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SEMANTICS OF THE CARDINAL PARTITIVE CONSTRUCTION

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Abstract

This paper proposes a semantic analysis of cardinal partitive sentences such as *Three of the boys left*. Its three components are: (i) the traditional 'two NP-hypothesis' of Jackendoff (1977), (ii) the traditional semantics of the preposition *of* of Ladusaw (1982) and Hoeksema (1983), and (iii) the semantic analysis of the numeral recently suggested in Kobuchi-Philip (2006b). Specifically, for a cardinal partitive DP such as *three of the boys*, the presence of a phonetically null classifier, a phonetically null NP, and a phonetically null determiner is hypothesized. These assumptions form the basis for the proposed unified semantic analysis, which accounts for the cardinal partitive sentence both in classifier languages such as Japanese and in non-classifier languages such as English.

1 Introduction

There are many types of partitive constructions. They can involve a weak quantifier, a strong quantifier, or a measure phrase, as illustrated in (1a-c), respectively. The fraction (1d) is also a type of partitive and one might consider the pseudopartitive (1e) a type of partitive construction as well.

(1) a. ***Three of the boys*** *left.*
b. ***All of the boys*** *left.*
c. *Mary first put* ***50 grams of the sugar*** *into the bowl.*
d. ***Two thirds of the highschool students*** *go to colleges.*
e. *Mary eventually put* ***200 grams of sugar*** *into the bowl.*

In this paper, I will concentrate on just one type of partitive, namely the cardinal partitive exemplified in (1a), which involves a numeral and a count noun. Putting aside discussion of well-known general properties of the partitive construction, such as the partitive constraint and anti-uniqueness, in this paper I will focus on the actual formal interpretation of the cardinal partitive sentence, i.e. a compositionality issue. This is motivated by the circumstance that a comprehensive formal semantic analysis of the cardinal partitive sentence has not yet been made completely explicit in the literature. One reason for this is that there exist various semantic as well as syntactic puzzles surrounding the numeral, which first have to be solved before a precise semantic analysis of the cardinal partitive can be formulated. The numeral has recently been examined in a new way which sheds light on some of these puzzles. In particular, a new analysis of numeral quantification in Japanese, a classifier language, has implications for numeral quantification in non-classifier languages such as English. In this paper I will show that at least a cardinal partitive sentence such as (1a) can receive a rather straightforward formal semantic analysis under the following set of theoretical assumptions: (i) the traditional 'two NP hypothesis' of Jackendoff (1977), (ii) the traditional semantic analysis of the preposition *of* offered in Ladusaw (1982) and Hoeksema

[1] I would like to thank the audience of SuB11 for thoughtful questions and comments, especially Carmen Dobrovie-Sorin for an inspiring discussion. All shortcomings are mine.

(1983), and (iii) the semantic analysis of the numeral recently suggested in Kobuchi-Philip (2006b).

2 Semantics of the Cardinal Numeral

Let us start with a presentation of the third assumption, the new semantic analysis of the numeral proposed in Kobuchi-Philip (2006b). In Japanese, a numeral usually cannot stand alone but rather must be composed morphologically with a so-called numeral classifier, as exemplified in (2):[2]

(2) a. *san-**nin**-no kodomo-ga kita.*
3-CL-GEN child-NOM came
'Three children came.'
b. *san-**kumi**-no kodomo-ga kita.*
3-CL-GEN child-NOM came
'Three groups of children came.'

Moreover, these two sentences form a minimal pair; they differ only with respect to the classifier and they have very different truth conditions. The classifier *nin* in (2a) is a unit for counting people, and this sentence means that three individual children came. In contrast, the classifier *kumi* in (2b) is a unit for counting groups or sets, and this sentence means that three groups of children came, irrespective of the precise number of individual children in any of the three groups. Because it has this sort of counting system, Japanese is classified as a 'classifier language', along with Chinese, Korean and many Southeast Asian languages (Simpson 2005).

In contrast, English has traditionally been classified as a 'non-classifier language' because no classifier seems to be involved in ordinary sentences such as (3):

(3) *Three birds landed in the pumpkin field.*

However, English actually does have quite a few numeral classifiers, which are used when the unit of counting is groups of objects, as illustrated in (4):[3]

(4) *Three **flocks** of birds landed in the pumpkin field.*

The data such as (2a), (2b) and (4) indicate that when an overt classifier is present what is actually counted is directly determined by the lexical semantics of this classifier. In (2a), the numeral 3 counts human beings (who are children) while in (2b), it counts groups (that consist of children). Comparable to (2b), in (4) the numeral 3 counts flocks (that consist of birds).

From the perspective of a classifier language, the unusual form of numeral quantification is (3), which apparently lacks a classifier, even though the numeral 3 counts individuals that are birds. Under the framework of generalized quantifier theory (Barwise and Cooper 1981), the numeral is treated as a kind of determiner quantifier. Its domain of quantification is the NP, which denotes a set of atomic (singular) individuals. Concretely, this standard analysis can be represented as shown in (5):

(5) $|\text{BIRD} \cap \text{LANDED IN THE PUMPKIN FIELD}| \geq 3$

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[2] The particle *no* in [NQ-*no* NP] in (2) is not really a genitive marker but rather an attributive form of the copula (Kuno 1973) or a 'linker' (Koike 1999, Den Dikken and Singhapreecha 2005).

[3] Since the scope of the present paper is limited to the cardinal partitive sentence involving a numeral and a count noun, I will not discuss cases involving a mass noun, e.g. *three glasses of the wine*, *three tons of the coal*, etc.

However, the standard analysis runs into a logical problem the minute we try to accommodate contemporary assumptions of the theory of plurality. In particular, it clashes with Link's (1983) lattice-theoretical account of plurality, which hypothesizes distinct denotations for the singular term and the plural term. A numeral whose cardinality is larger than one combines with a plural term, and the denotation of a plural term, under Link's theory, is not just a set of atomic individuals.

To be specific, suppose we have a context in which there are four birds, a, b, c and d. Under Link's theory, the denotation of the singular term *bird* and the plural term *birds* would differ as shown in (6):

(6) a. BIRD = {a, b, c, d}
 b. BIRDS = {a, b, c, d, a⊕b, a⊕c, a⊕d, b⊕c, b⊕d, c⊕d, a⊕b⊕c, a⊕b⊕d, a⊕c⊕d, b⊕c⊕d, a⊕b⊕c⊕d}

The denotation of the singular term is just a set of atoms, while the denotation of the plural term is a set containing sums as well as atoms.[4] The problem is that, if the plural term denotation contains sums, the basic truth conditions of a numeral quantificational sentence are not captured. For the interpretation of sentence (3), for example, three members of the set in (6b) must be selected. (3) is true if these three elements are in the intersection of (6b) and the denotation of *landed in the pumpkin field*, as represented in (5). However, no restriction applies to the selection of the elements; any three members of (6b) will do. This is the problem. Suppose that, for example, (7a), or (7b) happened to be selected:

(7) a. {a⊕b⊕c⊕d, a, b}
 b. {a⊕b, a, b}

If the truth conditions of (3) were satisfied by selecting the three elements in (7a), then (3) could be true when four birds landed in a pumpkin field, rather than three. Worse, if the three selected elements happened to be those in (7b), (3) would be true when only two birds landed in a pumpkin field. Clearly, the basic meaning of numeral quantification is not adequately explained when Link's theory of plurality is combined with the traditional analysis of the numeral.[5] The problem is that there is a possible discrepancy between the number of selected elements and the number of individuals in them when they are sums. An NP such as *three birds* refers to three individual birds, but as long as sums are contained in this set, the numeral will not necessarily count individual birds; it could count bird-sums instead. In order for *three birds* to refer to three individual birds, its domain of quantification must be restricted to a set of atoms only, just like the singular term denotation in (6a). This is a basic logical requirement for counting.[6]

In order to capture numeral quantification within a Linkian theory of plurality, we must abandon the traditional analysis of the numeral and consider some alternative treatment of it. Here it is useful to examine (3) in comparison to classifier sentences such as (2a,b) and (4). As noted above, in these sentences the numeral counts what the classifier refers to. *Three* in *three flocks* counts flocks, not birds; *san* '3' in *san-nin* '3-CL' counts 'nin-objects' (=people) not children. Generalizing from this cross-linguistic sample, it seems that the classifier denotes a set of atomic entities and functions as the domain of quantification for the numeral.

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[4] There is a debate about whether the plural term should include atoms as well as sums (e.g. Hoeksema 1983, Chierchia 1998a, b), or, just sums (e.g. Link 1983, Lasersohn 1988, Shwarzschild 1990, Landman 2000). This matter is irrelevant to the present discussion.

[5] Link was well aware of this and proposed an alterntive adjectival analysis of the numeral (Link 1983).

[6] This requirement, taken for granted in mathematics and logic for centuries, has recently been noted in the linguistics literature as well (e.g. Kratzer 1989, Chierchia 1998a, Landman 2000).

Examining more closely the kind of Japanese sentences exemplified in (2a-b), we see that the numeral counts the number of objects which have the properties specified by the classifier but that these counted objects must also have the properties specified by an associated NP. (2a) asserts not only that three people came; it also says that these people were children. This can be captured in the following manner (from Kobuchi-Philip 2003):

(8) a. ***san-nin**-no* ***kodomo**-ga* *kita.*
3 -CL -GEN child -NOM arrived
Q 1 2 (Q=Quantifier, 1=1st argument, 2=2nd argument)
'Three children came.'

b. san-nin-no kodomo-ga kita $_{t}$
↓
[san-nin-no kodomo $_{\langle\langle e,t\rangle,t\rangle}$]+[kita $_{\langle e,t\rangle}$]
↓ arrived
[$\varnothing_{a\ \langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle}$]+[san-nin-no kodomo $_{\langle e,t\rangle}$]
↓
[san-nin $_{\langle\langle e,t\rangle,\langle e,t\rangle\rangle}$]+[kodomo $_{\langle e,t\rangle}$]
↓ child
[san $_{\langle\langle e,t\rangle,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle}$]+[nin $_{\langle e,t\rangle}$]
3 CL

c. san '3': $\lambda C_{\langle e,t\rangle}\lambda P_{\langle e,t\rangle}\lambda x_e \exists K[K \subseteq (C \cap P) \wedge |K|=3 \wedge \oplus K \Pi x]$
nin 'nin(CL)': NIN_{AT}
kodomo 'child': $\lambda x_e[\text{KODOMO}(x)]$
$\varnothing_a$ 'a': $\lambda X_{\langle e,t\rangle}\lambda Y_{\langle e,t\rangle}\exists y[X(y) \wedge Y(y)]$
kita 'arrived': $\lambda x_e[\text{KITA}(x)]$

d. $\exists y[\exists K[K \subseteq (\text{NIN}_{AT} \cap \text{KODOMO}) \wedge |K|=3 \wedge \oplus K \Pi y] \wedge \text{KITA}(y)]$
nin child arrived

The numeral 3 is taken to be a quantifier which combines with the classifier (the 1st argument) and then the NP (the 2nd argument), as indicated in (8a), representing the number of individuals which have the property of being *nin* (person) and being *kodomo* (child). The lexical elements are combined as shown in (8b). (8c) is a list of the lexical entries, in which the denotation of the classifier is, following what we discussed earlier, a set containing only atoms, i.e. people. I assume also the presence of a null determiner equivalent to English *a*/*an*. This is independently motivated because it accounts for the definite/indefinite ambiguity of Japanese NPs generally (see Kobuchi-Philip 2003). More crucially, a phonetically null determiner is needed for theoretical reasons, since it is a determiner that relates the NP to the VP. Under this analysis, then, (8a) asserts that there are three people who are children and that the sum of these three people is an element of the set of arrivers, as shown in (8d).

This analysis of the Japanese sentence with a classifier can readily be adopted to the English numeral sentence with a classifier, as shown in (9):

(9) a. ***three flocks** of **birds** landed in the pumpkin field.*
Q 1 2

b. three flocks of birds landed in the pumpkin field $_t$
↓
[three flocks of birds$_{<<e,t>,t>>}$]+[landed in the pumpkin field.$_{<e,t>}$]
↓
[$\varnothing_{a\ <<e,t>,<<e,t>,t>>}$]+[three flocks of birds$_{<e,t>}$]
↓
[three flocks$_{<<e,t>,<e,t>>}$]+[birds$_{<e,t>}$]
↓
[three$_{<<e,t>,<<e,t>,<e,t>>>}$]+[flocks$_{<e,t>}$]
3 CL

c. three: $\lambda C_{<e,t>}\lambda P_{<e,t>}\lambda x_e \exists K[K \subseteq (C \cap P) \wedge |K|=3 \wedge \oplus K \Pi x]$
flock: FLOCK_{AT}
birds: $\lambda x_e[{}^*\text{BIRD}(x)]$ (* is a plural operator from Link 1983)
$\varnothing_a$ 'a': $\lambda X_{<e,t>}\lambda Y_{<e,t>}\exists y[X(y) \wedge Y(y)]$
landed ... field: $\lambda x_e[\text{LANDED...FIELD}(x)]$

d. $\exists y[\exists K[K \subseteq (\text{FLOCK}_{AT} \cap \text{BIRDS}) \wedge |K|=3 \wedge \oplus K \Pi y] \wedge \text{LANDED...FIELD}(y)]$

Note that I hypothesize the presence of the phonetically null indefinite determiner even in the case of English. It is this inaudible allomorph of *a*/*an* that relates the NP to the VP, asserting the existence of an entity (which is a sum of three flocks of birds) that has the property of having landed in a pumpkin field.[7] Thus, a unified analysis is obtained for both Japanese sentences like (8a) and English sentences like (9a).

Let us turn now to the peculiar case, i.e. English numeral sentences such as (3) which seem to lack a classifier. Pushing the above analysis further, what I propose is that (3) actually does have a classifier, although it is phonetically null, as shown in (10):

(10) a. ***three** ∅ **birds** landed in the pumpkin field.*
Q 1 2

b. $[[(\varnothing_{a\ <<e,t>,<<e,t>,t>>})\ [[\text{three}_{<<e,t>,<<e,t>,<e,t>>>}\ \varnothing_{<e,t>}]\ [\text{birds}]_{<e,t>}]_{<e,t>}]_{<<e,t>,t>}$
$[\text{landed in the pumpkin field}]_{<e,t>}]_t$

c. $\exists y[\exists K[K \subseteq (\text{AT} \cap \text{BIRDS}) \wedge |K|=3 \wedge \oplus K \Pi y] \wedge \text{LANDED IN THE PUMPKIN FIELD}(y)]$

The hypothesized null classifier, which perhaps occurs overtly as *thing* in *something* or *body* in *somebody*, denotes a set of highly underspecified atoms, atoms that have the sole property of being an object. This is because whenever there is no overt classifier, what is counted is the individuals which have the property specified by the following noun. If we say *three boys*, we count individual objects which are boys, and if we say *three computers*, we count individual objects that are computers. In this way, a unified analysis is obtained that covers both English sentences like (9a), which have an overt classifier, and English sentences like (10a), which seem to lack one. This hypothesis is theoretically advantageous in another sense as well. It also provides a unified analysis of numeral quantification both in classifier languages such as Japanese and in so-called non-classifier languages such as English.

[7] The plural marker *–s* on *flocks* in (10a) is assumed to be a meaningless syntactic form. It cannot make *flocks* semantically plural, since, as we have discussed, *flocks* must denote a set of atoms (a singular term) if it is to function as the domain of quantification for a numeral.

3 The Two-NP Hypothesis

Now let us consider the basic structure of cardinal partitive sentences such as *Three of the boys left*. The second assumption I make is the two-NP hypothesis, i.e. the hypothesis that there are two NPs involved in the partitive construction. That is, the partitive construction takes the form [X *of* Y], where X corresponds to the part and Y corresponds to the whole in the part-whole relation that the sentence asserts. X and Y each stand for a nominal constituent, as discussed by Jackendoff (1977) and many others since then. There are some linguistis who advocate single-NP hypothesis for the partitive construction (e.g. Martí 2003). However, Jackendoff's analysis is motivated by the basic concept of the fraction itself.

Consider a fraction such as *one third*, which expresses a pure partitive concept. Putting aside the syntactic analysis of such an expression, the important fact is that we need both *one*, which corresponds to the part, and *third*, which corresponds to the whole, to express the partitivity. In other words, it is logically impossible to express partitivity without presupposing a part and a whole. These two conceptually necessary components are linguistically realized precisely as the two NPs of the partitive construction.

Moreover, from a syntactic perspective, the following set of grammatical sentences strongly supports the two-NP hypothesis:[8]

(11) a. *Two _____ of these eight <u>apples</u> are quite good.*
b. *Two <u>apples</u> of these eight _____ are quite good.*
c. *Two <u>apples</u> of these eight <u>apples</u> are quite good.*

Normally, a partitive sentence might have just the second NP, as exemplified in (11a). However, it is possible to express the same proposition with (11b), which has only the former NP, and even with (11c), which is slightly marked only because of the redundancy. The fact that all of these sentences are grammatical shows that there must be two syntactic NP positions.

It is not the case that the two NPs must be identical, however. Sentences such as (12a) are completely grammatical in Japanese as well as in English (see the gloss of 12a). Here the part-denoting NP and the whole-denoting NP cooccur in a single sentence:

(12) a. *sharyoo 100-dai-(no uchi)-no torakku 16-dai-wa kaite-ga tsuita*
vehicle 100-CL-GEN in-GEN truck 16-CL-TOP buyer-NOM determined
'Buyers have been determined for 16 trucks out of the 100 vehicles.'
b. [16 trucks] $\subseteq$ [100 vehicles]

The two NPs in this Japanese instance of the partitive construction are different. The part-denoting NP is trucks, which is sixteen in number. The whole-denoting NP is vehicles (more general in meaning, including trucks), which is one hundred in number. In sum, there is strong semantic as well as distributional evidence in support of the two-NP hypothesis.

Let us also assume, following Barker (1998), that, when one of the NPs is missing, its lexical value is inherited from the overt NP. This seems reasonable enough given that (11a-b) have the same meaning as (11c).

What we discussed in the previous section and what we have just discussed in this section can now be put together in a first approximation of an analysis of the cardinal partitive construction, as shown in (13):

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[8] The sentences (11a-b) are taken from Ionin, Matushansky and Ruys (2006). The English grammaticality judgements in (11), and elsewhere in this paper, were obtained from native speakers.

(13) a. [[($\varnothing_1$) [[[Three ($\varnothing_2$)]($\varnothing_3$)][of [the boys]]]] left].
b. $\varnothing_1$ = a phonetically null determiner equivalent to *a*/*an*.
$\varnothing_2$ = a phonetically null classifier paraphrasable as 'body' or 'individual'.
$\varnothing_3$ = a phonetically null NP with the same value as the overt NP (*boys* here).

4 Semantics of the Partitive *Of*

We now turn to the third assumption needed for a complete account of the cardinal partitive sentence, namely an account of the semantics of the partitive preposition *of*. First consider the PP [*of the boys*] in (14):

(14) [*Three* [*of* [*the boys*]$_{DP}$]$_{PP}$] *left.*

Syntactically, this is a run-of-the-mill PP. PPs typically occur in positions such as shown in (15):

(15) a. *John* [*slept* [*on the sofa*]$_{PP}$]$_{VP}$.
b. *Mary opened the* [*window* [*in the kitchen*]$_{PP}$]$_{NP}$.

In (15a), the PP is contained in a VP. It modifies the verb *slept*, composing with it to form a VP. On the other hand, in (15b), the PP is contained in an NP. It modifies the noun *window*, forming an NP. Under standard assumptions, both an intransitive verb such as *slept* and a VP such as *slept on the sofa* are of semantic type <e,t>. This means the PP inside the VP must be of type <<e,t>,<e,t>>. Likewise, we standardly assume that both a bare noun such as *window* and a modified noun such as *window in the kitchen* are of semantic type <e,t>. Thus, the PP inside the NP must also be of type <<e,t>,<e,t>>. In short, the ordinary PP is of type <<e,t>,<e,t>>. The simplest hypothesis, then, is that the PP *of the boys* in (14) is also of type <<e,t>,<e,t>>.

Next, consider the definite DP that refers to the whole, *the boys* in (14). Adopting the analysis of Link (1983) and Landman (2000), this can simply be treated as an element of type e. That is, a definite DP such as *the boys* refers to the supremum of the set denoted by *boys*. As we have discussed earlier, the plural term *boys* denotes a set containing both atoms and sums, the atoms referring to the relevant boys in the context and all the sums derived from them.

Given that the PP is of type <<e,t>,<e,t>> and that the DP is of type e in the structure [P DP]$_{PP}$, the type of the partitive preposition *of* must be <e, <<e,t>,<e,t>>>, as Ladusaw (1982) and Hoeksema (1983) suggested.

Though this type-theoretical analysis should hold generally for all prepositions, the semantic content of the partitive *of* is distinct, not only from that of other prepositions but also from other occurrences of *of* such as in *the destruction* ***of*** *Carthage*, *a friend* ***of*** *John's*, etc. Perhaps it is also distinct from the *of* in *two cups* ***of*** *sugar* (pseudopartitive). The semantics of the partitive *of* is special in the sense that it has to assert the part-whole relation between its first argument and the second argument, i.e. the former is the whole, the latter the part. Thus, modifying slightly the basic analysis of Ladusaw and Hoeksema, which is given in (16a), let us assume that the basic meaning of partitive *of* is as shown in (16b). The modification incorporates Link's PART-OF operator:

(16) a. $\lambda x_e \lambda P_{<e,t>} \lambda y_e[P(y) \wedge y \leq x]$ (where $y \leq x$ represents that y is part of x)
b. $\lambda x_e \lambda P_{<e,t>} \lambda y_e[P(y) \wedge y \sqcap x]$ (where $y \sqcap x$ represents that y is part of x)

5 Semantics of the Cardinal Partitive Sentence

Putting together the three theoretical assumptions discussed above, but adding nothing else, we obtain the formal analysis of the cardinal partitive sentence shown in (17):

(17) a. *Three of the boys left.* = [[($\varnothing_a$)[[[Three ($\varnothing_{CL}$)]($\varnothing_{NP}$)][of [the boys]]]]left].

b. three of the boys left $_t$

↓

[three of the boys$_{<<e,t>,t>>}$]+[left.$_{<e,t>}$]

↓

[$\varnothing_{a\ <<e,t>,<<e,t>,t>>}$]+[three of the boys$_{<e,t>}$]

↓

[three $_{<<e,t>,<e,t>>}$] + [of the boys$_{<e,t>}$]

↓ ↓

[three$_{<<e,t>,<e,t>>}$]+[$\varnothing_{NP\ <e,t>}$] [of$_{<e,<<e,t>,<e,t>>}$]+[the boys $_e$]

↓

[three $_{<<e,t>,<<e,t>,<e,t>>>}$]+[$\varnothing_{CL\ <e,t>}$]

c. of: $\lambda x_e \lambda P_{<e,t>} \lambda y_e[P(y) \wedge y \Pi x]$
the boys: $\sigma[{*}\text{BOY}]$
three: $\lambda C_{<e,t>} \lambda P_{<e,t>} \lambda x_e \exists K[K \subseteq (C \cap P) \wedge |K| = 3 \wedge \oplus K \Pi x]$
$\varnothing$(=CL): $\lambda u_e[\text{AT}(u)]$ (N.B. the set of individual atoms)
$\varnothing$(=boys): $\lambda x_e[{*}\text{BOY}(x)]$
$\varnothing$(=a): $\lambda X_{<e,t>} \lambda Y_{<e,t>} \exists w_e[X(w) \wedge Y(w)]$
left: $\lambda x_e[\text{LEFT}(x)]$

d. $\exists x[\exists K[K \subseteq (\text{AT} \cap {*}\text{BOY}) \wedge |K| = 3 \wedge \oplus K \Pi x] \wedge x \Pi \sigma[{*}\text{BOY}] \wedge \text{LEFT}(x)]$

The cardinal partitive sentence *Three of the boys left* has the internal structure indicated in (17a=13a). This is shown in a tree structure analysis in (17b). The lexical entries are given in (17c); the partitive preposition *of*, denoting a part-whole relationship, is expressed by the PART-OF operator. The numeral is treated as a semantic element which combines first with a classifier and then with predicate (NP here), forming a set of objects. As noted above, the null classifier denotes a set of individual atoms. The other lexical entries in (17c) are as standardly assumed. When these elements are composed in the manner shown in (17a), the outcome is the logical representation in (17d). The numeral 3 counts the objects in the subset of the intersection of the classifier denotation and the NP denotation. The sum of these three elements is treated as part of an entity which also has the property specified by the predicate and this entity is asserted to exist by the null indefinite determiner.

The same analysis applies directly to the cardinal partitive sentence in Japanese, as shown in (18):

(18) a. *kodomo-no san-nin-ga kaetta.*
child-PART 3-CL-NOM left
'Three of the children left.'

b. [($\varnothing_a$) [[[kodomo]$_{DP}$ no$_{PART}$] [san-nin$_{CL}$ ($\varnothing_{NP}$)]]]-ga kaetta].

c. no 'of': $\lambda x_e \lambda P_{<e,t>} \lambda y_e[P(y) \wedge y \Pi x]$
kodomo 'child': $\sigma[{*}\text{KODOMO}]$
san '3': $\lambda C_{<e,t>} \lambda P_{<e,t>} \lambda x_e \exists K[K \subseteq (C \cap P) \wedge |K| = 3 \wedge \oplus K \Pi x]$
nin$_{CL}$: $\lambda u_e[\text{NIN}(u)]$ (N.B. the set of individual persons)
$\varnothing$(=kodomo): $\lambda x_e[{*}\text{KODOMO}(x)]$
$\varnothing$(=a): $\lambda X_{<e,t>} \lambda Y_{<e,t>} \exists w_e[X(w) \wedge Y(w)]$
kaetta 'left': $\lambda x_e[\text{KAETTA}(x)]$

d. $\exists x[\exists K[K \subseteq (\text{NIN}_{AT} \cap {}^{*}\text{KODOMO}) \wedge |K| = 3 \wedge \oplus K \Pi x] \wedge x \Pi \sigma[{}^{*}\text{KODOMO}] \wedge \text{KAETTA}(x)]$
child child left

Except for the word order (due to the head-finalness of Japanese), the syntax shown in (18b), in particular the constituency structure, is the same as the English analog in (17b). Furthermore, the lexical entries in (18c) are parallel to those in (17c). As a consequence, the resulting logical representation in (18d) is exactly the same as English (17d). In sum, by assuming the presence of a null classifier, a null indefinite determiner, and a null NP, along with a traditional analysis of semantics of *of*, the semantics of the cardinal partitive sentence can be explicitly formalized within the framework of a Linkian theory of plurality. This formal analysis applies to both English and Japanese cardinal partitive sentences, without the need for any additional stipulation.

6 Extending the Analysis

The analysis of the cardinal partitive sentence presented above is theoretically advantageous for the reasons mentioned. However, extending it to cover all quantificational partitives is not as simple as one might hope. First, consider a possible extention to partitive sentences involving a strong quantifier such as *all*, *both* or *each*. As shown in (19), replacing the numeral of the cardinal numeral partitive sentence with one of these quantifiers, we obtain a perfectly grammatical partitive sentence:

(19) a. *Three of the boys left.*
b. *All/Both/Each of the boys left.*

If we simply substitute a strong quantifier, e.g. *all*, for the numeral in our analysis of (19a) above, the following structure results:

(20) all of the boys left $_{t}$
↓
[all of the boys $_{<<e,t>,t>>}$]+[left. $_{<e,t>}$]
↓
[$\varnothing_{the\ <<e,t>,<<e,t>,t>>}$]+[all of the boys $_{<e,t>}$]
↓
[all $_{<e,t>}$] + [of the boys $_{<<e,t>,<e,t>>}$]
↓ ↓
[all $_{<<e,t>,<e,t>>}$]+[$\varnothing_{NP\ <e,t>}$] [of $_{<e,<<e,t>,<e,t>>}$]+[the boys $_{e}$]
↓
[all $_{<<e,t>,<<e,t>,<e,t>>>}$]+[$\varnothing_{CL<e,t>}$]

This is a rather odd analysis of (19b), given the traditional view that strong quantifiers like *all* are determiners. However, this traditional view actually raises empirical and theoretical issues in need of clarification, both with respect to the syntax and the semantics of strong quantifiers (e.g. Giusti 1991, Matthewson 2001, among many others). A detailed discussion of this matter goes beyond the scope of this paper. However, given the lack of consensus about the syntax and semantics of *all*, the analysis in (20) should be considered because it does yield a correct interpretation of the sentence. If we assume the lexical entries are as shown in (21a), and calculate them according to (20), we obtain the logical representation in (21b). This turns out to mean (21c), for a context in which there are three boys a, b and c:

(21) a. *of*, *the boys*, ∅ (=*boys*) and *left* as shown in (17c), and
all: $\lambda P \lambda y\ [\ \lambda z\ (z\ {}^{\bullet}\Pi\ y) \subseteq P\ ]$
$\varnothing_{the}$: $\lambda X \lambda Y[Y(\oplus X)]$ (following Landman 2000)

b. $\textsc{left}(\oplus\ \lambda y[[\lambda z(z\ {}^{\bullet}\Pi\ y) \subseteq {}^{*}\textsc{boy}]\ \wedge y \Pi \sigma[{}^{*}\textsc{boy}]])$

c. $\textsc{left}\ (a \oplus b \oplus c)$

Note here that *all* is treated as an element of type <<e,t>,<e,t>>. Syntactically, it is a modifier, rather than a determiner.[9] To be explicit, according to this 'modifier hypothesis', a special lexical property of *all* is that it includes its own domain of quantification, specifying that this set of atoms is a subset of the set denoted by the incoming lexical element. This is tantamount to the claim that *all* includes a nominal element in its lexical content, making it paraphrasable as something like 'all pieces' or 'all individuals'. Another unusual part of the analysis in (20) is the presence of a phonetically null determiner. Moreover, it is a definite determiner, an allomorph of *the*, unlike the case of the cardinal partitive. The definiteness of this determiner is plausible, however, given that *all* is a strong quantifier.

One piece of evidence in support of the claim that *all* is of type <<e,t>,<e,t>> is its distribution. *All* can also occur as a floating quantifier (FQ); the simplest syntactic analysis of FQs is the hypothesis that they are adverbs, i.e. of type <<e,t>,<e,t>>.[10] Consider the example in (22a):

(22) a. *The boys all left.*

b. left: $\lambda x[\ \textsc{left}(x)\ ]$
all: $\lambda P \lambda y\ [\ \lambda z\ (z\ {}^{\bullet}\Pi\ y) \subseteq P\ ]$
the boys: $\sigma({}^{*}\textsc{boy})$

c. $\lambda z[z\ {}^{\bullet}\Pi\ \sigma({}^{*}\textsc{boy})] \subseteq \lambda x[\textsc{left}(x)]$

The logical representation in (22c) asserts that the set of atomic individual parts of the supremum of the set denoted by *boys* is a subset of the leaver-set. In short, every boy has the property of having left. This is a distributive reading. As many linguists have noted, FQ sentences generally have a distributive reading (Link 1983, 1987, Roberts 1986, Junker 1990, Hoeksema 1996, etc.) If we assume that *all* is actually associated with a classifier-like element as part of its lexical content, as shown in (22b), the systematic distributive reading of an FQ sentence with *all* is straightforwardly explained. The FQ syntactically combines with the predicate, such that the predicate functions as the second argument of the quantifier-part of *all*. This entails that the quantified elements are atoms with the property specified by the predicate, hence the distributivity. In fact, this analysis exactly parallels that of the Japanese floating numeral quantifier sentence proposed in Kobuchi-Philip (2003), which is summarized in (23):

(23) *kodomo-ga* [*san-nin kita*].
child -NOM 3 -CL arrived
Q 1 2
'Three children arrived.'

Due to the atomicity condition of the classifier and its intersection with the predicate, the analysis in (23) accounts for the systematic distributive reading of the Japanese floating numeral quantifier sentence without the need of a Distributivity Operator (Link 1983). Thus, assuming the presence of a null-classifier element in association with a lexical element which can occur as an FQ, we have a way of accounting for the general distributivity of the FQ

[9] I only suggest that the type-theoretical equivalence between the numeral and *all* here, and in particular it is not the case that I assume that the numeral and *all* occupy the same syntactic position.

[10] The adverbial hypothesis of the FQ has been argued for by a number of authors in the literature (e.g. Roberts 1986, Link 1987, Junker 1990, Hoeksema 1996).

sentence. This provides additional support for the hypothesis that strong quantifiers like *all* are modifiers of type <<e,t>,<e,t>>, rather than determiners.

This general claim faces problems, however, when we examine the full distribution of *all* and when we take into account the distribution of other strong quantifiers. Consider the facts illustrated in (24) and (25):

(24) *All*

a.	partitive	*All of the kids have been to the beach.*
b.	floated	*The kids have all been to the beach.*
c.	pre-DP	*All the kids have been to the beach.*
d.	post-pronominal	*Joe liked them all.*
e.	pre-NP	*All kids have been to the beach.*

(25) *Each*

a.	partitive	*Each of the kids has been to the beach.*
b.	floated	*The kids have each been to the beach.*
c.	binominal	*The boys ate three sausages each.*
d.	pre-NP	*Each kid has been to the beach.*

I have shown how the modifier hypothesis works well for FQs; elsewhere I show how it also works well for binominal *each* (Kobuchi-Philip 2006a); and clearly this hypothesis readily captures pre-DP uses like (24c). However, the hard cases are sentences like (24e) and (25d), where the strong quantifier occupies a pre-NP position and behaves exactly like a determiner. To account for the determiner-like uses of *all*, *each*, etc. some additional stipulation will be needed. However, since these are not partitive sentences, I leave this topic for future research and simply weaken the claim as follows: Strong quantifiers can occur either as determiners (of type <<e,t>,<<e,t>,t>>) or as modifiers (of type <<e,t>,<e,t>>). Together with this weaker hypothesis about the cross-categorial status of strong quantifiers, the analysis of cardinal partitives proposed in this paper can be successfully extended to cover partitives like (24a) and (25a) as well.

7 Concluding Remarks

In this paper I suggested a formal semantic analysis of cardinal partitive sentences such as *Three of the boys left*. In order to give an explicit analysis of this construction, I used three basic hypotheses as theoretical assumptions. Two of these are traditional hypotheses, i.e. the two-NP hypothesis of Jackendoff (1977) and the semantics of *of* suggested by Ladusaw (1982) and Hoeksema (1983). The third is the null-classifier hypothesis for the semantics of numerals, proposed in Kobuchi-Philip (2006b). With these assumptions, I have shown how a null indefinite determiner, a null classifier, and a null NP are involved in the interpretation of a sentence such as *Three of the boys left*. The analysis is attractive in that it is consistent with a well-established assumption in the theory of plurality, and provides a unified analysis for both English and Japanese cardinal partitive sentences. In the last section, an extention of the analysis was explored with respect to partitive sentences with strong quantifiers like *all*. Here I suggested that *all* is not a determiner but rather a modifier, and that, given this modifier hypothesis, a sentence such as *All of the boys left* can readily be analyzed along the same lines as proposed for cardinal partitive sentences. The modifier hypothesis was shown to receive independent motivation from FQ sentences such as *The boys all left*, and from Japanese floating numeral quantifier sentences. However, in light of sentences like *Each boy left*, the modifier hypothesis was abandoned and replaced by the weaker claim that strong quantifiers can in principle be modifiers, even if they also readily occur as determiners. Given this weaker claim, the proposed analysis of the cardinal partitive could be extended to cover partitives with strong quantifiers.

References

Barker, C.: 1998, Partitives, Double Genitives and Anti-Uniqueness, *Natural Language and Linguistic Theory* **16**, 679-717.

Barwise, J. and R. Cooper: 1981, Generalized Quantifiers and Natural Language, *Linguistics and Philosophy* **4**, 159-219.

Chierchia, G.: 1998a, Reference to Kinds across Languages, *Natural Language Semantics* **12**, 339-405.

Chierchia, G.: 1998b, Plurality of Mass Nouns and the Notion of 'Semantic Parameter', *in* S. Rothstein (ed), *Events and Grammar*. Dordrecht: Kluwer, pp. 53-103.

den Dikken, M. and P. Singhapreecha: 2005, Complex Noun Phrases and Linkers, *Syntax* **7**, 1-54.

Giusti, G.: 1991, The Categorial Status of Quantified Nominals, *Linguistische Berichte* **136**, 438-454.

Hoeksema, J.: 1984, Partitives, unpublished ms. University of Groningen.

Hoeksema, J.: 1996, Floating Quantifiers, Partitives and Distributivity, *in* J. Hoeksema (ed), *Partitives*. Berlin: Mouton de Gruyter. pp,57-106.

Ionin, T., O. Matushansky and E. Ruys: 2006, Parts of Speech: Toward a Unified Semantics for Partitives, *in* C. Davis, A. R. Deal and Y. Zabbal (eds), *Proceedings of NELS 36*, Amherst, MA: GLSA. pp. 357-370.

Jackendoff, R.: 1977, *X' Syntax: A Study of Phrase Structure*. Cambridge, MA: MIT Press.

Junker, M.-O.: 1990, Floating Quantifiers and Georgian Distributivity, *in* M. Ziolkowski, M. Noske, and K. Deaton (eds), *CLS 26*. Chicago: Chicago Linguistic Society. pp. 211-219.

Kobuchi-Philip, M.: 2003, *Distributivity and the Japanese Floating Numeral Quantifier*. Ph.D. Diss. CUNY Graduate Center.

Kobuchi-Philip, M.: 2006a, A Unified Semantic Analysis of Floated and Binominal *Each*, *in* C. Ebert and C. Endriss (eds), *Proceedings of Sinn und Bedeutung 10*, Berlin: ZAS. pp. 183-197.

Kobuchi-Philip, M.: 2006b, Identity of the domain of quantification for numerals, *in* L. Tasmowski and S. Vogeleer (eds), *Non-definiteness and Plurality*. Amsterdam: John Benjamins, pp. 267-290.

Koike, S.: 1999, *A Monosemy Approach to the Japanese Particle No: Functional Categories as Linkers and Antisymmetry in Natural Language*. Ph.D. Diss. CUNY Graduate Center.

Kratzer, A.: 1989, An Investigation of the Lumps of Thought, *Linguistics and Philosophy* **12**, 607-653.

Kuno, S.: 1973, *The Structure of the Japanese Language*. Cambridge, MA: MIT Press.

Ladusaw, W.: 1982, Semantic Constraints on the English Partitive Construction, *in* D. Flickinger, M. Macken and N. Wiegand (eds), *Proceedings of WCCFL 1*. Stanford: CSLI. pp. 2310242.

Landman, F.: 2000, *Events and Plurality*. Dordrecht: Kluwer.

Lasersohn, P.: 1988, *A Semantics for Groups and Events*. Ph.D. Diss. Ohio State University.

Link, G.: 1983, The Logical Analysis of Plural and Mass Terms: A Lattice-theoretical Approach, *in* R. Bäuerle, C. Schwarze, and A. von Stechow (eds), *Meaning, Use, and Interpretation of Language*. Berlin: de Gruyter, pp. 302-323.

Link, G.: 1987, Generalized Quantifiers and Plurals, *in* P. Gärdenfors (ed), *Generalized Quantifiers. Linguistic and Logical Approaches.* Dordrecht: Reidel. pp. 151-180.

Martí, N.: 2003, Partitives: One or Two Nouns?, talk presented in the conference Incontro di Grammatica Generativa. Urbino.

Matthewson, L.: 2001, Quantification and the Nature of Crosslinguistic Variation, *Natural Language Semantics* **9**, 145-189.
Roberts, C: 1986, *Modal Subordination, Anaphora and Distributivity*. Ph.D. Diss. University of Massachusetts at Amherst.
Shwarzschild, R.: 1990, *On the Meaning of Definite Plural Noun Phrases*. Ph.D. Diss. University of Massachusetts at Amherst.
Simpson, A.: 2005, Classifiers and DP Structure in Southeast Asia, *in* G. Cinque and R. Kayne (eds), *Handbook of Comparative Syntax*. Oxford: Oxford University Press, pp. 806-838.