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“Mixed Predicates” are, in fact, Atom Predicates

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Abstract

In this paper, I examine the traditional distinction among distributive predicates, mixed predi- cates, and collective predicates, focusing on mixed predicates and collective predicates. Under the traditional three-way distinction of predicates, a mixed predicate can be both a collective predicate and a distributive predicate because a plural noun in a mixed-predicate sentence is ambiguous be- tween a distributive reading and a collective reading. In this paper, adopting Winter’s (2002) analysis of set/atom predicates, I argue that mixed predicates are atomic predicates, whereas col- lective predicates are set predicates in Japanese. Support for my proposal comes from distributive and collective readings in the Japanese Floating Quantifier Construction (henceforth, JFQC).

When a verb composes with a classifier to denote a set of sets in the JFQC, there is a sharp contrast between the mixed-predicate JFQC and the collective-predicate JFQC, which is problem- atic for Link 1983 and Landman 1989. When a verb composes with a classifier to denote a set of sets in the JFQC, a mixed predicate, which is an atom predicate, can have only a distributive read- ing, whereas a collective predicate, which is a set predicate, can have both a distributive reading and a collective reading. In my analysis, this difference can be reduced to the properties of an atom predicate and a set predicate, as proposed by Winter (2002).

"Mixed Predicates" are, in fact, Atom Predicates

Hironobu Hosoi*

1 Introduction

In this paper, I examine the traditional distinction among distributive predicates, mixed predicates, and collective predicates, focusing primarily on mixed predicates and collective predicates. Under the traditional three-way distinction of predicates, a mixed predicate can be both a collective predicate and a distributive predicate because a plural noun in a mixed-predicate sentence is ambiguous between a distributive reading and a collective reading. For example, in (1), the verb *smile* is a distributive predicate because the sentence in (1) describes each smiling act of Mary and John.

(1) Mary and John smiled. (distributive predicates)
(2) Mary and John met. (collective predicates)
(3) Mary and John ate a pizza. (mixed predicates) (Winter 2002)

On the other hand, the verb *meet* in (2) is a collective predicate. The sentence in (2) describes a joint meeting of Mary and John. The predicate *eat a pizza* in (3) is a mixed predicate. The sentence in (3) is ambiguous between a distributive reading and a collective reading. Mary and John each ate a pizza individually or ate one pizza together.

In this paper, adopting Winter's (2002) analysis of set/atom predicates, I argue that mixed predicates are atomic predicates, whereas collective predicates are set predicates in Japanese. Support for my proposal comes from the distributive and collective readings in the Japanese Floating Quantifier Construction (henceforth, JFQC).

2 Prior Research

In this section, I examine two important prior analyses of plurality discussing distributive predicates, collective predicates, and mixed predicates, i.e., Link 1983 and Landman 1989.

2.1 Link 1983

Link (1983) uses a lattice partially ordered by a *part of* relation for the domain of singular and plural individuals, as shown in Figure 1.[1]

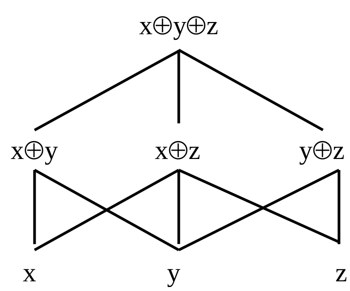


Figure 1: A lattice partially ordered by a *part of* relation for the domain of singular and plural individuals.

In Figure 1, x, y, and z at the bottom are singular atomic individuals. The connective ⊕ is an

*This paper is a revised version of Hosoi (2012). I am very grateful to Mark Freiermuth and Neal Snape for their help in editing.

[1]Link (1983) proposes this lattice approach for a similarity between plural nouns and mass nouns.

individual sum operator. The lines indicate the "part-of" relation. Thus, the denotation of a singular noun such as *a book* is a set of singular individuals {x, y, z}. The denotation of a plural noun such as *books* is a set of individuals, namely, $\{x, y, z, x\oplus y, x\oplus z, y\oplus z, x\oplus y\oplus z\}$.

Under Link's analysis, distributive predicates, collective predicates, and mixed predicates can be expressed as follows:

Distributive predicates such as *smile* are derived from pluralizations of singular verbs, which denote a set of singular individuals. The pluralization operation * in (4) applies to one-place predicate P, and it generates all the individual sums of members of the extensions of P.

(4) $[\![{*P}]\!] = \{y \in A: \exists X \subseteq [\![P]\!]\ y = +X\}$
(5) John is a pop star and Paul is a pop star if John and Paul are pop stars.
(6) pop-star' (j) $\wedge$ pop-star' (p) $\rightarrow$ **pop-star'* (j$\oplus$p)

Under this analysis, if the sum of individuals is in the extension of *P, each individual of the sum is also in the extension of P, as shown in (5) and (6). This leads to a distributive reading.

Collective predicates such as *gather* and *meet* directly take plural individuals (or individual sums) in their extension. As shown in (7), the property denoted by a collective predicate holds of a whole plural individual but not each element of the plural individual.

(7) meet' (j$\oplus$p) $\nrightarrow$ meet' (j) [not a valid inference]

Mixed predicates such as *carry a piano upstairs* are assumed to be like collective predicates. Furthermore, a distributive reading is obtained when a D-operator in (8) applies to a mixed predicate. Thus, the sentence in (9) has the distributive reading as shown in (10).

(8) $\lambda x.\forall y\ [y \leq x \wedge AT(y) \rightarrow P(y)]$
(9) John and Paul carried a piano upstairs.
(10) $\forall y\ [y \leq j\oplus p \wedge AT(y) \rightarrow$ *carry a piano upstairs'* (y)]

A collective reading is obtained when the mixed predicate directly takes a plural individual in its extension, in the same manner as the collective predicate.

2.2 Landman 1989

Landman (1989) bases his analysis of plurality on Links's theory. However, he proposes one crucial technical change. Concerning a collective reading, a collective predicate such as *meet* or a mixed predicate such as *carry a piano upstairs* does not take sums but rather groups in its extension. Based on this change, he proposes the following revision (1989:593):

(11) a. All basic predicates of LP (the language of plurality) denote sets of atoms only.
b. Basic predicates never take sums in their extension.

Under this analysis, distributive readings are created by pluralization of basic predicates. The basic predicate *P*, e.g., *pop-star*' in (12) and (13), takes only atoms in its extension. As in (14) and crucially in (15), the pluralization operation * generates all the individual sums of members of a basic predicate P. In other words, in (15), a plural individual which is in the extension of **pop star* is derived from two individual atoms which are in the extension of a basic predicate *pop-star*'. Therefore, **P* such as **pop star* in (15) is always distributive.

(12) David is a pop star and Tina is a pop star.
(13) pop star' (d) $\wedge$ pop star' (t)
(14) David and Tina are pop stars.
(15) *pop star (d$\oplus$t)

Collective readings are obtained if collective predicates apply to group atoms, as shown in (17):

(16) The boys met. (collective reading)
(17) meet' (↑(σx.*boy'(x)))

The group-forming operation ↑ maps a sum *σx.*boy'(x)* onto an atomic group. The collective (basic) predicate *meet'* applies to this atomic group and yields a collective reading, as in (17).

Mixed predicates, such as *carry a piano* in (18), are ambiguous between a distributive reading and a collective reading. As shown in (19), if a mixed predicate, which is a basic atom predicate, is pluralized and the pluralized mixed predicate is predicated of a sum of individuals, we have a distributive reading in the same manner as a distributive reading in (15). If a mixed predicate is predicated of an atomic group as shown in (20), we have a collective reading in the same manner as a collective reading in (17).

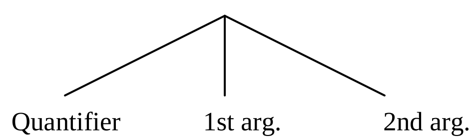
(18) The boys carry a piano upstairs.
(19) *carry' (σx.*boy'(x)) — distributive reading
(20) carry' (↑(σx.*boy'(x))) — collective reading

3 Prior Research

Link (1983) and Landman (1989), as discussed in Section 2, encounter some problems with distributivity and collectivity of the JFQC. In this section, I discuss these problems. Before starting our discussion, however, I first wish to discuss Kobuchi-Philip's (2003) analysis of the JFQC, which will be assumed for the discussion that follows it.

3.1 Kobuchi-Philip 2003

Kobuchi-Philip (2003) applies the general scheme for quantification over objects, given as figure 2, to the JFQC such as the example in (21).



1st argument — Domain of quantification (Restriction)
2nd argument — Nuclear Scope

Figure 2: The general scheme for quantification over objects.

(21)	Gakusei-ga	kinoo	3-nin	isu-o	tsukut-ta.
	student-NOM	yesterday	3-CL	chair-ACC	make-PAST
	"Three students made a chair yesterday."				

(22)		Q	1st arg.	2nd arg.
	JFQC	numeral	classifier	predicate
		3	-nin	made a chair

Concerning the JFQC, she assumes that the numeral and the classifier are separate and independent semantic entities, as shown in (22). The classifier corresponds to the first argument of Figure 2. It denotes a set of atomic individuals. This shows the domain of quantification. The verbal predicate corresponds to the second argument. Thus, the three components of the JFQC quantification, i.e., the numeral, the classifier, and the verbal predicate, are contained within the verbal domain, excluding the host NP.

Based on the above assumptions, Kobuchi-Philip proposes the interpretation in (23) for the floating quantifier (FQ):

(23) $[\![n]\!] = \lambda C \lambda P \lambda x \exists K\, [K \subseteq (C \cap P) \wedge |K| \geq n \wedge \oplus K{=}x]$

C is a classifier denotation such as the denotation of *-nin*. *P* is a predicate denotation, which corresponds to a verbal predicate. *K* is a set of objects in the intersection of the classifier denotation and the predicate denotation. *K* contains *n*-many elements. Furthermore, the supremum generated by the elements in *K* is identified as *x*.

Under Kobuchi-Philip's analysis, the interpretation in (25) is assigned to the distributive JFQC in (24):

(24) Gakusei-ga san-nin hashit-ta.
student-NOM 3-CL run-PAST
"Three students ran." (Kobuchi-Philip 2003)

(25) $\exists y[gakusei'(y)\ \&\ \exists K[K \subseteq (\lambda u \exists v[nin'(v)\ \&\ u \bullet\!\prod v] \cap hashitta')]\ \&\ |K| \geq 3\ \&\ \oplus K{=}y]$

As in (25), the predicate *hashitta'* "ran" denotes a set of individuals. Furthermore, the classifier *-nin* quantifies over atomic individuals because of the atomic individual-part operator $\bullet\!\prod$ (Link 1983) in the classifier denotation $\lambda u \exists v[nin'(v)\ \&\ u \bullet\!\prod v]$. Therefore, the intersection of the sets denoted by *ran* and by *-nin* consists of atomic individuals which have the property *ran*'. Thus, each member, i.e., each individual atom of set K must have the property *ran'*. This yields a distributive interpretation in the sentence in (24).

3.2 Data

In this section, I discuss data which are problematic for Link 1983 and Landman 1989.

In (26) and (27), a mixed predicate *ronbun-o happyosuru* "present a paper" composes with a FQ to denote a set of individual atoms. If the numeral associated with the classifier is one, we can have the sentence in (26). If the numeral is two or more, the JFQC with a mixed predicate has only a distributive reading, and not a collective reading, as shown in (27):

(26) Gakusei-ga gakkai-de hito-ri ronbun-o happyoshi-ta..
student-NOM conference-at one-CL paper-ACC present-PAST
"One student presented a paper at a conference."

(27) Gakusei-ga gakkai-de san-nin ronbun-o happyoshi-ta.
student-NOM conference-at three-CL paper-ACC present-PAST
"Three students presented a paper at a conference." (distributive ok, collective*)

(28) Gakusei-ga gakkai-de hito-kumi ronbun-o happyoshi-ta.
student- NOM conference-at one-CL paper-ACC present-PAST
"One group of students presented a paper at a conference."

(29) Gakusei-ga gakkai-de san-kumi ronbun-o happyoshi-ta.
student- NOM conference-at three-CL paper-ACC present-PAST
"Three groups of students presented a paper at a conference." (distributive ok, collective*)

(30) *Gakusei-ga gakkai-de hito-ri icchidanketsushi-ta.
student-NOM conference-at one-CL unite-PAST
"One student united at a conference."

(31) Gakusei-ga gakkai-de san-nin icchidanketsushi -ta.
student-NOM conference-at three-CL unite-PAST
"Three students united at a conference." (*distributive, collective ok)

(32) Gakusei-ga gakkai-de hito-kumi icchidanketsushi-ta.
student-NOM conference-at one-CL unite-PAST
"One group of students united at a conference."

(33) Gakusei-ga gakkai-de san-kumi icchidanketsushi-ta.
student- NOM conference-at three-CL unite-PAST
"Three groups of students presented a paper at a conference." (distributive ok, collective ok)

In (28) and (29), a mixed predicate *ronbun-o happyosuru* "present a paper" composes with a FQ to denote a set of group atoms. If the numeral associated with the classifier is one, we can have the sentence in (28). If the numeral is two or more, as shown in (29), the JFQC with a mixed predicate has only a distributive reading, and not a collective reading.

We continue on now to collective predicates. As shown in (30) and (31), when a collective predicate composes with a classifier to denote a set of individual atoms, the numeral associated with the classifier cannot be one; it must be two or more. As shown in (31), when the numeral is two or more, the JFQC has only a collective reading.

On the other hand, as shown in (32), when a collective predicate composes with a classifier to denote a set of groups, the numeral associated with the classifier can be one, like a mixed predicate. Furthermore, as shown in (33), when the numeral associated with the classifier is two or more, the JFQC can have both a distributive reading and a collective reading. This is a sharp contrast with the mixed-predicate JFQC as in (29). When a mixed predicate or a collective predicate composes with a classifier to denote a set of groups, the numeral associated with the classifier can be one. However, as shown in (29) and (33), when the numeral associated with the classifier is two or more, the mixed-predicate JFQC has only a distributive reading, whereas the collective-predicate JFQC can have both a distributive reading and a collective reading.

3.3 Problem

This section discusses how the clear contrast between the mixed-predicate JFQC and the collective JFQC, discussed in Section 3.2, poses a problem for Link 1983 and Landman 1989. As discussed above, when the numeral associated with the classifier to denote a set of groups is two or more, the mixed-predicate JFQC has only a distributive reading, whereas the collective-predicate JFQC can have both a distributive reading and a collective reading.

Link (1983) assumes that the mixed predicate is lexically a collective predicate. Therefore, Link's analysis incorrectly predicts that there is no difference in the interpretations of FQs between the collective-predicate JFQC in (33) and the mixed-predicate JFQC in (29) with regard to a collective reading. A collective reading of a mixed predicate sentence is obtained when the mixed predicate directly takes a plural individual in its extension, in the same manner as the collective predicate.

Under Landman's (1989) analysis, a mixed predicate is ambiguous between a collective predicate and a distributive predicate. Therefore, it also incorrectly predicts that there is no difference in the interpretations of FQs between the collective-predicate JFQC in (33) and the mixed-predicate JFQC in (29). As a collective predicate is predicated of an atomic group and has a collective reading, a mixed predicate should also be able to be predicated of an atomic group and to have a collective reading.

In sum, under both analyses, a collective predicate is a subset of a mixed predicate in its meaning. Thus, the interpretation allowed in a collective predicate JFQC should also be allowed in a mixed-predicate JFQC.

4 Alternative Analysis

In this paper, adopting Winter's (2002) analysis, I argue that mixed predicates are atom predicates which range over atomic individuals, whereas collective predicates are set predicates which range over sets, at least in Japanese. Thus, the denotations of mixed predicates are lexically different from those of collective predicates in my proposal. This difference in lexical meaning leads to the sharp contrast between a collective predicate JFQC and a mixed-predicate JFQC. Before discussing my analysis, I first introduce Winter's analysis of atom and set predicates.

4.1 Winter 2002

Winter (2002) proposed a new typology of predicates, based on Vendler's (1967) and Dowty's (1986) observations.

4.1.1 Atom Predicates and Set Predicates

The predicates *meet* and *be a good team* are both traditionally classified as collective predicates.

However, these predicates behave differently in sentences in (34) and (35), as noticed by Dowty (1989):

(34) a. All the students met.
b. *Every student met.
(35) a. *All the students are (is) a good team.
b. *Every/each student are (is) a good team.

As shown in (34), the predicate *meet* is acceptable with a plural noun phrase with a quantifier *all*, whereas it is unacceptable with a singular noun phrase with a quantifier *every*. On the other hand, as shown in (35), the predicate *be a good team* is unacceptable with both a plural noun phrase with a quantifier *all* and a singular noun phrase with a quantifier *every*. As shown in (36) and (37), the same distinction can be observed between other plural quantifiers such as *all*, *no*, *at least*, and *many* and other singular quantifiers such as *every*, *no*, *more than one*, and *many a*.

(36) all the/no/at least two/many students PRED
(37) every/no/more than one/many a student PRED

Winter (2002) proposes that predicates which behave in the same manner as *meet* with regard to (36) and (37) are set predicates. On the other hand, predicates which behave like *a good team* with regard to (36) and (37) are atom predicates.

Under Winter's analysis, as shown in (38) and (39), atom predicates such as *smile* denote sets of atoms in their uninflected form, whereas set predicates such as *meet* denote sets of plural entities, i.e., sets consisting of singular entities in their uninflected form.

(38) Atom predicates
smile' = {m', j', s'}
(39) Set predicates
meet' = {{m', j', s'}, {c_A, c_B}, {c_C}}

In (38) and (39), m', j', and s' represent individuals such as Mary, John, and Suzy. c_A, c_B, and c_C represent "group atoms" such as committees A, B, and C. For example, in the case of the atom predicate *smile'* in (38), Mary, John, and Sue each smile. In the case of the set predicate *meet'* in (39), there are three meetings, one meeting of Mary, John, and Sue, one joint meeting of committees c_A and c_B, and one meeting of a committee c_C.

4.2 My Analysis

Adopting Winter's analysis, I argue that, in Japanese, the mixed predicate is an atom predicate, whereas the collective predicate is a set predicate. Under this analysis, the mixed predicate such as *ronbun-o happyosuru* "present a paper" and the collective predicate such as *icchidanketsusuru* "unite" have the semantic denotations in (40) and (41):

(40) Atom predicates
present a paper' = {m', j', c'_A, c'_B}
(41) Set predicates
unite' = {{m', j', s'}, {c_A, c_B}, {c_C}}
[m', j', and s' represent "real individuals" such as Mary, John, and Suzy. c_A, c_B, and c_C represent "group atoms".]

In the JFQC, as discussed in Section 3.2, both a "mixed" predicate and a "collective" predicate can take as their arguments an NP associated with a classifier to denote a set of groups. However, as shown in (42) and (43), the mixed-predicate JFQC does not allow a collective reading, whereas the collective-predicate JFQC does.

A mixed-predicate JFQC — a distributive reading, but not a collective reading

(42)	Gakusei-ga	gakkai-de	san-kumi	ronbun-o	happyoshi-ta.
	student-NOM	conference-at	three-CL	paper-ACC	present-PAST

"Three groups of students presented a paper at a conference." (distributive ok, collective*)

A collective-predicate JFQC

(43)	Gakusei-ga	gakkai-de	san-kumi	icchidanketsushi-ta.
	student-NOM	conference-at	three-CL	unite-PAST

"Three groups of students united at a conference." (distributive ok, collective ok)

In my analysis, I account for the absence of a collective reading in the mixed-predicate JFQC with the classifier -*kumi*, following Kobuchi-Philip's analysis of the absence of a collective reading in the mixed-predicate JFQC.

First, as for a distributive reading of the mixed-predicate JFQC with the classifier -*kumi*, such as (42), a mixed predicate is an atom predicate, which denotes a set of group atoms. Furthermore, as shown in (44), when the classifier -*kumi* composes with a "mixed" predicate, it is assumed to denote a set of group atoms, following Kobuchi-Philip's 2003 analysis.

(44) $\lambda u \exists v[\text{kumi'}(v) \& u \bullet \prod v]$
($u \bullet \prod v$ functions to take only the singletons from the denotation of -*kumi*')

When an atom predicate such as *present a paper* is combined with the classifier -*kumi*, we have the denotation in (45) for the mixed predicate JFQC in (42).

(45) $\exists y[\text{student'}(y) \wedge \exists K[K \subseteq (\lambda u \exists v[\text{kumi'}(v) \& u \bullet \prod v] \cap \text{present a paper'}) \wedge |K| = 3 \wedge K = y]]$

Because of the atomicity of the classifier denotation $\lambda u \exists v[kumi'(v) \& u \bullet \prod v]$ and the denotation of the atom predicate *present a paper*', in (45), each atom in K has the properties denoted by *kumi*' "group" and by *present a paper*'. This leads to a distributive reading.

As for the absence of a collective reading, the mixed predicate is an atom predicate. It has an atomic individual as an element. Therefore, the mixed predicate cannot have a collective reading just by applying to a set. The only possibility for a mixed predicate to have a collective reading is if, after a set of groups is mapped to a group atom, the mixed predicate applies to the group atom. However, the numeral quantifier cannot look inside the group atom and count the number of the members (groups) inside the group. Therefore, the JFQC with a classifier -*kumi* cannot have a collective reading.

We now turn to the collective-predicate JFQC, given in (43). When a "collective" predicate, which is a set predicate, composes with a quantifier to denote a set of sets of atoms, i.e., -*kumi*, it can have both a distributive reading and a collective reading.

In the case of a distributive reading, the JFQC in (43) has the semantic interpretation in (46):

(46) $\exists y[\text{student'}(y) \wedge \exists K[K \subseteq \lambda v[\text{kumi'}(v)] \cap \text{unite'}] \wedge |K| = 3 \wedge K = y]$

The collective verb *icchidanketsus* "unite" is a set predicate, which denotes a set of sets (of atoms). Furthermore, the classifier -*kumi* is also assumed to be a set predicate when it composes with another set predicate. Thus, in (46), K ranges over sets of sets, which have the properties *group'* and *unite'*. Furthermore, each set in the set has the properties *group'* and *unite'*. This leads to a distributive reading.

In the case of a collective reading, I adopt Hosoi's (2009) analysis of the absence of a distributive reading in the collective-predicate JFQC. In this case, the set predicate *unite'* is assumed to have the denotation given in (47):

(47) unite' = $\{\{\{m', j', s'\}, \{b', d'\}, \{f', g'\}\}, \{\{k', t'\}\}\}$
(48) the classifier *kumi'* $\lambda v[\text{kumi'}(v)]$ — $<<e,t>, t>$

As shown in (47), the set predicate lexically has a set of sets of sets (of atoms) in its denotation, which is of type <<<e,t>,t>,t>. On the other hand, as shown in (48), the classifier *kumi'* is of type <<e,t>, t>. So, they cannot compose with each other because of a type mismatch. Therefore, as shown in (49), a type fitting rule applies to the denotation of the classifier –*kumi* and changes the basic type of -*kumi*, i.e., type <<e,t>,t> to type <<<e,t>,t>,t>.

(49) the classifier *kumi'* <<e,t>, t> □ <<<e,t>,t>,t> $\lambda B[B \subseteq \lambda v[\text{kumi'}(v)]]$
(50) $\exists y\, [\text{student'}(y) \wedge \exists K[K \in [\lambda B[B \subseteq \lambda v[\text{kumi'}(v)]] \cap \text{unite'}] \wedge |K| = 3 \wedge K = y]$

As shown in (49), this shifted interpretation of -*kumi*, i.e., $\lambda B[B \subseteq \lambda v[kumi'(v)]]$ can be composed with the set predicate *unite'*. The complex predicate, which is of type <<<e,t>,t>,t>, denotes a set of sets of sets, and those sets of sets have a property of being a group and a property of uniting. Thus, *K* in (50) is a set of sets, which has a property of being a group and a property of uniting, such as (51):

(51) K = {{m', j', s'}, {b', d'}, {f', g'}} □ unite' ({{m', j', s'}, {b', d'}, {f', g'}})

This leads to a collective reading.

4.3 The Source of the Difference between Mixed-predicate and Collective-predicate JFQCs

As discussed above, when a verb composes with a classifier to denote a set of sets in the JFQC, a mixed predicate, which is an atom predicate, can have only a distributive reading, whereas a collective predicate, which is a set predicate, can have both a distributive reading and a collective reading. In my analysis, this difference can be reduced to the properties of an atom predicate and a set predicate.

A mixed predicate has a set of atoms in its lexical (uninflected) meaning. In other words, it has atoms as its elements. Thus, as shown in (52), it cannot have a set (of group atoms) as its element, which leads to the absence of a collective reading.

As discussed in Section 4.2, the only possibility for a mixed predicate as an atom predicate to have a collective reading is that, as shown in (53), after a set of groups is mapped to a group atom by a group-forming operator ↑, the mixed predicate applies to the group atom. However, the numeral quantifier cannot look inside the group atom and count the number of the members (groups) of the group, as shown in (54). Therefore, the JFQC with a classifier -*kumi* cannot have a collective reading, as shown in (42).

(52) {↑{m', j'}, ↑{k', l', t'}} □ NOT *make a presentation*' (↑{m', j'}, ↑{k', l', t'})
(53) {↑{↑{m', j'}, ↑{k', l', t'}}} □ *make a presentation*' (↑{↑{m', j'}, ↑{k', l', t'}})
(54) |{↑{↑{m', j'}, ↑{k', l', t'}}}| =1 not 2, though 2 is an expected number.

Thus, a "mixed-predicate" JFQC cannot have a collective reading.

On the other hand, a set predicate denotes a set of sets in its lexical meaning. Thus, as shown in (55) and (56), a set predicate can have a set of atoms or a set of sets of atoms as its element.

(55) {{m', j', s'}, {b', d'}, {f', g'}, {k', t'}}
□ unite'({m', j', s'}), unite({b', d'}), unite({f', g'}), unite({k', t'})
(56) {{{m', j', s'}, {b', d'}, {f', g'}}} □ unite' ({{m', j', s'}, {b', d'}, {f', g'}})
(57) |{{m', j', s'}, {b', d'}, {f', g'}}| = 3

In (55), a set predicate can apply distributively to each member (i.e., each set) of a set. This yields a distributive reading. In (56), a set predicate can apply collectively to a set of sets. The numeral quantifier can also count the number of sets inside the set, as shown in (57). This yields a collective reading. Thus, the collective-predicate JFQC can have both a distributive reading and a collective reading

.

5 Conclusion

In this paper, adopting Winter's (2002) analysis of set and atom predicates, I argue that, at least in Japanese, the mixed predicate is an atom predicate, whereas the collective predicate is a set predicate. Under this analysis, there is no overlap in lexical meaning between a mixed predicate and a collective predicate.

My analysis can account for the clear-cut contrast between the mixed-predicate JFQC and the collective-predicate JFQC, which is problematic for Link 1983 and Landman 1989. When a verb composes with a classifier to denote a set of sets in the JFQC, a mixed predicate, which is an atom predicate, can have only a distributive reading. On the other hand, a collective predicate, which is a set predicate, can have both a distributive reading and a collective reading. In my analysis, this difference can be reduced to the properties of an atom predicate and a set predicate.

My analysis of the sharp contrast between the mixed-predicate JFQC and the collective-predicate JFQC can also be connected to the count/mass distinction in classifier languages, discussed by Muromatsu (2003). I need to conduct further research on this issue.

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