for *eigaka-suru* 'make into a movie':

$$\begin{bmatrix} \text{COMPS} & \left\langle \ldots, \left[\text{CLTYPE} \quad \boxed{1}\right], \ldots \right\rangle \\ \text{ARG-ST} & \left\langle \ldots, \left[\text{CLTYPE} \quad \boxed{1} \cap \left\{\text{BOUND\_OBJECT}\right\}\right], \ldots \right\rangle \end{bmatrix}$$

Adverbial measure phrases then interact with the filtered CLTYPE value for the noun they measure over:

(27) Adverbial MP Modification Rule

$$\begin{bmatrix} \text{ARG-STR} & \left\langle \ldots, \begin{bmatrix} \text{INDEX} & \boxed{5} \\ \text{CLTYPE} & \boxed{1} \end{bmatrix}, \ldots \right\rangle \\ \text{RESTR} & \boxed{2} \cup \left\{ \begin{bmatrix} \text{INDEX} & \boxed{5} \\ \text{NUM} & \boxed{3} \\ \text{UNIT} & \boxed{6} \\ \text{CLTYPE} & \boxed{1} \cap \boxed{4} \end{bmatrix} \right\} \end{bmatrix}$$

MP

$$\begin{bmatrix} \text{RESTR} & \begin{bmatrix} \text{NUM} & \boxed{3} \\ \text{UNIT} & \boxed{6} \\ \text{CLTYPE} & \boxed{4} \end{bmatrix} \end{bmatrix}$$

V

$$\begin{bmatrix} \text{RESTR} & \boxed{2} \end{bmatrix}$$

Example (28) and Figure 1 show the differential filtering of measurable aspects of the noun *hon* 'book' by the relative clause and matrix clause verbs. Note that the basic set of classifiable dimensions in CLTYPE of *hon*, marked as 1, does not directly interact with the adverbial classifiers that modify it; instead, the matrix and relative clause verbs hold a restricted set of available dimensions in their ARG-STR representation of *hon*, which interact with the adverbial classifiers.

[8] There are at least two other reasonable alternatives to resorting to ARG-STR on phrases here. One would be to directly match the adverbial MP with the semantic representation of the measured argument on the verbal projection. Another would be to let the verb take the adverbial MP as a complement via a lexical rule, and specify the required CLTYPE relationship between the classified argument and the MP in the lexical rule.

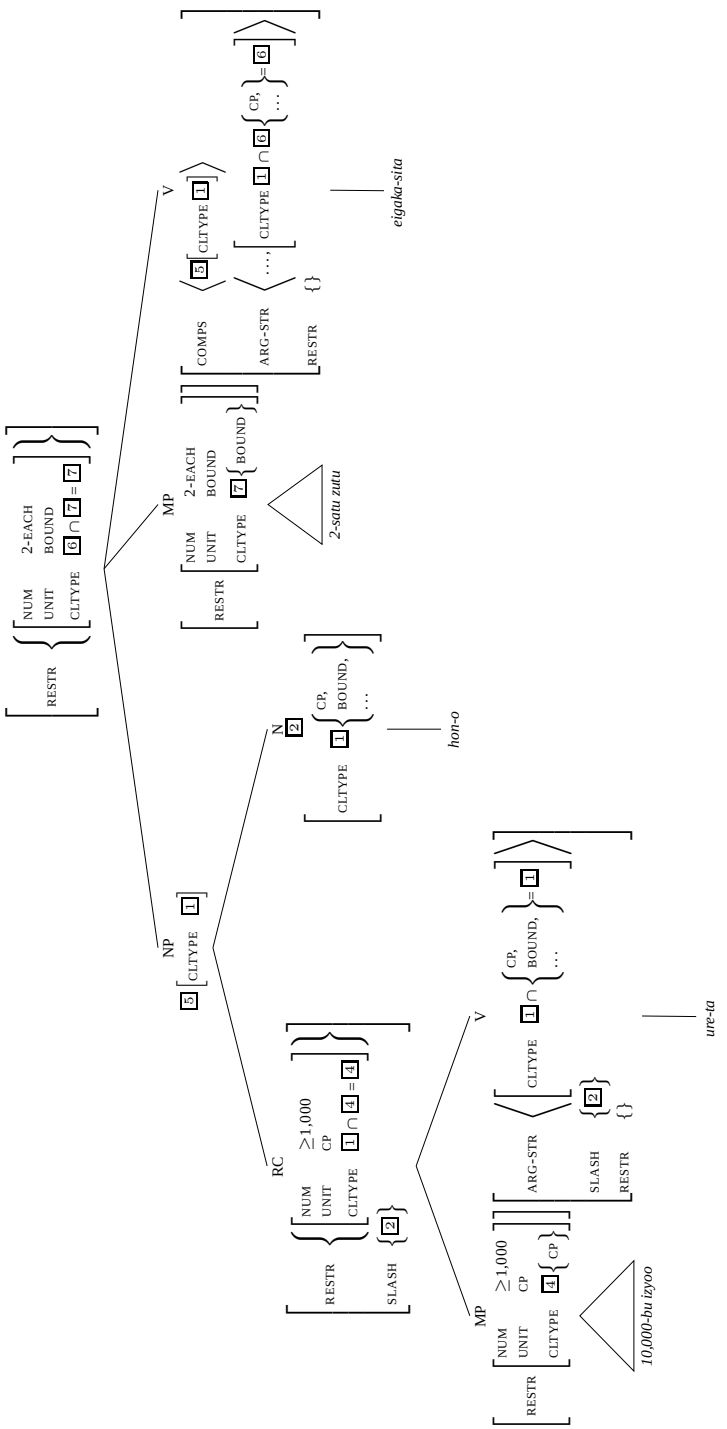


Figure 1: Analysis of Example (28)

(28) [10,000-bu izyoo ure-ta] hon-o 2-satu
[10,000-CL.copy above $\text{sell}_{\text{intr}}$-Past] book-Acc 2-CL.bound_object
eigaka-sita.
make.into.movie-Past
'(I) made into movies two books that sold more than 10,000 copies.'

3.3 Intranominal measure phrases

The previous section has given us an understanding of the interaction of adverbial classifiers with NP and verb syntax and semantics. In this section we address intranominal classifiers. We begin by illustrating two crucial facts for our analysis.

First, in type-token multiple classifier cases involving an intranominal classifier, the type classifier must be syntactically at least as close to the noun as the token classifier (cf. (14a)). This is illustrated below:

(29) (=(6))
a. 2-syurui-no sakana 3-biki-zutu-o tabe-ta.
2-CL.species-Gen fish 3-CL.animal-each-Acc eat-Past
'(I) ate three each of two types of fish.'
b. *3-biki(-zutu)-no sakana 2-syurui-o tabe-ta.
3-CL.animal(-each)-Gen fish 2-CL.species-Acc eat-Past

(30) (=(8))
a. (i) 2-syurui-no sakana-o gookei 10-piki tabe-ta.
2-CL.species-Gen fish-Acc in.total 10-CL.animal eat-Past
(ii) Sakana 2-syurui-o gookei 10-piki tabe-ta.
fish 2-CL.species-Acc in.total 10-CL.animal eat-Past
b. (i) *(Gookei) 10-piki-no sakana-o 2-syurui tabe-ta.
in.total 10-CL.animal-Gen fish-Acc 2-CL.species eat-Past
(ii) *Sakana (gookei) 10-piki-o 2-syurui tabe-ta.
fish in.total 10-CL.animal-Acc 2-CL.species eat-Past

The classifiers *syurui* (species) and *hiki* (animal) stand in a type-token relationship. The two may cooccur as adverbial classifiers, which are of equal syntactic distance from the noun, but if at least one is an intranominal classifier, then the type classifier *syurui* must be closer than the token classifier *hiki* to the noun. (Recall that both prenominal and postnominal classifiers are closer than adverbial classifiers to the noun, and prenominal are closer than postnominal.)

The second crucial fact is that nouns premodified by both measure phrases and relative clauses may have their interpretation and felicity affected by the relative ordering of premodifiers. In particular, a prenominal MP *between* a relative clause and the noun must be compatible with the verb in the relative clause governing the relativized noun, as well as with the noun's external governing verb. A prenominal MP *preceding* a relative clause, however, need only be compatible with the external governing verb.[9] This is illustrated in (31) below:

[9]As far as we know, a verb in a relative clause never restricts the occurrence of a postnominal

(31) a. 1,000-bu-no eigaka-s-are-ta hon-o moyasi-ta.
1,000-CL.copy-Gen make.into.movie-Pass-Past book-Acc burn$_{trans}$-Past
'(I) burned 1,000 copies of books that were made into movies.'

b. ?*Eigaka-s-are-ta 1,000-bu-no hon-o moyasi-ta.[10]
make.into.movie-Pass-Past 1,000-CL.copy-Gen book-Acc burn$_{trans}$-Past

c. Eigaka-s-are-ta 2-satu-no hon-o (gookei
make.into.movie-Pass-Past 2-CL.bound-Gen book-Acc (in_total
1,000-bu) moyasi-ta.
1,000-CL.copy) burn$_{trans}$-Past
'I burned (1,000 total copies of) two books that were made into movies.'

We put forth the following pretheoretical explanation for the type-token measure phrase placement asymmetry, based on what we take as the way humans intuitively conceptualize types and tokens. If an object is quantifiable on two dimensions that are in a type-token relationship (such as species-individual), a specified quantity of *tokens* implies a concrete, even if unspecified, quantity of associated types. A specified quantity of *types*, on the other hand, does not presuppose any quantization by token. This is probably most clearly seen in the basic case of kinds, such as species, discussed by Carlson (1977) and others: *three fish* implies a certain number of species of fish (three or less), but *three species of fish* implies nothing about a particular number of fish. This is also consistent with the asymmetry in predicate type, that there are kind-specific predicates such as *go extinct*, which are incompatible with individual-level NPs, but there seem to be no individual-specific predicates incompatible with all kind-level NPs.[11]

It seems, then, that an intranominal MP sets up a cognitive object, quantified on a particular dimension determined by the MP's classifier, that has a certain independence from any particular predicate with which the NP may be associated. This is quite unlike adverbial MPs, which measure the extent of participation of the quantified argument in a predicate-specific event. An adverbial MP modifying an NP with an intranominal MP can only quantify on dimensions that are neither explicitly nor implicitly specified by the quantification of the intranominal MP. Since a type classifier specifies nothing explicitly or implicitly about a quantity of tokens, a token MP may adverbially modify an NP with an intranominal type MP, but not vice versa, as we saw in (8).

The independence of cognitive objects set up by intranominal MPs also ex-

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MP:

[Eigaka-s-are-ta] hon 1,000-bu-o moyasi-ta.
[make.into.movie-Pass-Past] book 1,000-CL.bound-Acc burn$_{trans}$-Past
'(I) burned 1,000 copies of books that were made into movies.

[10] We also predict a grammatical reading of (31b), as will be seen momentarily.

[11] Note that we are *not* claiming that any individual-oriented predicate can be used with any kind-level NP. At the least, definite singular NPs are not compatible with a kind interpretation when used with an individual-oriented predicate: *The spotted hyena ate my chickens* is about an individual spotted hyena, not about the kind *the spotted hyena*. But *N kinds of X* NPs always seem to be compatible with individual-oriented predicates.

plains the fact that a single NP may take adverbial MPs with the same classifier but different quantities, as long as the MPs are associated with different predicates:

(32) [3-ton sika nokotte-i-nai] 2-syurui-no kinzoku-o 2-ton
[3-CL.ton other-than remain-Prog-Neg] 2-CL.species-Gen metal-Acc 2-CL.ton
seiren-sita.
purify-Past
'(We) purified two tons of the two types of metal, of which only three tons remained.'

Our analysis entails that type-token dimensions of measurement (which can be picked out by classifiers) are ordered on a scale with respect to each other. An object that is already quantified at one level is cognitively *closed* to further quantification at a higher level on the scale.

(33) a. Fish: *syurui* 'species' > *hiki* 'individual-animal'
b. Beer: *meigara* 'brand' > *syurui*[12] 'species' > *hon* 'bottle'

We formalize this idea by letting a type classifier have as its CLTYPE value the set of further classifications (corresponding to the set of as-yet unspecified dimensions) open to a so-classified noun.

(34) *syurui*:

$$\left[\text{CLTYPE} \quad \left\{\text{SPECIES, IND\_ANIMAL}\right\}\right]$$

The syntactic rule for intranominal classifiers requires (i) that the intranominal classifier's CLTYPE be a complete subset of the modified nominal's; and (ii) the resulting nominal phrase have the intranominal classifier's CLTYPE.

(35) Prenominal MP Modification Rule[13]

$$\begin{array}{c} \text{NP} \\ \left[\begin{array}{ll}\text{QSTORE} & \boxed{5} \cup \left\{\boxed{3}\right\} \\ \text{CLTYPE} & \boxed{2}\end{array}\right] \\ \hline \text{MP} \qquad\qquad \text{N}' \\ \left[\text{RESTR} \ \boxed{3}\left[\begin{array}{ll}\text{NUMBER} & \boxed{6} \\ \text{CLTYPE} & \boxed{2} \subseteq \boxed{1} \\ \text{INDEX} & \boxed{4}\end{array}\right]\right] \qquad \left[\begin{array}{ll}\text{CLTYPE} & \boxed{1} \\ \text{INDEX} & \boxed{4} \\ \text{QSTORE} & \boxed{5}\end{array}\right] \end{array}$$

Example (36) and Figure 2 show the analysis of a grammatical sentence involving one intranominal and one adverbial MP.

[12]This leaves us with assuming polysemy for classifiers such as *syurui*, since different uses of *syurui* will require different members of their CLTYPE value corresponding to the possible token-level classification.

[13]The postnominal MP modification rule would be identical to (35), except for the directionality of phrasal combination, assuming that the noun remains the phrasal head. We ignore the issue of ensuring the correct location of case marking, as it plays no role in our analysis.

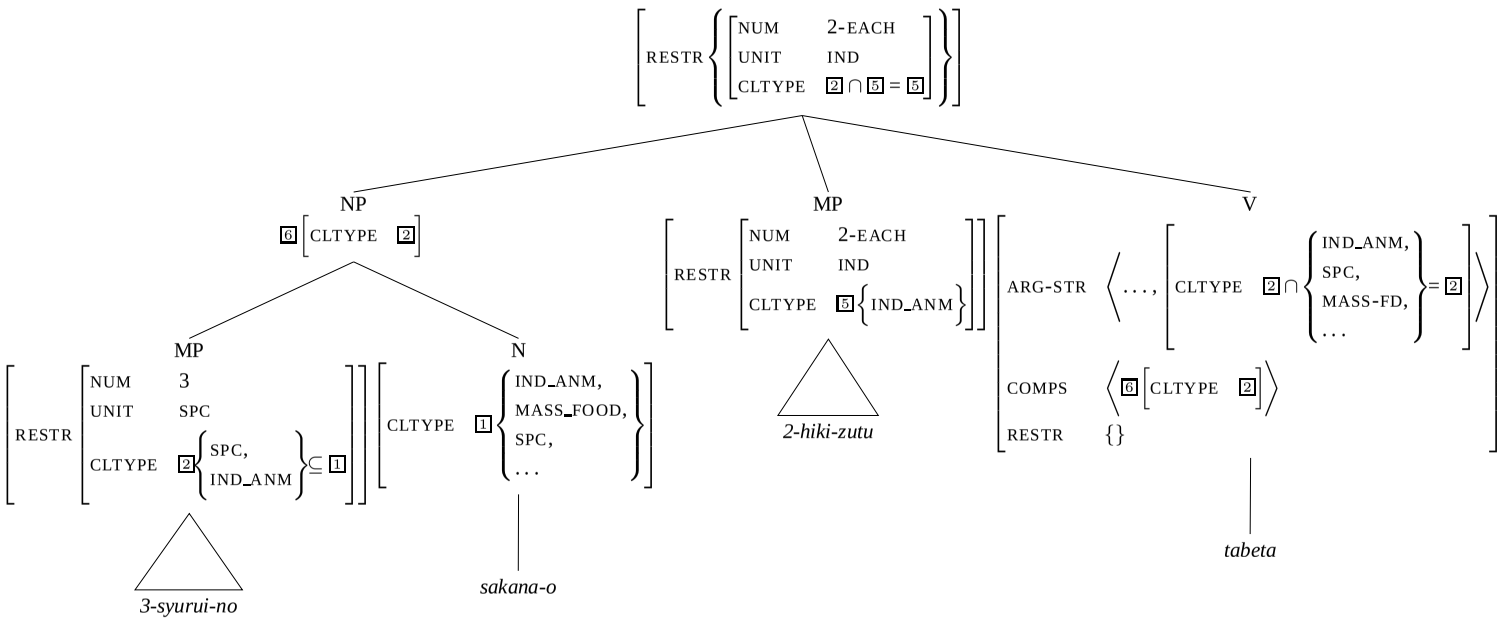


Figure 2: Analysis of Example (36)

(36) 2-syurui-no sakana-o 3-biki-zutu tabe-ta.
2-CL.species-Gen fish-Acc 3-CL.animal-each eat-Past
'(I) ate three each of two types of fish.'

3.4 A problem neatly solved

The analysis presented in the previous section neatly solves the problem of why the interaction of prenominal classifiers with relativization depends on the word order of prenominal modifiers. We repeat the crucial data below.

(31) a. 1,000-bu-no eigaka-s-are-ta hon-o moyasi-ta.
1,000-CL.copy-Gen make.into.movie-Pass-Past book-Acc $\text{burn}_{\text{trans}}$-Past
"(I) burned 1,000 copies of books that were made into movies."

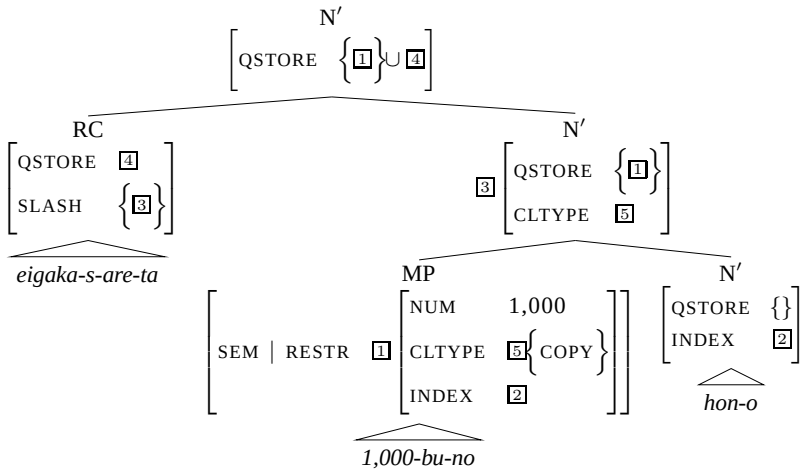
b. ?*Eigaka-s-are-ta 1,000-bu-no hon-o moyasi-ta.
make.into.movie-Pass-Past 1,000-CL.copy-Gen book-Acc $\text{burn}_{\text{trans}}$-Past

c. Eigaka-s-are-ta 2-satu-no hon-o (gookei
make.into.movie-Pass-Past 2-CL.bound-Gen book-Acc (in.total
1,000-bu) moyasi-ta.
1,000-CL.copy) $\text{burn}_{\text{trans}}$-Past
'I burned (1,000 total copies of) two books that were made into movies.'

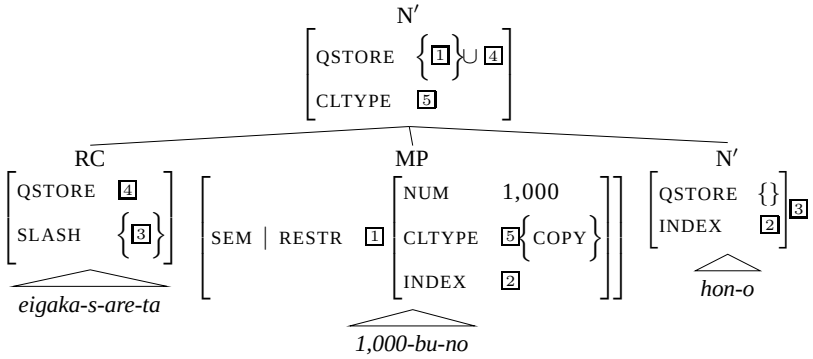
Example (31b) illustrates the generalization that a prenominal MP preceding an RC must be compatible with both the RC and matrix verbs. This generalization can be derived directly from our analysis in conjunction with the standard HPSG theory of relativization (Pollard and Sag, 1994), where relativized nominals are associated with their relative governing verbs by structure-sharing passed locally through the SLASH feature. If we assume that nominal modification is binary-branching, the sister of the RC will contain the MP if and only if the MP is between the RC and the noun. An example of the information-sharing for this word order is shown in (37). This particular structure is unacceptable within the relative clause as the RC verb *eigaka-s-are-ta* 'made into a movie' is incompatible with the 'copy' dimension corresponding to the classifier *bu*. If another RC verb, or the classifier *satu* 'bound_object', were substituted, this structure would be acceptable.

Alternatively, though, multiple prenominal modification could involve a single *flat* structure. In this case, there would be no intermediate node where just the prenominal classifier and the noun combine, and the relative clause would not have the prenominal MP's restriction in it. This possibility is illustrated in (38). We propose that both these representations are possible and that native speakers may have internalized either or both of them. Speakers with the flat representation should have an acceptable reading of (31b); speakers with only the binary-branching representation should find it ungrammatical. Our analysis makes the clear prediction, however, that no speaker will accept (31b) *and* reject (31a).

(37)



(38)



4 Other considerations

4.1 An alternative approach to cognitive objects and classifiers: Nunberg's "deferred ostension"

The problem of multiple measuring is a subtype of the more general problem of polysemy and vagueness: when are two distinct aspects of a phonological string's meaning part of a single sense, and how should cases of simultaneously using two aspects of a single meaning be represented? There has been long-standing interest within generative grammar in a precise answer to this problem. An early proposal in transformational literature was to represent these cases by a single supertype representation in the lexicon with multiple subtypes, such as the abstract and concrete aspects of a *book*. The more recent theory of Pustejovsky (1995) is much more elaborate but like in spirit. An alternative set forth by Nunberg (1979) argued against an explicit *lexical* treatment of polysemy, and instead dealt with reference to multiple aspects of an apparently single linguistic entity uniformly via pragmatic means ("deferred ostension"):

(39) a. The chair you're sitting in was faddish during the 1960's. (token,type)

b. The window was broken, so he went right through it. (cover,opening)
c. Yeats allegedly didn't enjoy hearing himself read. (person,ouvre)
d. The newspaper decided to change its format. (publishing company, publication)

Nunberg argued that the multiple possibilities of reference in examples such as (39) should be handled by *relations* between referent types: between token and type, a publisher and a publication, and so forth:

(40) $r(token, type), r(publisher, publication), r(author, ouvre), r(cover, opening)$

Although Nunberg doesn't explicitly mention it, the verb has to play a filtering function in such an account, ruling out unsuitable referent types (e.g. ruling out the 'person' reading for 'himself' in (39c)). Our approach, although it treats multiply-classified nouns as single, complex cognitive objects, yields equivalent results in terms of empirical predictions. It is not clear, however, how the type-token asymmetry for intranominal + adverbial classifier combinations might be dealt with in an account such as Nunberg's, where types and tokens can be mapped back and forth between.

4.2 Classifier ordering reversals

There are also some exceptions to the general ordering principles for type-token and alternative-unit classifiers (cf. (14a) and (15b)). These generally seem explainable on semantic grounds; Example (41) below illustrates instances of reversal.

(41) a. 2-hiki-no sakana-o 3-syurui tabe-te-mi-ta.
two-CL.ind_animal-Gen fish-Acc 3-CL.species eat-Ger-look-Past
'(I) tried three different types of two-fish dishes [i.e., dishes consisting of two individual fish].'
b. 100-satu-no hon-o 3-hako hakon-da.
100-CL.bound-Gen book-Acc 3-CL.box transport-Past
'(We) moved three boxes of 100 books [each box containing 100 books].'

In all these examples, the adverbial MP measures in units determined by the combination [MP_{prenom} N], resulting in a multiplicative interaction between the classifiers. Example (41a), for example, involves six fish in total. In the ordinary multiple-classifier instances, in contrast, multiplicative interaction is not forced (although it can often be specified with the use of *zutu* 'each'). We propose that these are cases of MP_{prenom}+N combinations being used here as an irreducible cognitive object, distinct from the base N.

5 Conclusions

In this paper we have investigated a number of issues in the syntax and semantics of Japanese noun-classifier matching, showing that it involves non-transitive

relationships similar to those encountered in case government and case concord in European languages. We have show that similar formal techniques are required for the two problems. We have further shown that there are a variety of syntactic relationships between classifier and noun and that syntax strongly determines the semantic import of measure phrases. We have shown how asymmetries in positional possibilities for classifiers in type-token relationships follow directly from semantic principles, and provided a formal analysis which directly derives correct generalizations about the interaction between word order and felicity for prenominal classifiers and relative clauses, as well as generalizations about asymmetries between dimensions of measurement that can and cannot be excluded by governing verbs. The formal analysis generalizes cleanly to technically difficult cases of noun phrase coordination.

In addition to further illuminating the syntax and semantics of an important area of Japanese grammar, the results of this paper have greater implications in two respects. First, we have shown that the most complicated problems of nontransitive information sharing, first discussed by Ingria (1990) for the purely formal problem European case concord, also occur in a different language family for a phenomenon that rests squarely on the syntax-semantics boundary. Second, this paper sheds light on subtle problems of reference and polysemy taken up by authors such as Nunberg (1979) and Pustejovsky (1995). Although much of what we discuss here is compatible with Nunberg's accounts, the syntax of Japanese has allowed us to clearly show that different aspects of complex cognitive objects (deferred referents in Nunberg's theory) are in some cases hierarchically related, a finding not at all obvious from prior studies focused on English.

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