

“Mixed” Predicates as Atom Predicates

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1. Introduction

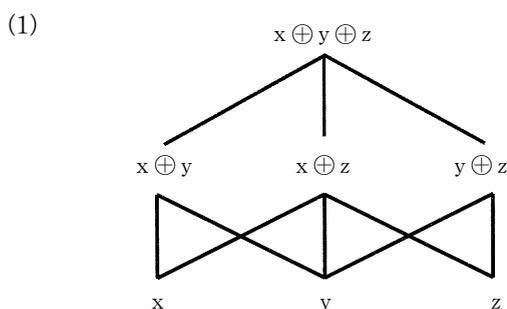
In this paper, I examine the traditional distinction among distributive predicates, mixed predicates, and collective predicates, particularly focusing on mixed predicates and collective predicates. Under the traditional three way distinction of predicates, a mixed predicate can be both a collective predicate and a distributive predicate, because a plural noun in a mixed –predicate sentence is ambiguous between a distributive reading and a collective reading. In this paper, I argue that mixed predicates are atomic predicates, whereas collective predicates are set predicates in Japanese, adopting Winter’s (2002) analysis of set/atom predicates. 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.

2.1. Link (1983)

In Link’s (1983) theory, he uses a lattice partially ordered by a *part of* relation for the domain of singular and plural individuals. The lattice is also ordered by an operation of sum formation, as illustrated in (1).¹



In the figure in (1), x , y , and z at the bottom are singular individuals, which are atomic. \oplus is an individual sum operator. The lines indicate the “part-of” relation. Furthermore, a plural individual such as $x \oplus y$ is the sum of two individuals such as x and y . Thus, in (1), the

1 In fact, Link (1983) proposes this lattice approach to capture a similarity between plural nouns and mass nouns, which is not observed in singular nouns, namely, cumulativity.

denotation of a singular noun such as *book* is a set of singular individuals $\{x, y, z\}$. The denotation of a plural noun such as *books* is a set of non-atomic individuals, such as $\{x \oplus y, x \oplus z, y \oplus z, x \oplus y \oplus z\}$.

In this analysis, there are two types of lexical predicates: the singular predicate and the plural predicate. The former, such as *doctor*, denotes a set of singular individuals. The latter, such as *gather*, denotes a set of plural individuals.

In the literature on plurality, a distinction is traditionally made among *distributive* predicates, *collective* predicates, and *mixed* predicates. These three types of predicates can be expressed as follows, based on Link's analysis.

Distributive predicates are derived from pluralizations of singular verbs. The pluralization operation $*$ works on one-place predicate P , and it generates all the individual sums of members of the extensions of P , as illustrated in (2).

$$(2) \quad [*P] = \{y \in A : \exists X \subseteq [P] y = +X\}$$

Thus, $*P$ denotes the set of all the individual sums of atomic individual in P .

When this pluralized predicate $*P$ is predicated of a sum of individuals, each individual of the sum has a property P . As mentioned above, $*P$ is derived from a pluralization of a singular verb P . $*$ generates all the individual sums of members of the extensions of P . Thus, the property P of each member is inherited on their sums, as illustrated in (3) and (4).

(3) John is a pop star and Paul is a pop star if John and Paul are pop stars.

(4) pop-star' (j) \wedge pop-star' (p) \rightarrow pop-star' (j \oplus p)

Looking at this "cumulativity" the other way round, if the sum of individuals is in the extension of $*P$, each individual of the sum is also in the extension of P . This leads to a distributive reading.

Collective predicates such as *gather* and *meet* directly take plural individuals (or individual sums) in their extension. The property denoted by a collective predicate holds of a whole plural individual but not each element of the plural individual, as shown in (5).

(5) meet' (j \oplus p) \rightarrow meet' (j) [not a valid inference]

Mixed predicate such as *carry a piano upstairs* are ambiguous between a distributive reading and a collective reading. The distributive reading is obtained when the D-operator applies to a mixed predicate. The D-operator is defined as follows:

$$(6) \quad \lambda x. \forall y [y \leq x \wedge AT(y) \rightarrow P(y)]$$

(7) John and Paul carried a piano upstairs.

$$(8) \quad \forall y [y \leq j \oplus p \wedge AT(y) \rightarrow \textit{carry a piano upstairs}' (y)]$$

Under the above definition of the D-operator, the sentence in (7) has the interpretation in (8).

The collective reading of a mixed predicate sentence is obtained when the mixed predicate directly takes plural individuals in their extension, in the same manner as the collective predicate does.

2.2. Landman (1989)

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

- (9) i . All basic predicates of LP (the language of plurality) denote sets of atoms only.
- ii. Basic predicates never take sums in their extension.

Under this analysis, singular predicates such as *be a pop star* denote sets of singular individuals only. Collective predicates such as *meet* take groups but not singular individuals in their extension. Thus, there is a distinction between singular individual-atom predicates and group-atom predicates. Mixed predicates such as *carry a piano upstairs* take both individual atoms and group atoms in their extension.

Distributive readings are created by pluralization of basic predicates. The pluralization operation $*$, as Link (1983) discusses, denotes the closure of P under sums. In Landman’s theory, the basic predicate P takes only atoms in its extension. Therefore, $*P$ is always distributive, as illustrated in (10)-(13).

- (10) David is a pop star and Tina is a pop star.
- (11) pop star’ (d) \wedge pop star’ (t)
- (12) David and Tina are pop stars.
- (13) *pop star (d \oplus t)

Collective readings are obtained if collective predicates apply to group atoms, as illustrated in (15).

- (14) The boys met. (collective reading)
- (15) meet’ (\uparrow (σx . *boy’ (x)))

The group-forming operation \uparrow maps a sum σx . *boy’(x) onto an atomic group. The collective (basic) predicate applies to this atomic group and yields a collective reading.

Mixed predicates such as *carry a piano upstairs* are ambiguous between a distributive reading and a collective reading. 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. If a mixed predicate is predicated of an atomic group, we have a collective reading. This is shown in (17) and (18).

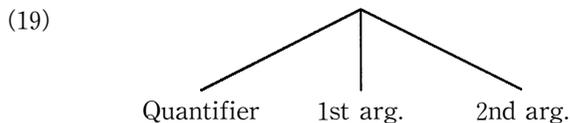
- (16) The boys carry a piano upstairs.
 (17) *carry' (σx . *boy' (x)) -- distributive reading
 (18) carry' ($\uparrow(\sigma x$. *boy' (x)) -- collective reading

3. Problem

The above analyses of predicates from a perspective of distributive readings and collective readings of plural NPs, namely, Link (1983) and Landman (1989) face some problems with distributivity and collectivity of the floating quantifier construction in Japanese. In this section, I discuss those problems. Before starting our discussion about problems for each analysis, however, I first discuss Kobuchi-Philip's analysis of the Japanese floating quantifier construction (JFQC), which we assume for our following discussion.

3.1. Kobuchi-Philip (2003)

Kobuchi-Philip (2003) applies the following general scheme for quantification over objects to the JFQC :



1st argument --- Domain of quantification (Restriction)

2nd argument --- Nuclear Scope

Concerning the JFQC, she assumes that the numeral and the classifier are separate and independent semantic entities. The classifier corresponds to the first argument of the above scheme. It is a predicate which denotes a set of only atomic individuals. The verbal predicate corresponds to the second argument. Thus, the three components of the FQC 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 following interpretation for the floating quantifier (FQ) :

$$(20) \quad \lambda P \lambda x \exists K [K \subseteq (C \cap P) \wedge |K| = n \wedge \oplus K = x]$$

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. $|K| \geq n$ means K contains n -many elements.

Under Kobuchi-Philip's analysis, the interpretation in (22) is assigned to the distributive JFQC in (21).

- (21) Gakusei-ga san-nin hashitta.
 student-NOM 3-CL ran
 “Three students ran.” (Kobuchi-Philip 2003)
- (22) $\exists y[\text{gakusei}'(y) \ \& \ \exists K[K \subseteq (\lambda u \exists v[\text{nin}'(v) \ \& \ u \cdot \Pi v] \cap \text{hashitta}') \ \& \ |K| \geq 3 \ \& \ \oplus K = y]]$

The predicate *hashitta'* “*ran*” denotes a set of individuals. Furthermore, the classifier *-nin* quantifies over atomic individuals as illustrated by $\lambda u \exists v[\text{nin}'(v) \ \& \ u \cdot \Pi v]$ in (22). The symbol $\cdot \Pi$ is an atomic individual-part operator, as discussed by Link (1983). Therefore, the intersection of the sets denoted by *ran* and by *-nin* consists of atomic individuals which have the property *ran'*. Thus, the property *ran'* must hold of each member, i.e., each individual atom of set K. This yields a distributive interpretation in the sentence in (21).

3.2. Data

Under Kobuchi-Philip’s (2003) analysis of the JFQC, Link’s (1983) analysis and Landman’s (1989) analysis face problems with distributive and collective readings of some JFQC constructions. In this section, we discuss those data.

The so-called “mixed-predicate” such as *ronbun-o happyosuru* “present a paper” can take a subject NP with a prenominal classifier to denote a set of atomic individuals as its argument. This prenominal numeral quantifier construction is henceforth referred to as the PNQC. If the numeral associated with the classifier is one, we can have a sentence shown in (23). This example shows that the mixed predicate *ronbun-o happyosuru* “present a paper” can take an individual atom as its argument. If the numeral associated with the classifier is two or above, we can have a distributive reading and a collective reading, as shown in (24).

- (23) Hito-ri-no gakusei-ga ronbun-o happyoshi-ta.
 one-CL-GEN student-NOM paper-ACC present-PAST
 “One student presented a paper.”
- (24) San-nin-no gakusei-ga ronbun-o happyoshi-ta.
 three-CL-GEN student-NOM paper-ACC present-PAST
 “Three students presented a paper.” (distributive ok, collective ok)
- (25) Hito-kumi-no gakusei-ga ronbun-o happyoshi-ta.
 one-CL-GEN student-NOM paper-ACC present-PAST
 “One group of students presented a paper.”
- (26) San-kumi-no gakusei-ga ronbun-o happyoshi-ta.
 three-CL-GEN student-NOM paper-ACC present-PAST
 “Three groups of students presented a paper.” (distributive ok, collective ok)
- (27) *Hito-ri-no gakusei-ga icchidanketsushi-ta.
 one-CL-GEN student-NOM unite-PAST
 “One student united.”
- (28) San-nin-no gakusei-ga icchidanketsushi-ta.
 three-CL-GEN student-NOM unite-PAST
 “Three students presented a paper.” (*distributive, collective ok)

- (29) Hito-kumi-no gakusei-ga icchidanketsushi-ta.
 one- CL-GEN student-NOM unite-PAST
 “One group of students united.”
- (30) San-kumi-no gakusei-ga icchidanketsushi-ta.
 three-CL-GEN student-NOM unite-PAST
 “Three groups of students united.” (distributive ok, collective ok)

The mixed predicate can also take a subject NP with a prenominal classifier to denote a set of groups as its argument. If the numeral associated with the classifier is one, then we can have a sentence shown in (25). This example shows that *ronbun-o happyosuru* “present a paper” can take a group as its argument. If the numeral is two or above, then we can have both a distributive reading and a collective reading, as shown in (26).

The collective predicate such as *icchidanketsusuru* “unite” cannot take a singular NP with a prenominal classifier to denote a set of individual atoms as its argument, as shown in (27). When the numeral is two or above, then we can have only a collective reading, as shown in (28). A collective predicate can also take a singular NP with a classifier to denote a set of groups as its argument, as shown in (29). When the numeral is two or above, we can have both a distributive reading and a collective reading, as shown in (30). Therefore, when a collective verb such as *icchidanketsusuru* “unite” takes a group as its argument, it behaves like a mixed predicate concerning the interpretation of the numeral quantifier.

We now turn to the JFQC. As discussed in the literature (Nakanishi 2003, 2006 ; Kobuchi-Philip 2003 among others), the JFQC with a mixed predicate has only a distributive reading, and not a collective reading. This is shown in the example in (32).

- (31) 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.”
- (32) 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*)
- (33) 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.”
- (34) 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*)
- (35) *Gakusei-ga gakkai-de hito-ri icchidanketsushi-ta.
 student-NOM conference-at one-CL unite-PAST
 “One student united at a conference.”
- (36) 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)
- (37) Gakusei-ga gakkai-de hito-kumi icchidanketsushi-ta.
 student-NOM conference-at one-CL unite-PAST
 “One group of students united at a conference.”
- (38) 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 (32), where a mixed predicate *ronbun-o happyosuru* “present a paper” composes with a FQ to denote a set of individual atoms, the sentence has only a distributive reading. In the same manner, when the mixed predicate composes with a FQ to denote a set of groups, the sentence also has only a distributive reading, as shown in (34).

We now move on to a discussion on a collective predicate. Like the PNQC, when a collective predicate composes with a classifier to denote a set of individual atoms, the numeral associated with the classifier cannot be one, but must be two or above, as shown in (35) and (36). When the numeral is two or above, the JFQC has only a collective reading, as shown in (36). However, when a collective predicate composes with a classifier to denote a set of groups, the numeral associated with the classifier can be one, as shown in (37). Furthermore, when the numeral associated with the classifier is two or above, the JFQC can have both a distributive reading and a collective reading, as shown in (38). This is a sharp contrast with a mixed-predicate JFQC in (34). Even though both a “mixed” predicate and a “collective” predicate can take an NP associated with a classifier to denote a set of groups as their arguments, the former does not allow a collective reading in the JFQC, whereas the latter does. The following table summarizes the observation discussed in this section.

(39)

	Classifier to denote a set of individuals		Classifier to denote a set of groups	
	Mixed predicate	Collective Predicate	Mixed Predicate	Collective Predicate
PNQC	distributive, collective	collective	distributive, collective	distributive, collective
JFQC	distributive	collective	distributive	distributive, collective

3.3. Problem

As discussed in section 3.2., when a mixed predicate such as *ronbun-o happyosuru* “present a paper” takes an NP with a prenominal numeral quantifier to denote a set of groups as its argument, the PNQC has both a distributive reading and a collective reading. Furthermore, when a mixed predicate composes with a FQ to denote a set of groups, the sentence has only a distributive reading. This follows the observation discussed in the traditional literature on JFQC.

A collective predicate such as *icchidanketsusuru* “unite” can also take a singular NP with

a prenominal numeral quantifier to denote a set of groups as its argument, as shown in (29). Furthermore, the PNQC has both a distributive reading and a collective reading, as shown in (30). This is exactly like a mixed-predicate construction. However, in contrast with a mixed-predicate JFQC, when a collective predicate composes with a FQ to denote a set of groups in the JFQC, the sentence has both a distributive reading and a collective reading, as shown in (38).

Link (1983) assumes that the mixed predicate is lexically a collective predicate. 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 does. A distributive reading is obtained when the D-operator applies to a mixed predicate, as discussed in section 2.1. Then, under Kobuchi-Philip's analysis of the JFQC, Link's analysis faces a problem with the data discussed in (34) and (38).

As discussed in section 3.2., a collective predicate is like a mixed predicate when it takes a group as its argument. It can take a singular NP with a classifier to denote a set of groups as its argument, as shown in (29). Furthermore, it can have both a distributive reading and a collective reading, as shown in (30). If the "collective" predicate is a mixed predicate in this case, Link's analysis incorrectly predicts that there is no difference in the interpretations of FQs between the collective-predicate JFQC in (38) and the mixed-predicate sentence JFQC in (34), since the "collective" predicate is in fact a mixed predicate.

One possibility to solve this problem is that a collective reading of the collective-predicate JFQC with a classifier to denote a set of groups is allowed because the collective predicate can also be a plural predicate. In (36), *icchidanketsusuru* "unite" as a mixed predicate allows only a distributive reading. However, the verb as a plural predicate can compose with the classifier *-kumi* which denotes a set of plural groups (or sums of groups) in some manner. As a result, the complex predicate is a plural (or collective) predicate which applies to a sum of groups. This leads to a collective reading in (38). However, a serious problem is that, under Link's analysis, a mixed predicate is lexically a collective (or plural) predicate. Then, the above potential solution should also be available to the mixed-predicate. This enables a mixed-predicate JFQC to allow a collective reading.

Under Landman's analysis (1989), the mixed predicate denotes a set of individual atoms or a set of group atoms. Under Kobuchi-Philip's (2003) analysis of the JFQC, when a mixed predicate composes with a classifier to denote a set of group atoms in the JFQC as shown in (34), the complex predicate consisting of the classifier and the mixed predicate is pluralized. In this case, a group atom which has the properties denoted by *-kumi* and by *icchidanketsusuru* "unite" is pluralized. This leads to a distributive reading and the absence of a collective reading of the JFQC.

As discussed in section 3.2., a collective predicate can take a singular NP with a prenominal numeral quantifier to denote a set of group atoms as its argument. When a collective predicate composes with a classifier to denote a set of group atoms in the JFQC as shown in (38), the complex predicate consisting of the classifier and the collective predicate is pluralized. However, this analysis incorrectly predicts that the complex predicate leads to the absence of a collective reading in the same manner as the complex predicate consisting of the classifier to

denote a set of group atoms and the mixed predicate.

A potential solution to this problem would be to make an instrument such that, if a collective predicate can compose with a classifier to denote a set of group atoms in the JFQC, it can also compose with a classifier to denote a set of groups of group atoms. In this case, the collective predicate with the classifier can denote a set of groups of group atoms. This can yield a collective reading, since the complex predicate consisting of the collective predicate and the classifier applies to a group of group atoms and a property denoted by the collective predicate holds of a group of group atoms. However, under Landman’s analysis, this still has a problem. Under his analysis, a collective reading is obtained if a collective predicate applies to a group atom. Given that, a collective predicate cannot apply to a group of group atoms, which are not atomic. Furthermore, if a group of group atoms are mapped onto a group atom by the group-forming operation \uparrow , then this analysis cannot tell a set of group atoms from a set of groups of group atoms, since it cannot look into the inside of an atomic group. Moreover, even if we can have a solution along this line, a serious problem still remains. The solution also enables a mixed predicate to yield a collective reading, because, in Landman’s theory, a mixed predicate can be both a distributive predicate and a collective predicate. Therefore, any instrument available to a distributive predicate or a collective predicate can also be available to a mixed predicate.

4. Alternative Analysis

A problem of Link’s (1983) analysis and Landman’s (1989) analysis is that both analyses assume that a mixed predicate can be lexically a collective predicate. Under Link’s (1983) analysis, a mixed predicate is lexically a collective predicate. Under Landman’s (1989) analysis, a group predicate is ambiguous between a collective predicate and a distributive predicate. As long as a collective predicate is a subset of a mixed predicate in its lexical meaning, the interpretation of the JFQC with a mixed predicate should include that of the JFQC with a collective predicate. Thus, any instrument to solve a problem of the collective JFQC should also apply to the mixed-predicate JFQC.

In this paper, I argue that, adopting Winter’s (2002) analysis, mixed predicates such as *ronbun-o happyosuru* “present a paper” and *piano-o mochiageru* “life a piano” are atom predicates, which range over atomic individuals, whereas collective predicates such as *icchidan- ketetsu* “unite” and *atsumaru* “gather” are set predicates which range over sets. Thus, the denotations of mixed predicates are lexically different from those of collective predicates in my proposal. Before discussing my analysis, I first introduce Winter’s analysis of atom and set predicates, on which my analysis is based.

4.1. Winter (2002)

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

4.1.1. Atom Predicates and Set Predicates

Predicates *meet* and *be a good team* are both traditionally classified as collective predicates. However, those predicates behave differently in sentences in (40) and (41), as noticed by Dowty (1986) :

- (40) a. All the students met.
 b. *Every student met.
- (41) a. *All the students are (is) a good team.
 b. *Every/each student are (is) a good team.

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*, as illustrated in (40). On the other hand, 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 (41). 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*.

Based on the distinction discussed above, Winter (2002) proposes a new typology of predicates. He classifies predicates into two types of predicates, *atom predicates* and *set predicates*, according to its behavior in sentences such as (42) and (43).

- (42) all the/no/at least two/many students PRED
 (43) every/no/more than one/many a student PRED

PRED is an atom predicate if the sentences in (42) and the corresponding sentences in (43) are equally acceptable and, if acceptable, are furthermore semantically equivalent. PRED is a set predicate if the sentences in (42) and (43) differ in either acceptability or truth-condition.

Under this analysis, distributive predicates such as *smile* or *sleep* are atom predicates, as shown in (44) and (45).

- (44) Every/no student smiled/slept.
 (45) All the/no students smiled/slept.

The sentences in (44) and (45) are both acceptable and, furthermore, are semantically equivalent to each other. In both (44) and (45), the property of the predicate *smile* or *sleep* holds of individual students, but not of a group of students.

Furthermore, under this analysis, the traditional collective predicates *be a good team* and *meet* belong to a different group. For example, the predicate *be a good team* is an atom predicate, because the sentences in (46) and (47) are both acceptable and are semantically equivalent to each other :

- (46) All the committees are good teams.
 (47) Every committee is a good team.

On the other hand, the predicate *meet* is a set predicate, because the sentence in (48) is not semantically equivalent to the sentence in (49), even though they are both acceptable:

- (48) All the committees met in the hall.
 (49) Every committee met in the hall.

The sentence in (49) is acceptable only in a situation where there were separate meetings of the committees. On the other hand, the sentence in (48) also allows a situation where there was a joint meeting, in contrast to (49).

Under Winter’s (2002) analysis, 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 singular entities, in their uninflected form, as illustrated in (50) and (51).

- (50) Atom predicates
 $\text{smile}' = \{m', j', s'\}, \text{committee}' = \{c_A, c_B, c_C\}$
 (51) Set predicates
 $\text{meet}' = \{\{m', j', s'\}, \{c_A, c_B\}, \{c_C\}\}$

$m', j',$ and s' represent “real individuals” such as Mary, John, and Suzy. $c_A, c_B,$ and c_C represent “group atoms”. In the case of the atom predicate *smile'* in (50), Mary, John, and Sue each smiles. In the case of the set predicate *meet'* in (51), 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 the mixed-predicate in Japanese 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 following semantic denotations:

- (52) Atom predicates
 $\text{present a paper}' = \{m', j', c'_A, c'_B\}$
 (53) Set predicates
 $\text{unite}' = \{\{m', j', s'\}, \{c_A, c_B\}, \{c_C\}\}$

$m', j',$ and s' represent “real individuals” such as Mary, John, and Suzy. $c_A, c_B,$ and c_C represent “group atoms”.

Furthermore, along the above line of a set predicate, I assume that the classifier *-kumi* is a classifier to denote a set of sets of atoms. This classifier ranges over sets.

As for the absence of a collective reading in the mixed-predicate JFQC with a classifier to denote a set of individual atoms or a set of sets of individual atoms, shown in (32) and (34), I argue that Kobuchi-Philip’s analysis of the absence of a collective reading in the mixed

-predicate JFQC basically applies to these cases.

Under Kobuchi-Philip's analysis of the JFQC, when a "mixed predicate", which is an atom predicate, is combined with a classifier to denote a set of individual atoms, the complex predicates still denote a set of individual atoms. For example, when an atom predicate *present a paper* is combined with a classifier to denote a set of individual atoms, i.e., *-nin*, we have the denotation in (54) for the complex predicate JFQC.

$$(54) \quad \exists y[\text{student}'(y) \ \& \ \exists K[K \subseteq (\lambda u \exists v[\text{nin}'(v) \ \& \ u^* \Pi v] \cap \text{present a paper}') \wedge |K| \geq 3 \wedge \oplus K = y]]$$

$$(55) \quad \exists y[\text{student}'(y) \ \wedge \ \exists K[K \subseteq (\lambda v[\text{kumi}'(v)] \cap \text{unite}') \wedge |K| = 3 \wedge K = y]]$$

Because of the atomicity of the classifier denotation and the atom predicate, the semantic denotation in (54) allow only a distributive reading.

In the case of a classifier to denote a set of sets of atoms, the classifier, i.e., *-kumi* restricts the domains of quantifications to sets of sets of atoms. Thus, in (55), *K* ranges over sets of sets (of atoms) which have the properties *group'* and *unite'*. In other words, each set in the set has the properties *group'* and *unite'*. This leads to a distributive reading.

Finally, 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 (56) has the semantic interpretation in (57)

(56)	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."			

$$(57) \quad \exists y[\text{student}'(y) \wedge \exists K[K \subseteq (\lambda v[\text{kumi}'(v)] \cap \text{unite}') \wedge |K| = 3 \wedge K = y]]$$

As discussed above, I assume a classifier *-kumi* denotes a set of sets of atoms. This classifier restricts the domain of a quantification to sets of sets of atoms. Thus, in (57), *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 Japanese JFQC. In this case, I assume the set predicate *unite'* is assumed to have a denotation given in (58).

$$(58) \quad \text{unite}' = \{ \{ \{ m', j', s' \}, \{ b', d' \}, \{ f', g' \} \}, \{ \{ k', t' \} \} \}$$

$$(59) \quad \exists y[\text{student}'(y) \wedge \exists K[K \in ([\lambda B[B \subseteq \lambda v[\text{kumi}'(v)]] \cap \text{unite}') \wedge |K| \geq 3]]$$

The set predicate lexically has a set of sets of sets of atoms in its denotation, which is of type $\langle\langle\langle e, t \rangle, t \rangle, t \rangle$. On the other hand, the classifier *kumi'* is of type $\langle\langle e, t \rangle, t \rangle$. They cannot compose with each other as they are, because of a type mismatch. Therefore, a type fitting rule applies to the denotation of the classifier *-kumi*, and changes the basic type of it, i.e., $\langle\langle e,$

$t\rangle, t\rangle$ to a type $\langle\langle\langle e, t\rangle, t\rangle, t\rangle$. This shifted interpretation of *-kumi*, i.e., $\lambda B[B\subseteq\lambda v[kumi'(v)]]$ can be composed with the set predicate *unite'* as shown in (59). The complex predicate denotes a set of sets which has a property of being a group of persons and a property of uniting. This leads to a collective reading.

4.3. Where the difference between mixed-predicate and collective-predicate JFQCs comes from

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 denotes a set of atoms in its lexical (uninflected) meaning, as shown in (60). Therefore, it cannot have a set of atoms as an element, as shown in (61).

$$(60) \quad \{m', j', c'_A, c'_B\}$$

$$(61) \quad *{\{\{m', j'\}, \{k', l', t'\}\}} \rightarrow (62) \quad \{\uparrow\{m', j'\}, \uparrow\{k', l', t'\}\}$$

The only way to have sets as members is to map each set onto an atomic group by the group forming operation, as shown in (62). However, each member of the set in (62) is just an atom. It cannot be an argument of a collective predicate, which is a set predicate under my analysis. 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 (uninflected) meaning. Thus, it can denote a set of sets of atoms or a set of sets of sets of atoms, as shown in (63) and (64). This is because, as discussed by Landman (1989), the process of group formation iterates.

$$(63) \quad \{\{m', j', s'\}, \{b', d'\}, \{f', g'\}, \{k', t'\}\}$$

$$(64) \quad \{\{\{m', j', s'\}, \{b', d'\}, \{f', g'\}\}, \{\{k', t'\}\}\}$$

Thus, a set predicate can apply distributively to each set of atoms which a set has as its element or collectively to a set of sets of atoms. This yields both a distributive reading and a collective reading.

5. Conclusion

In this paper, I discussed Link’s (1983) analysis and Landman’s (1989) analysis, which assume the traditional three way distinction among distributive, mixed, and collective predicates. Their analyses face a problem with distributive readings and collective readings of JFQC constructions with a classifier to denote a set of sets of atoms. In this paper, adopting Winter’s 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 an atom predicate and a set predicate

unlike the three way distinction among distributive, mixed, and collective predicates. My analysis can account for the data problematic for Link's (1983) analysis and Landman's (1989) analysis, under Kobuchi-Philip's analysis of the JFQC.

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