

Japanese *Mo*: Universal, Additive, and NPI

Mana Kobuchi-Philip

UiL-OTS, Utrecht University

m.kobuchi@let.uu.nl

Abstract: This paper discusses four distinct functions of the Japanese particle *mo*, namely, (i) the universal quantificational use of *mo* with an indeterminate; (ii) *mo* within a negative polarity item containing an indeterminate; (iii) *mo* within a negative polarity item functioning as a minimizer; and (iv) additive *mo*. Starting with Shimoyama (2001, 2006) and a significantly modified adaptation of Kobuchi-Philip's (2008a) analysis of universal quantificational *mo*, this paper proposes a unified semantic analysis of all four uses of *mo*. It is argued that *X-mo* is syntactically an adjunct, and that its semantics involves (i) a condition of membership in the denotation of the DP construed with the *mo*-phrase (the Condition of Inclusion in Moltmann 1995), (ii) a condition of membership in the predicate denotation, and (iii) a condition requiring the existence of an additional element with the same properties as the referent of what *mo* syntactically combines with.

Keywords: Universal quantifier, additive, NPI, indeterminate, minimizer

1 Introduction

The Japanese particle *mo* occurs in a various semantic environments. (1) shows that it has at least four distinct uses:

- | | | |
|-----|---|---|
| (1) | a. <i>dono hito -mo hashitta.</i>
which person MO ran
'Everybody ran.' | (universal quantificational <i>mo</i>) |
| | b. <i>dare-mo hashira-na-katta.</i>
who MO run NEG PAST
'Nobody ran.' | (indeterminate NPI <i>mo</i>) |
| | c. <i>hito-ri-mo hashira-na-katta.</i>
1 CL MO run NEG PAST
'Not one person ran.' | (minimizer NPI <i>mo</i>) |
| | d. <i>John-mo hashitta.</i>
John MO ran
'John also ran.' | (additive <i>mo</i>) |

In (1a), *mo* associated with the indeterminate *dono hito* 'which person' has universal quantificational force (e.g. Hagstrom 1998, Kobuchi-Philip 2008a, b, Nishigauchi 1990, Ohno 1989, Shimoyama 2001, 2006, von Stechow 1996, Watanabe 1992). In (1b) it is part of a negative polarity item (NPI) with an indeterminate pronoun (e.g. Aoyagi 1994, Kato 1985, Watanabe 2004). In (1c) *mo* is part of a 'minimizer' NPI (e.g. Watanabe 2004). Finally, (1d) illustrates *mo* as an additive particle (e.g. Shudo 2002).

In the literature these various uses of *mo* are often discussed separately. This is likely to be due to the assumption that they are formally distinct from each other with respect to prosodic, syntactic and semantic or pragmatic properties. *Mo* is a very complicated lexical element. As is often mentioned in the literature (e.g.

Watanabe 2004), the *mo*-phrase in (1b) and (1c) is regularly pronounced with a rising prosodic pattern, rather than a falling prosodic pattern, but this is not the case for (1a) and (1d). Syntactically, *mo* may compose with a phrase of virtually any category.¹ Semantically, all uses of *mo* seem to give rise to quantification, yet the interpretation is apparently not uniform. Pragmatically, the presence of a presupposition with *mo* is not always clear. These diverse properties make the complete picture of *mo* quite intricate and thus, at first blush, it might seem impossible to attain a unified analysis of the four different uses.

On the other hand, we are confronted with the fact that these four sentence types, each with a different meaning, all contain the same element *mo*. Despite the diversity of semantic functions, we must assume that there are some uniform formal properties of *mo* which straightforwardly contribute to the different interpretations that are observed. We pursue this matter in this paper. In order to do so effectively, we will limit ourselves to the simplest types of syntactic construction, namely *mo* associated with a nominal element as in (1), and concentrate on the formal semantics of *mo*, i.e. its quantificational properties yielding truth conditions, and put aside its presuppositional effects. Although the presuppositional aspect of *mo* is quite important to understand the whole picture of *mo*, it is important to start with the formal semantic properties.

2 Universal quantificational *mo*

In this section, we look at two analyses of universal quantificational *mo*, that of Shimoyama (2001, 2006) and that of Kobuchi-Philip (2008a).

2.1 Shimoyama (2001, 2006)

Shimoyama (2001, 2006) offers a semantic analysis of the Japanese indeterminate quantifier construction with *mo* which yields a universal quantificational interpretation, e.g. sentences such as (2):

¹ Aside from the nominal category (NP/DP), *mo* can be associated with quite a few other syntactic categories. Some examples are shown below:

- | | | |
|-------|--|-----------------------|
| (i) | Taro-wa [dare-ga denwashite]-mo deru. | (IP) (Shimoyama 2001) |
| | Taro TOP who NOM phone MO attend | |
| | ‘Taro picks up the phone no matter who calls.’ | |
| (ii) | daihyoosha -ga [nihon-kara]-mo shussekishita. | (PP) |
| | representative NOM Japan from MO attended | |
| | ‘A representative attended also from Japan.’ | |
| (iii) | tashikani [sono kanoosei -ga aru -to] -mo i -eru | (CP) |
| | certainly that possibility NOM exist COMP MO say POSS | |
| | ‘Certainly we can also say that the possibility exists.’ | |
| (iv) | moo [itaku]-mo naku -natta. | (Adjective) |
| | already painful MO disappear became | |
| | ‘It has no longer been hurting, either.’ | |
| (v) | soko-e -wa [aruite] -mo ik-eru. | (Verb) |
| | there to TOP walking MO go POSS | |
| | ‘It is possible to go there also on foot.’ | |

- (2) $[[dono\ gakusei-no\ okaasan]_{NP-mo}] odotta.$
 which student GEN mother MO danced
 ‘Every mother of a student danced.’

In accordance with earlier work (e.g. Ohno 1989, Nishigauchi 1990, Watanabe 1992, von Stechow 1996, Hagstrom 1998), *mo* is analyzed as a universal quantifier in Shimoyama’s analysis. However, unlike these authors, Shimoyama proposes that the restrictor of the universal quantifier *mo* is directly provided by its whole sister phrase. Thus, according to this ‘direct restrictor view’, the restrictor of *mo* in (2) would be the entire NP *dono gakusei-no okaasan* ‘which student’s mother’. Under an alternative ‘embedded restrictor view’, the restrictor of *mo* in (2) would be only the embedded NP *dono gakusei* ‘which student’. Under Shimoyama’s analysis, the composition of *mo* with its restrictor is straightforwardly determined by the surface syntax. This is a significant improvement over earlier analyses that had adopted an embedded restrictor view. The definition of *mo* and *X-mo* under Shimoyama’s analysis is given in (3):²

- (3) a. $MO = \lambda P \lambda Q \forall x [P(x) \rightarrow Q(x)]$, where $x \in D_\tau$, and $P, Q \in D_{\langle \tau, t \rangle}$.
 b. $[[X]-MO] = \lambda Q \forall x [P(x) \rightarrow Q(x)]$, of type $\langle \langle \tau, t \rangle, t \rangle$.

Here, if *mo* combines with a nominal element, i.e. if X of *X-mo* is a nominal element, *mo* would be analyzed as an element of type $\langle \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle \rangle$, *X-mo* being a generalized quantifier of type $\langle \langle e, t \rangle, t \rangle$. Thus, under this analysis, *mo* is treated as a universal quantifier just like English *every* in standard generalized quantifier theory (Barwise and Cooper 1981).

2.2 Kobuchi-Philip (2008a)

Although Shimoyama’s analysis is a substantial improvement over the traditional embedded restrictor view, Kobuchi-Philip (2008a) notes that there are syntactic, i.e. compositionality, problems with Shimoyama’s analysis. Consider the data in (4) and (5):

- (4) a. $[[dono\ hito]_{NP-mo}] odotta.$
 which person MO danced
 ‘Every person danced.’
 b. $[gakusei-no\ okaasan]-ga\ [[dono\ hito]_{NP-mo}] odotta.$
 student GEN mother NOM which person MO danced
 ‘All the mothers of the students danced.’
- (5) a. $John-ga\ [[dono\ hito]-mo] hometa.$
 John NOM which person MO praised
 ‘John praised every person.’
 b. $John-ga\ [gakubu-no\ gakusei]-o\ [[dono\ hito]-mo] hometa.$
 John NOM dep’t GEN student ACC which person MO praised
 ‘John praised every student in the department.’

² In (3) τ is a variable ranging over any semantic type, as defined in (3a). This is to cover the various syntactic category of X of *X-mo* exemplified in footnote 1.

In (4a) the *mo*-phrase might be considered the subject of the sentence; however, in (4b) there is an overt subject in addition to this *mo*-phrase. Similarly, in (5a), the *mo*-phrase might look like the object; yet in (5b) we see that an overt object can co-occur with this *mo*-phrase. Sentences like (4b) and (5b) are perfectly grammatical and quite unmarked. However, under Shimoyama's analysis, they are predicted to be ill-formed, since the extra subject or object would not be included in the interpretation computation of the sentence.

It is clear that the *ga*-marked nominal element in (4b) and the *o*-marked nominal element in (5b) must be taken to be the subject and the object, respectively. If so, the *mo*-phrase in (4b) cannot be a subject, given that in Japanese, as in other languages, a sentence can have only one logical subject (e.g. Heycock 1993). The same can be said for the direct object of (5b). Therefore, following e.g. Aoyagi (1994), Kobuchi-Philip (2008a) adopts the hypothesis that sentences such as (4a) and (5a) have a null subject and a null object, respectively, and claims that *mo*-phrase is not an argument but rather an adjunct. This is supported by the fact that a single sentence can contain more than one such *mo*-phrase, as exemplified in (6):

- (6) *gakusei-ga dono danshi-mo dono joshi-mo hashitta.*
 student NOM which boy MO which girl MO ran
 'The students ran, including every boy and including every girl.'

Treating the *mo*-phrase as an adjunct, Kobuchi-Philip (2008a) proposes the alternative analysis summarized in (7):³

- (7) a. *Mo*-phrase is a modifier of type $\langle\langle e,t \rangle, \langle e,t \rangle\rangle$, thus, there is a phonologically null subject for sentences which lack an overt one.
 b. The semantic value of a null subject is drawn from the NP in the *mo*-phrase.
 c. *Mo*: $\lambda P \lambda R \lambda x [x \sqcap \oplus (P \cap AT(\oplus R)) \wedge |AT(x)| \geq 2]$

Under this analysis, *X-mo* in a sentence such as (1a) or (2) is a VP modifier. Assuming that a parallel statement of (7a) holds for sentences like (5a), when a *mo*-sentence lacks an overt subject or object, it is simply an instance of a null subject or null object sentence, a pervasive phenomenon in Japanese. It is argued that the semantic value of the null element is directly taken from the NP inside the *mo*-phrase, as stated in (7b). In (2), for example, *gakusei-no okaasan* 'student's mother' provides the meaning of the subject.

The plurality specification (the second conjunct of the denotational formula of *mo* in 7c) is included to account for the ill-formedness of a sentence such as (8), in which the subject refers to just a single individual:⁴

- (8) *#John -ga, dono hito -mo hashitta.*
 John NOM which person MO ran

An advantage of the analysis by Kobuchi-Philip's (2008a) is that it covers both sentences such as (4b) and (5b) (with an overt argument) and sentences like

³ Here and throughout, Hamblin's (1973) semantics of questions, Link (1983) and Landman's (2000) plurality theory, Kobuchi-Philip's (2006) null determiner hypothesis are adopted. For a more detailed explication of this hypotheses, see 3.5.

⁴ I thank Daisuke Bekki for pointing this out to me, correctly.

(4a) and (5a) (without an overt argument). Thus, it has better empirical coverage than Shimoyama's analysis.

3 A unified analysis of *mo*

In this section, we propose a unified semantic analysis which is applicable to all four of the different uses of *mo* illustrated in (1) above. We first observe in 3.1 that Kobuchi-Philip's (2008a) analysis of universal quantificational *mo* would not easily extend to additive *mo*. In 3.2 we modify the analysis of null argument sentences with *mo*. Then we re-examine the formal properties of *mo* in detail in 3.3, 3.4 and 3.5.

3.1 Problems with additive *mo*

Although Kobuchi-Philip's (2008a) analysis of universal quantificational *mo* can be viewed as an improvement over Shimoyama's (2001, 2006) analysis, it turns out that this analysis cannot easily be extended to the other uses of *mo*. In particular, let us consider the case of additive *mo* in (1d). First, (7b) is problematic since it produces a sentence such as (9) as the underlying structure for (1d):

- (7) b. The semantic value of a null subject is drawn from the NP in the *mo*-phrase.
- (1) d. *John-mo hashitta.*
John MO ran
'John also ran.'
- (9) #*John-ga, John-mo hashitta.*
John NOM John MO ran

The sentence in (9) is clearly highly infelicitous, if not simply ungrammatical. Given the grammaticality of a sentence such as (6) above and (10) below, we might try using *gakusei* 'student' as the underlying subject of (1d) instead of *John*, as shown in (11a). But then the interpretation calculation yields a fatally incorrect result, as shown in (11b):^{5,6}

- (10) *gakusei-ga John-mo Mary-mo hashitta.*
student NOM John MO Mary MO ran
'The students ran, including John and including Mary.'
- (11) a. *gakusei-ga John-mo hashitta.*
student NOM John MO ran
'The students ran, including John.'

⁵ Partee's (1987) type-shift theory is adopted here.

⁶ The sentence in (11a) contains an overt subject and a *mo*-phrase in which *mo* combines with a proper noun. Such a sentence may not sound natural and some readers may hesitate to judge (11a) as totally well-formed. However, the grammaticality of (6), which has the same construction but another *mo*-phrase, suggests that the awkwardness in (11a) is not due to a semantic problem but rather a minor pragmatic anomaly, e.g. a redundancy problem. Here we assume that (11a) is syntactically fully well-formed.

$$b. \oplus\text{STUDENT} \prod \oplus(\text{JOHN}_{\text{AT}} \cap \text{AT}(\oplus\text{RAN})) \wedge |\text{AT}(\oplus\text{STUDENT})| \geq 2$$

The logical representation (11b) asserts (i) that the supremum of the set of the relevant students is part of the sum of the individuals in the intersection of the singleton set of John and the set of runners, and (ii) that the cardinality of this set of students is 2 or more. Here a substantial contradiction arises: According to (i), for the sentence to be true, the cardinality of the set of the contextually relevant students must be 2 or more; yet according to (i) this has to be part of just John, since the intersection of the singleton set of John and the set of runners turns out to be the set containing just John.

There is another problem for the plurality specification $|\text{AT}(x)| \geq 2$, i.e. the assertion that the cardinality of x (the students in 11b) be 2 or more. Consider the following sentence:⁷

- (12) *gakusei-ga [Taro-to Hanako]-mo hashitta.*
 student-NOM Taro-AND Hanako -MO ran
 ‘The students ran, including Taro and Hanako.’

In this sentence, X of X -*mo*, i.e. the bracketed part of the sentence, is already plural. Native speaker intuition tells us that for this sentence to be true there must be somebody other than Taro and Hanako who is also a student; i.e. all together there must be at least three students in the domain of discourse. No matter how many individuals are referred to by X of X -*mo*, the condition which makes the sentence true is that there be at least one relevant individual other than those included in X . Thus, reference to the number 2 does not do the job.

For this reason, as is, the analysis in (7) cannot be extended to additive *mo*. (7b) and (7c) must be reconsidered if we are to pursue a unified analysis of *mo* that also covers additive *mo*.

3.2 Identity of null arguments

Given the problem noted in 3.1, let us step back and re-examine the formal properties of *mo*. Let us start our re-examination with (7b):

- (7) b. The semantic value of a null subject is drawn from the NP in the *mo*-phrase.

As we saw in the last section, (7b) does not yield the desired meaning for the null subject, when we consider a sentence with additive *mo*.

When a sentence has a null subject, as in the case of (6) and (10) above, the referent of the null subject must already be in the discourse context, such that it can be recovered effortlessly. Otherwise, use of the null argument would be just as infelicitous as the use of a pronoun with no discourse antecedent. This context dependency introduces a certain indeterminacy as to the exact reference of the argument. When the sentence lacks an overt subject, as in (1d), the referent of the null subject might be ‘the students’, ‘the members of the club’, ‘the people the speaker thought would run’, etc.; the exact reference completely depends on the context.

⁷ I thank Chris Tancredi for calling my attention to sentences such as (12).

This context dependency of the identity of the null element can be assumed to be a general phenomenon, since it is also observed in the sentences in (1a-c). The set of individuals which *dono hito-mo* ‘everyone’, *dare-mo* ‘everyone’, and *hito-ri-mo* ‘one person’ refer to is some set of people who are salient in the context. For example, *dono hito-mo* ‘everyone’ denotes a set of people, but (1a) does not usually allude to everyone in the world, but only to the particular subset of people who are relevant in the context in which this sentence is uttered. The same applies to *dare-mo* and *hito-ri-mo*. The same can be said for sentences with *mo*-phrase and a null object. Thus, we can replace (7b) with the following:

- (13) The semantic value of a null argument is drawn from the context by means of accommodation mechanisms.

This accords with the general licensing condition of the null subject and object in Japanese, at least from the pre-theoretical, intuitive point of view. In the next subsection we examine the denotation of *mo* itself.

3.3 Predicate membership and argument membership

In accordance with our discussion in the last subsection, let us here suppose that the contextually provided referent of the null subject of the sentences in (1) is *gakusei* ‘student’, such that these sentences are equivalent to the sentences in (14):

- (14) a. *gakusei-ga dono hito -mo hashitta.*
 student NOM which person MO ran
 ‘Every student ran.’
 b. *gakusei-ga dare-mo hashira-na-katta.*
 student NOM who MO run NEG PAST
 ‘No student ran.’
 c. *gakusei-ga hito-ri-mo hashira-na-katta.*
 student NOM 1 CL MO run NEG PAST
 ‘Not one student ran.’
 d. *gakusei-ga John-mo hashitta.* (=11a)
 student NOM John MO ran
 ‘The students ran, including John.’

Now, let us look at Kobuchi-Philip’s (2008a) (7c) again:

- (7) c. *Mo*: $\lambda P \lambda R \lambda x [x \prod \oplus (P \cap_{AT} (\oplus R)) \wedge |_{AT}(x)| \geq 2]$

Let us first focus on the first conjunct of the formula, i.e. $x \prod \oplus (P \cap_{AT} (\oplus R))$.⁸ This states two things at the same time. When (14a) is calculated with this denotation of *mo*, it will assert that the students relevant in the context are part of the set of people and also part of the set of runners. However, when (14d) with additive *mo* is calculated, it will assert that the students relevant in the context are part of John. Obviously this is wrong. So, let us make some modifications.

⁸ The motivation for the first conjunct of the denotation (7c) is not explained completely clearly in Kobuchi-Philip (2008a). Aside from making the motivation more explicit, we here also improve the denotational formula of Kobuchi-Philip (2008b).

3.4 Additivity

Let us now examine the plurality specification expressed in the second conjunct of (7c), shown in isolation in (17):

$$(17) \quad Mo: \lambda P \lambda R \lambda x [\dots \wedge |AT(x)| \geq 2]$$

Although we have just made a reasonable improvement of the first conjunct of (7c), as we saw in 3.1, the plurality specification in the second conjunct created a substantial problem for the analysis of additive *mo*. Consider again (14d):

$$(14) \text{ d. } \begin{array}{l} \textit{gakusei-ga} \textit{ John-mo} \textit{ hashitta.} \\ \text{student NOM John MO ran} \\ \text{'The students ran, including John.} \end{array} \quad (=11a)$$

In the interpretation computation, the element *x* in (7c) will be replaced by the denotation of *gakusei* ‘student’, and thus, $|AT(x)| \geq 2$ will determine that the cardinality of the students is two or more. However, this was the problem in light of a sentence such as (12), repeated here as (18):

$$(18) \quad \begin{array}{l} \textit{gakusei-ga} \textit{ [Taro-to Hanako]-mo} \textit{ hashitta.} \\ \text{student-NOM Taro-AND Hanako -MO ran} \\ \text{'The students ran, including Taro and Hanako.'} \end{array}$$

In order to obtain the correct meaning of the sentence, it is not adequate to merely specify that the cardinality of the students be 2 or more. What is needed to guarantee the correct meaning of *mo* in this sentence is that there be at least one individual *aside from Taro and Hanako* who also ran. Note that this individual must also be a student, since this sentence is not true if, say, a professor also ran. Satisfying the argument membership and predicate membership constraints discussed in 3.3 above, Taro and Hanako have to be included in the set of the students in the context as well as in the set of runners. The additional individual needed here is an individual just like Taro and Hanako, namely, a student runner. Our analysis leads us, then, to propose the formula in (19a) as the replacement for the second conjunct of (7c=17), yielding (19b) when (18) is calculated:¹²

$$(17) \quad Mo: \lambda P \lambda R \lambda x [\dots \wedge |AT(x)| \geq 2]$$

$$(19) \text{ a. } Mo: \lambda P \lambda R \lambda x [\dots \wedge (((AT(x)-AT(\oplus P)) \cap R) \neq \emptyset)] \\ \text{ b. } (((AT(\oplus \text{STUDENT})-AT(\text{TARO} \oplus \text{HANAKO})) \cap \text{RAN}) \neq \emptyset)$$

The logical representation (19b) asserts that there exists some student runner aside from Taro and Hanako, an additional individual who has the same property as Taro and Hanako. I will use the term ‘additivity’ to refer to this constraint in the rest of the paper.

¹² Consideration of predicate membership leads Kobuchi-Philip (2008b) to offer another formulation of the plurality specification, which is shown in (i):

(i) $Mo: \lambda P \lambda R \lambda x [(AT(x) \cap AT(\oplus P)) \subseteq R \wedge |AT(x) \cap R| \geq 2]$

3.5 Additivity and universality

At this point, let us summarize the modifications we have made to Kobuchi-Philip's (2008a) analysis of universal quantificational *mo*. The way in which this new analysis captures the meaning of additive *mo* in sentences like (14d) is shown in detail in (20):

- (14) d. *gakusei-ga, John-mo hashitta.*
 student NOM John MO ran
 'The students ran, including John.'

- (20) a. syntax
 [\emptyset_{the} [*gakusei*] -ga] [[*John -mo*] *hashitta*].
 student NOM John MO ran
 'The students ran, including John.'

- b. lexical entries

mo 'MO': $\lambda P_{\langle e,t \rangle} \lambda R_{\langle e,t \rangle} \lambda x_e [(AT(\oplus P) \subset AT(x)) \wedge (AT(\oplus P) \subset R) \wedge$
 $((AT(x) - AT(\oplus P)) \cap R) \neq \emptyset)]$
 John: $\lambda x_e [\text{JOHN}(x)]$ (the singleton set of John: Partee 1987)
 hashitta 'ran': $\lambda x_e [\text{RAN}(x)]$
 gakusei 'student': $\lambda x_e [\text{STU}(x)]$
 \emptyset_{the} : $\lambda X_{\langle e,t \rangle} \lambda Y_{\langle e,t \rangle} [Y(\oplus X)]$

- c. outcome

$(AT(\oplus \text{JOHN}) \subset AT(\oplus \text{STU})) \wedge (AT(\oplus \text{JOHN}) \subset \text{RAN})$
 [John is a student.] [John ran.]
 $\wedge (((AT(\oplus \text{STU}) - AT(\oplus \text{JOHN})) \cap \text{RAN}) \neq \emptyset)$
 [There is some non-John student runner.]

Though the analysis in (20) provides the correct interpretation for a sentence with additive *mo*, when applied to universal quantificational *mo* and the two types of NPI *mo*, there arises an issue with respect to universality. Here I will discuss this issue and outline the solution to the problem.

Using the new definition of *mo* shown in (20b), the calculation of (14a) with a universal quantificational *mo* would be as shown in (21):

- (14) a. *gakusei-ga dono hito -mo hashitta.*
 student NOM which person MO ran
 'Every student ran.'

- (21) a. syntax
 [\emptyset_{the} [*gakusei*]] -ga [[*dono hito -mo*] *hashitta*].
 student NOM which person MO ran
 'The students all ran.'

- b. lexical entries

mo 'MO': $\lambda P_{\langle e,t \rangle} \lambda R_{\langle e,t \rangle} \lambda x_e [(AT(\oplus P) \subset AT(x)) \wedge (AT(\oplus P) \subset R) \wedge$
 $((AT(x) - AT(\oplus P)) \cap R) \neq \emptyset)]$

dono hito ‘which person’: $\lambda x_e[\text{PERSON}_{\text{AT}}(x)]^{13}$

hashitta ‘ran’: $\lambda x_e[\text{RAN}(x)]$

gakusei ‘student’: $\lambda x_e[\text{STU}(x)]$

\emptyset_{the} : $\lambda X_{\langle e,t \rangle} \lambda Y_{\langle e,t \rangle} [Y(\oplus X)]$

c. *outcome*

$(\text{AT}(\oplus \text{PERSON}_{\text{AT}}) \subset \text{AT}(\oplus \text{STU})) \wedge (\text{AT}(\oplus \text{PERSON}_{\text{AT}}) \subset \text{RAN})$

$\wedge (((\text{AT}(\oplus \text{STU}) - \text{AT}(\oplus \text{PERSON}_{\text{AT}})) \cap \text{RAN}) \neq \emptyset)$

The first conjunct of (19) asserts that the relevant set of people (the extension of *dono hito* ‘every person’) are students. This is correct. The second conjunct asserts that these people ran. This is also correct. However, there seems to be a problem in the third conjunct. It asserts that there exists some non-person student runner(s). Note that all the students are people; thus, in principle there is no such thing as ‘non-person student’. The same problem arises for (14b) and (14c) with the two types of NPI *mo* sentences, since both *dare-mo* ‘everyone’ and *hito-ri-mo* ‘(not) one person’ require reference to a totality, giving rise to exactly the same apparent paradoxical computation.

There is a solution to this problem. The interpretation of the sentence (14a) is exactly the same as the interpretation of (22), and in turn, as the interpretation of (23), provided that John, Mary and Tom are the set of all the students given in the context:

(22) *gakusei-ga John-mo Mary-mo Tom-mo hashitta.*
 student NOM John MO Mary MO Tom MO ran
 ‘The students ran, including John, including Mary and including Tom.’

(23) *gakusei-ga John-mo hashiri,*
 student NOM John MO run
Mary-mo hashiri,
 Mary MO run
Tom-mo hashitta.
 Tom MO ran
 ‘The students ran, including John, including Mary and including Tom.’

That is, given the context in which John, Mary and Tom are all the students, the interpretation of (14a) can be assumed to be calculated as the collection of three sentences, as in (24):

(24) i. *gakusei-ga, John-mo hashitta.*
 student NOM John MO ran
 ‘The students ran, including John.’
 ii. (*gakusei-ga,*) *Mary-mo hashitta.*
 student NOM Mary MO ran
 ‘The students ran, including Mary.’
 iii. (*gakusei-ga,*) *Tom-mo hashitta.*
 student NOM Tom MO ran
 ‘The students ran, including Tom.’

¹³ Following Hamblin (1973), the indeterminate *dono hito* ‘which person’ is assumed to denote a set of contextually relevant people. However, adopting Kobuchi-Philip (2006), it is assumed to denote a set of atoms only, excluding sums.

Each of these sentences is interpreted as in (14d), i.e. (20). Thus, (24i) yields the interpretation such that John is a student; John ran; and there is some non-John student runner. This non-John student runner turns out to be Mary or Tom. (24ii) yields a similar interpretation: Mary is a student; Mary ran; and there is some non-Mary student runner, namely John or Tom. Likewise, (24iii) yields a similar interpretation and here the non-Tom student runner is John or Mary. Thus, the interpretation of the sentence (14a) can be calculated without any resulting contradiction.

This approach concords with the original idea behind Hamblin's (1973) analysis of questions in the sense that a question sentence such as *Who left?*, in the context in which the possible alternative individuals are John, Mary, and Tom, denotes the set of possible answers such as {John left, Mary left, Tom left}. Thus, in the interpretation of (14a), *mo* applies to the denotation of *dono hito* 'which person' distributively (and exhaustively), rather than to the set of people (relevant in the context) as a sum.

In relation to this, note the difference in interpretation of sentences with multiple *mo*-phrases and sentences with a single *mo*-phrase when plural individuals are involved. Consider (25) and (26):

(25) *gakusei-ga John-mo Mary-mo hashitta.* (=10)
 student NOM John MO Mary MO ran
 'The students ran, including John and including Mary.'

(26) *gakusei-ga [Taro-to Hanako]-mo hashitta.* (=12)
 student NOM Taro AND Hanako MO ran
 'The students ran, including Taro and Hanako.'

The sentence in (25) is true in the situation in which there is no student other than John and Mary. In contrast, the sentence in (26) is not true if there is no student other than Taro and Hanako. This shows clearly that *John-mo* and *Mary-mo* in (25) are computed separately, satisfying additivity in each *mo*-phrase computation, while *Taro-to Hanako-mo* in (26) is computed once as a sum, requiring the existence of some individual other than Taro and Hanako.

The observations discussed in relation to universal quantificational *mo* and additive *mo* also hold for the two types of *mo* that occur in NPI environments, i.e. sentences such as (14b) and (14c):

- (14) b. *gakusei-ga dare-mo hashira-na-katta.*
 student NOM who MO run NEG PAST
 'No student ran.'
- c. *gakusei-ga hito-ri-mo hashira-na-katta.*
 student NOM 1 CL MO run NEG PAST
 'Not one student ran.'

In (14b), *dare* 'who' can be assumed to have the same denotation as *dono hito* 'which person' in (14a). Thus, the interpretation would proceed in the same way as with (14a) except that the predicate *hashiranakatta* 'didn't run' is negative, which we took to denote a set of individuals who did not run. In (14c), *hitori* 'one person' also denotes a set of individual persons. This turns out to be equivalent to that denoted by *dono hito* 'which person' in (14a) and *dare* 'who' in (14b).

Having the subject *gakusei* ‘student’, (14c) yields an interpretation asserting that each student did not run. In sum, the additivity condition as formulated in the last subsection is well motivated both empirically and theoretically.

4 Summary and further considerations

This paper aimed at finding the formal semantic properties of *mo* which are at work in four different uses of it as shown in (1), repeated here:

- (1) a. *dono hito -mo hashitta.* (universal quantificational *mo*)
 which person MO ran
 ‘Everybody ran.’
- b. *dare-mo hashira-na-katta.* (*mo* in NPI with indeterminate)
 who MO run NEG PAST
 ‘Nobody ran.’
- c. *hito-ri-mo hashira-na-katta.* (*mo* in minimizer NPI)
 1 CL MO run NEG PAST
 ‘Not one person ran.’
- d. *John-mo hashitta.* (additive *mo*)
 John MO ran
 ‘John also ran.’

We discussed Shimoyama’s (2001, 2006) analysis of universal quantificational *mo* as the starting point, then moved on to Kobuchi-Philip’s (2008a) modification to Shimoyama’s analysis. In order to derive an analysis which covers other uses of *mo*, including additive *mo*, we re-examined the truth conditions of *mo* and clarified the relationship between elements of the sentence with *mo*. Despite the apparent diversity of meaning of the four different *mo*-sentence types, a unified analysis is possible. This is summarized in (27):

- (27) a. *Mo*-phrase is a modifier of type $\langle\langle e,t\rangle, \langle e,t\rangle\rangle$, thus, there is a phonologically null argument for a sentence which lacks overt one.
- b. The semantic value of a null argument is drawn from the context by means of accommodation mechanisms.
- c. $Mo: \lambda P_{\langle e,t\rangle} \lambda R_{\langle e,t\rangle} \lambda x_e [(AT(\oplus P) \subset AT(x)) \wedge (AT(\oplus P) \subset R) \wedge (((AT(x) - AT(\oplus P)) \cap R) \neq \emptyset)]$

Under this analysis, *mo* has the following formal properties:

- (28) a. Argument membership constraint (first conjunct of 27c)
 b. Predicate membership constraint (second conjunct of 27c)
 c. Additivity constraint (third conjunct of 27c)

Finally, the solution to the apparent conflict between additivity and universality was found in a distributive computation of each individual in association with *mo*.

Although the unified analysis outlined in this paper overcomes a number of large obstacles, there do remain some tasks for future research. First, although we suggested an approach to the conflict between additivity and universality, the exact semantics of indeterminates has to be more precisely defined in order for this approach to attain the desired formal rigor. Second, the analysis suggested

here has limited application. That is, we restricted our discussion to the most basic construction with *mo*, where it combines with a nominal element. As mentioned in the introduction, *mo* in fact can combine with a great variety of types of phrases. In order to cover such diversity, Shimoyama (2001, 2006) proposes the analysis in (3), which allows type-flexibility. We have not yet addressed this issue. Thus, one of the future tasks is to see how the analysis suggested here can be generalized, so that it covers *mo*-phrases with non-nominal elements. Third, there is another intriguing matter touched on in our discussion, namely the relationship between the argument membership constraint and Moltmann's (1995) analysis of English exception constructions with *except for* and *but*. In Japanese, there is a similar lexical item *shika*. This lexical item appears to have a very similar, if not the same, meaning as English *except for*, and to obey the argument membership constraint. In addition it is syntactically similar since a phrase with *shika* is an adjunct (Kobuchi-Philip 2009). Thus, an important topic for future research is the relationship between *mo* and *shika*. Fourth, although the proposed analysis included the additivity constraint as part of the formal semantic component, some linguists argue that it is part of the pragmatic component (e.g. Kato 1985, Shudo 2002). The controversy parallels with respect to English *too/also* (e.g. Soams 1989 for the semantic view; Horn 1969, 1972, Karttunen and Peters 1979, etc. for the pragmatic view). Thus, this issue has to be examined in conjunction with an investigation of the semantics and pragmatics of English lexical items corresponding to Japanese *mo*. Fifth, since Japanese and Korean are well-known to be closely related, it is of our great interest to investigate the behavior of Korean *to*, which corresponds to Japanese *mo*.

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