

# Denotational Semantics for Interrogative Sentences in Japanese

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## Abstract

We present a new approach to a sentence of interrogative form in Japanese within the framework of Montague Grammar. The possibility of various uses of an interrogative sentence; uses as a question, an exclamation, a rhetorical question, a demand and a recommendation is explained based on the same denotation for the sentence. The denotation which is neutral for all possible uses is defined in terms of a new modal operator in the formal language level, and of possible world semantics in the denotational level. Our interpretation of the Japanese end marker particle "ka" also explains some other usages of the same particle "ka" in a uniform way; especially, "ka" as the parallel listing (disjunctive) particle, which is another important usage of "ka", is explained uniformly with the interrogative "ka". This uniform interpretation in the denotational semantics level will be supported by the historical development of usages of "ka", as briefly explained. Some part of our new approach for the Japanese interrogative forms can be, in our opinion, generalized to many other languages, although there are also some part particular to Japanese.

## 1 Introduction

A sentence of interrogative form usually gives several different uses and meanings depending on a situation of utterance, besides the literal use of interrogatives. In Japanese, a sentence of interrogative form may express;

- (1) a. question
- b. exclamation
- c. rhetorical question
- d. ordering
- e. recommendation

For example, the following Japanese sentence has a), b), c) of the above depending on situations of utterance.

- (2) Mari ga kita ka.  
      Mari NOM came Q  
      'Did Mari come?'

Before going into a specific discussion, let us explain briefly a notational convention we employ in this paper. To each example sentence of Japanese, we append a gloss which shows the corresponding English expression to each Japanese word and an English translation. Within our examples of Japanese, there are expressions which lack corresponding English expressions. For these

items, we use the following symbols: for *ga* (which stands for nominative case marker in Japanese), we use *NOM*, for *ka* (which stands for modal particle in Japanese), we use *Q*, and for *wa* (which stands for topic marker in Japanese), we use *TOP*<sup>1</sup>.

At first sight, it seems to be very difficult to build a Montague type denotational semantics for interrogatives since the denotational semantics should have a unique interpretation for each sentence while an interrogative form actually has many different meanings depending on situations of utterance. Here, the uniqueness of denotation for a sentence is driven from the principle of compositionality of the translation, which is the essential basis for the denotational semantics in general. At first look, this observation seems to lead us to realize the limitation of expressive power of the Montague's theory, or of the denotational semantics in general. However, a more careful observation would provide us with another possibility: first of all, we can ask ourselves what is the meaning of interrogative form itself from the semantic point of view, instead of asking what is the meaning of each use (a)-(e) of the interrogative. In other words, we can ask ourselves whether it is possible to characterize the basic meaning of an interrogative form which should be the basis for many different usages (a)-(e) and from which the different meanings of (a)-(e) are driven. In this paper, we show that there is a basic and common meaning of the interrogative sentence by providing a translation rule and a denotation in the framework of Montague Grammar, with the help of a new modal operator.

Through our interpretation of the interrogative form, it turns out that the interrogative end marker "*ka*" (in Japanese) and the parallel listing particle "*ka*" can be translated in the same manner, hence have the same denotation. This uniform translation of ours seems to be supported by the historical fact on the usage of "*ka*". The modal operator used in the translation of "*ka*" defines, roughly speaking, a set of possible worlds in the denotational semantics level. The different meanings (a)-(e) which depend their interpretation on situations of utterances are explained by how to focus on the possible worlds (based on the situation) from the original denotation.

Our approach to sentences of interrogative form in Japanese can cast a light to the analysis of interrogative sentences in general. The semantic nature of interrogative sentences in general has been one of the most mysterious things in the literature<sup>2</sup>. Especially, within truth conditional semantics, it is not easy to deal with an interrogative sentence because it is not clear whether we can define truth condition for it. Although there has been no real solution that reveals the nature of interrogative sentences in natural language, there are several works that try to remove the complexity of it. There are two major approach to interrogatives. The first approach tries to relate an interrogative sentence with a declarative one. For example, in Lewis[6]'s theory, the following example sentences are semantically equivalent:

- (3) a. Is it raining?
- b. I ask you (to tell me) whether it is raining.

In this approach, an interrogative sentence is understood to be a statement of the desire to know, i.e., an epistemic request. Although this approach succeeds in defining truth conditions for interrogatives in the same way as for declaratives, it also has a problem raised by a feel of counterintuitivity, i.e., the result of

assuming that the two sentences above have the same semantic value.

The other approach of interrogatives is those works that have been done within possible world semantics for natural language, using the framework of Montague Grammar[8]. This approach, avoiding the complexity of direct interrogatives, deals only with indirect interrogatives and tries to give explanations in terms of possible world semantics. The basic idea of this approach is that the meaning of an interrogative sentence can be expressed not by its truth condition, as being done for declarative sentences, but by what they call "answerhood condition". In Karttunen[4]'s theory, the denotation of an interrogative is defined by a set of possible and true answers. The main concern of this approach after the work of Karttunen[4] has been on how every possible form of question-answer relationships can be expressed. In Karttunen[4], the set of answers are in propositional form. The recent theory of Groenendijk and Stokhof[1] makes it possible to describe at least two possible forms of answers, i.e., propositional answers, e.g., John came, Stan is a student, etc., and categorial ones, e.g., Helen, Bill, in the park, yesterday, etc. There are other forms of answers whose proper treatment seems to be impossible within this framework, for example, answers like "yes" and "no", and a rejection to answer like "I do not know". This fact suggests us that if we consider the meaning of an interrogative as answerhood conditions, we have difficulty in taking into consideration all possible question-answer pairs. In our opinion, this difficulty arises from confusing a linguistic expression with its usage, in the present case, an interrogative form with a question. As we have seen in the case of interrogatives in Japanese, a sentence of interrogative form has various usages depending on the context of use. "Question" is only one of these usages. On the other hand, the "denotation" of a sentence is the meaning which is independent of the context of use. So it is inappropriate to define the meaning (denotation) of an interrogative form in terms of a set of answers. In other words, the denotational meaning of an interrogative form should be defined independent of pragmatic notions like "questions" and "answers". In our framework, the denotation for a direct interrogative is defined independent of its usage. Moreover, the denotation, which is defined neutrally, becomes a basic and common meaning from which all possible usages of the sentence can be derived. The usage in a particular context is determined by focusing on the basic denotation. In other words, in our theory, the interpretation of a sentence of interrogative form needs two levels. On the first level, what we call *denotational semantics level*, the basic meaning which is common for all its usages is defined. The actual usage of a sentence is defined on the second level, where a particular denotation is chosen by the intention of the speaker. The nature of interrogative form, having various usages depending on the context of use, is not the nature particular to Japanese. Thus we assume that our approach to interrogative form can be applicable to languages other than Japanese. Now, from the next section, we present the theory of interrogative sentences in Japanese.

## 2 Interrogatives in Japanese

In Japanese, an interrogative sentence are distinguished from a declarative sentence by a particle, "ka" at the end of a sentence. It has been understood that this particle has several uses depending on places where it appears in a sentence,

as in the following;

- (4) a. Mari ga kita ka.  
Mari NOM came Q  
'Did Mari come?'
- b. Mari ka Kaoru ga kita.  
Mari Q Kaoru NOM came  
'Either Mari or Kaoru came.'
- c. Dare ka ga kita.  
Who Q NOM came  
'Someone came.'

Most traditional grammarians of Japanese treat each "ka" above as belonging to different grammatical categories, e.g., according to Shinkiti Hashimoto[12], "ka" of (4)a is called "shuu-joshi (end marker)" and that of (4)b, "heiretsu-joshi (parallel-listing particle)". Teramura[13] points out a similarity among these, but there has been no precise definition as to what the similarity is. At first sight, functions of each "ka" in these three sentences are different but closer observation indicates us a semantical similarity among these. A similarity we soon notice is the similarity of truth conditional meaning between (4)b and (4)c. (4)b is true when either *Mari* or *Kaoru* came. (4)c is true when and only when there exists a person who came. Here, it is very natural to regard these as the natural language counterpart of logical disjunction and existential quantifier. As is well known in logic, the existential quantifier is considered as a generalization of the disjunction. Then how about (4)a and (4)b? At first sight, these two sentences have nothing in common, i.e., the former seems to state nothing about the real world, while the latter is a proposition that asserts at least one of the two came. But more careful observation leads us to realize the similarity among these. Consider the followings;

- (5) a. Mari ka Kaoru ga kita.  
Mari Q Kaoru NOM came  
'Either Mari or Kaoru came.'
- b. Kitano wa Kaoru ka Mari da.  
the person who came TOP Kaoru Q Mari  
'The person who came was either Kaoru or Mari.'
- (6) a. Kita no wa Kaoru ka.  
Who came TOP Kaoru Q  
'Was it Kaoru who came?'
- b. Kitano wa Kaoru ka ina ka (da).  
Who came TOP Kaoru Q not Q  
'Was it Kaoru or other who came?'

(5)a, in which "ka" is used as a typical parallel-listing particle, can be transformed into (5)b. Note that (5)b has the same form as (6)a except the fact that the latter lacks "Mari da". We consider what (6)a expresses essentially is

the proposition expressed by (6)b. Here, “ka” can be regarded as a parallel-listing particle, as in (5)b. From this observation, we conclude that sentences with “ka” at the end is an elliptical form of sentences with parallel listing “ka”. More generally, a sentence of the form ‘A ka’ is an unsaturated or incomplete sentence which lacks B of ‘A ka B’. For this hidden B, we consider “not A”. Then ‘A ka’ is interpreted as ‘A ka not A’.

The above observation leads us to assume the common ancestor for both “ka” of parallel-listing particle and that of end marker. We have “ka” in classical Japanese which appears in the middle of a sentence and still expresses “question” and “rhetorical question”. This “ka” was called as *kakari-joshi* (“modal particles”, named by Yoshio Yamada[15]) because of its function in the sentence, i.e., *kakari-musubi*, which appears after a term phrase and changes the form of a predicate of the sentence<sup>3</sup>, as in the following;

- (7) Mizu ka nagaruru.  
 water Q flow  
 ‘Does the water flow?’

The function of this “ka”, which expresses “question”, was said to be taken place by the end marker “ka” during the Kamakura and Muromachi period. Contrary to the accepted view that the function of “ka” in “*kakari-musubi*” and “ka” of end marker is the same, we propose a view that the “ka” in “*kakari-musubi*” used to have independent function which was distinct from sentential end marker “ka”. For example, in the above sentence, we consider “ka” picks up the term phrase, *mizu* “water”, and asks whether it flows or not, rather than asking neutrally whether the water flows or not. This function is very similar to the function of topic marker, like “wa” in modern Japanese. It seems that after the extinction of this independent function, “ka” of “*kakari-musubi*” disappeared because it’s function became almost the same as end marker “ka”. Hence, in our opinion, the function of “ka” in “*kakari-musubi*” was the basic function, from which all “ka” in modern Japanese derived.

Next we consider the meaning of “ka”, which is common for “ka” of parallel listing “ka”, end marker “ka” and “ka” of “*kakari-musubi*”. The most naive interpretation of “ka” as usual logical disjunction has various difficulties. For example, let us consider the following;

- (8) Mari ka Einstein ga aruiteiru.  
 Mari Q Einstein NOM walk  
 ‘Either Mari or Einstein is walking.’

Suppose the world where *Mari* is walking and *Einstein* is already dead, i.e., he cannot be the person who is walking. Then in that world, this sentence becomes false according to our intuition of Japanese. On the other hand, if we think of “ka” in this sentence as ordinary logical disjunction, this sentence is true according to the interpretation of logical disjunction. Here, we face the deficiency of the interpretation of “ka” as logical disjunction. In order to get an interpretation which correctly describes our intuition for “ka”, we need more than logical disjunction. Then why (8) sounds false? It seems to be closely related to the fact that there is no possibility for Einstein to be walking. For

this sentence to be true, the condition is needed which guarantees the possibility for Einstein to be walking. Now in order for 'A ka B' to be true, we need the following condition: there are possibilities for both "A" and "B" to be true and actually at least one of "A" and "B" is true. According to this condition, (8) is false in the world where Einstein is dead because there is no possibility for Einstein to be walking in that world. Now we have got the most plausible interpretation for "ka". In the next section, we give the formal account of this interpretation in terms of possible world semantics.

### 3 Montague Grammar for Japanese Particle "ka"

We give a basic and common meaning which is independent of the contexts of use of an interrogative sentence and at the same time become the basis of several uses of the sentence. Viewed in this way, in our denotational semantics, a sentence of interrogative form has the same status as an ordinary declarative sentence. This means that we can define the denotational meaning for an interrogative in the same way as for a declarative sentence, which is free from notions like "questions" and "answers". The following shows categorial syntax and its translation into a logical language for interrogative sentences in Japanese, based on the framework of Montague Grammar. We have revised Montague's original version in order to incorporate some peculiarities which are unique to Japanese. For a motivation and more specific discussion of Montague Grammar for Japanese, see our paper[10]. For simplicity of our argument, we define a minimal fragment of the Montague Grammar of Japanese which is necessary to describe our theory of Japanese "ka". In particular, we do not consider Montague's definition of "intensionality". We call our formal language "Extensional Logic (EL)", since we do not include "intensionality" (however one can easily extend EL to IL).

#### 3.1 Syntax (Categorial Grammar)

Let us define categorial syntax for a fragment of Japanese. We start by introducing syntactic categories.

**Definition 1** *Syntactic categories*

1. *S (sentence) is a basic category.*
2. *Prn (pronoun) PN (proper name), CN (common noun) are basic categories. All of Those are identified as a basic category T (term) in our Categorial Grammar.*
3. *IV (intransitive verb phrase) is a category.*
4.  *$X_1, X_2, \dots$  are categories, which are called category variable (or polymorphic category)<sup>4</sup>.*
5. *If A, B are categories, then  $A \setminus B$ ,  $A / B$ , and  $A \setminus B / C$  are categories.*

This syntax contains four basic categories: S, the category of sentences; Prn, the category of pronouns; PN, the category of proper names; CN, the category of common nouns; and IV, the category of intransitive verb phrases. Prn, PN,

and CN are identified as T, the category of terms. The category variables are needed in order to give a proper treatment for a particle “ka”.

We consider the following reduction rules.

**Definition 2** *Reduction Rules*

1.  $(A / B) B \rightarrow A$
2.  $A (A \setminus B) \rightarrow B$
3.  $(X \setminus X / X) A \rightarrow A \setminus A$
4.  $A (X \setminus X / X) \rightarrow A / A$

In general, if  $B[X]$  is a type expression in which  $X$  appears, then 3 and 4 above are special cases of;

$$\begin{aligned} (B[X] / X) A &\rightarrow B[A] \\ A (X \setminus B[X]) &\rightarrow B[A] \end{aligned}$$

The following shows expressions of a fragment of Japanese corresponding to the syntactic categories.

**Definition 3** *Expressions*

1. As for category Prn, we consider Japanese words; dare (who), nani (what), dore (which).
2. As for category CN, we consider Japanese words; gakusei (student), sensei (professor), inu (dog), neko (cat),...
3. As for category PN, we consider Japanese words; Mari, Kaoru.
4. As for category IV, we consider Japanese words; kita (came), aruku (walk).
5. As for category  $X \setminus X / X$  (parallel listing particles), we consider the following; ka.
6. As for category  $T \setminus S / IV$  (case particles), we consider the following; ga.

An expression of the fragment is obtained from basic expressions above by concatenations.

Now we define the intermediate language, Extensional Modal Logic (EL).

### 3.2 Extensional Logic (EL)

**Definition 4** *Semantic Types*

1.  $e, t$  are base types.
2.  $X_1, X_2, \dots$  are type variables (or polymorphic types).
3. If  $a, b$  are types, then  $a \rightarrow b$  is a type.

We give the definition of  $\lambda$  terms.

**Definition 5** *Definition of  $\lambda$  terms*

1. Every constants and variables are expressions of *EL*.
2. If  $\alpha$  is an expression of a type  $a$  and  $u$  is a variable of type  $b$ , then  $\lambda u \alpha$  is an expression of type  $b \rightarrow a$ .
3. If  $\alpha$  is an expression of type  $a \rightarrow b$  and  $\beta$  is an expression of type  $a$ , then  $\alpha(\beta)$  is an expression of type  $b$ .
4. If  $\phi, \psi$  are expressions of type  $t$ , then  $\phi \vee \psi$  and  $\diamond\phi$  are expressions of type  $t$ .

### 3.3 Translation into Extensional Logic

Now we are going to translate our fragment into logical language, extensional modal logic. Here we consider homomorphism " $f$ " from the categorial language to the logical language *EL* such that;

1.  $f(IV) = f(T) = e \rightarrow t$
2.  $f(S) = t$
3.  $f(X) = X$
4. If  $A, B$  are categories, then  $f(A/B) = f(B) \rightarrow f(A)$ .

The following shows examples of translations of a fragment of Japanese into *EL*.

- $gakusei = \lambda x [gakusei(x)]$
- $dare = \lambda x [x = dare]$
- $kita = \lambda x [kita(x)]$
- $ga = \lambda PQ \exists x [P(x) \wedge Q(x)]$

Now we present the translation for "ka".

- $A \text{ ka } B = (\diamond A \wedge \diamond B) \wedge (A \vee B)$
- $A \text{ ka } = Aka(\text{otherwise}) = Aka\neg A$   
 $= (\diamond A \wedge \diamond(\neg A)) \wedge (A \vee \neg A) = \diamond A \wedge \diamond(\neg A)$

Now we can generalize this:

- For all  $n$ ,  $A_1 \text{ ka } A_2 \text{ ka } \dots \text{ ka } A_n$   
 $= (\diamond A_1 \wedge \dots \wedge \diamond A_n) \wedge (A_1 \vee \dots \vee A_n)$
- For all  $n$ ,  $A_1 \text{ ka } A_2 \text{ ka } \dots \text{ ka } A_n \text{ ka}$   
 $= A_1kaA_2ka \dots A_nka(\text{otherwise})$   
 $= (\diamond A_1 \wedge \dots \wedge \diamond A_n \wedge \diamond \text{otherwise}) \wedge (A_1 \vee \dots \vee A_n \vee \text{otherwise})$   
 $= (\diamond A_1 \wedge \dots \wedge \diamond A_n \wedge \diamond \neg(A_1 \vee \dots \vee A_n)) \wedge (A_1 \vee \dots \vee A_n \vee \neg(A_1 \vee \dots \vee A_n))$   
 $= (\diamond A_1 \wedge \dots \wedge \diamond A_n \wedge \diamond \neg(A_1 \vee \dots \vee A_n))$



- dare ka =  $\lambda P.[(\forall x \diamond P(x)) \wedge \exists x P(x)]$

A sentence with “ka” at the end is an incomplete sentence, i.e., does not have type S, in the categorial grammar level. For example, “Gakusei ga kita ka (Did the student come?)” is of type S/S. In the translation into EL, as shown above, we add “otherwise” from the right hand side which makes the incomplete sentence complete after the translation. Then, “Gakusei ga kita ka” is to be “Gakusei ga kita ka (otherwise)” which is of type  $t (X \setminus X / X) t = t$ . Here, “otherwise” is “ $\neg(\text{Gakusei ga kita})$ ”, which means “not (Gakusei came)”.

Now let us give examples which show whether our grammar defines intended interpretations for sentences in our fragment.

1. Gakusei ka sensei ga kita.

the student Q the professor NOM came

‘Either the student or the professor came.’

- syntax

- gakusei : CN = T
- ka :  $X \setminus X / X$
- sensei : CN = T
- gakusei ka sensei : T
- ga :  $T \setminus S / IV$
- kita : IV = T
- gakusei ka sensei ga kita :  $T (T \setminus S / IV) IV = S$

- translation into EL

- gakusei =  $\lambda x [gakusei(x)]: e \rightarrow t$
- ga =  $\lambda PQ \exists x [P(x) \wedge Q(x)]: (e \rightarrow t) \rightarrow (e \rightarrow t) \rightarrow t$
- kita =  $\lambda x [kita(x)]: e \rightarrow t$
- gakusei ga kita =  $\exists x [gakusei(x) \wedge kita(x)]: t$
- ka =  $\lambda AB.((\diamond A \wedge \diamond B) \wedge (A \vee B)) : (X \rightarrow X) \rightarrow X$
- sensei =  $\lambda y [sensei(y)]: e \rightarrow t$
- ga =  $\lambda PQ \exists y [P(y) \wedge Q(y)]: (e \rightarrow t) \rightarrow (e \rightarrow t) \rightarrow t$
- kita =  $\lambda y [kita(y)]: e \rightarrow t$
- sensei ga kita =  $\exists y [sensei(y) \wedge kita(y)]: t$
- gakusei ga kita ka sensei ga kita =  $(\diamond \exists x [gakusei(x) \wedge kita(x)] \wedge \diamond \exists y [sensei(y) \wedge kita(y)]) \wedge (\exists x [gakusei(x) \wedge kita(x)] \vee \exists y [sensei(y) \wedge kita(y)]) : t$

Here, sentences of the form ‘(A ka B) ga C’, where A and B are term phrases, is transformed into ‘(A ga C) ka (B ga C)’, by distributive rule before the translation into EL. For example, the present sentence, (gakusei ka sensei) ga kita, becomes (gakusei ga kita) ka (sensei ga kita). Hence the type of “ka” becomes  $(t \rightarrow t) \rightarrow t$  in EL level. Consequently, “ka” is polymorphic only in the categorial grammar level.

According to the translation above, the denotation of this sentence is a set of possible worlds which are accesible from real world and in the real world, at least one of *gakusei*, *sensei* came. Here, the possible worlds in

question are such that in which 'The student came.' is true and in which 'The professor came' is true.

The following shows the translation for a sentence of interrogative form.

2. Sensei ga kita ka.

the professor NOM came Q

'Did the professor come?'

• syntax

- (a) sensei : CN = T
- (b) ga : T \ S / IV
- (c) kita : IV = T
- (d) sensei ga kita : S
- (e) ka : X \ X / X
- (f) sensei ga kita ka : S / S

• translation into EL

- (a) sensei =  $\lambda x$  [sensei (x)]: e→t
- (b) ga =  $\lambda P Q \exists y [P(y) \wedge Q(y)]: (e \rightarrow t) \rightarrow (e \rightarrow t) \rightarrow t$
- (c) kita =  $\lambda y$  [kita (y)]: e→t
- (d) sensei ga kita =  $\exists y [\text{sensei}(y) \wedge \text{kita}(y)]: t$
- (e) ka =  $\lambda AB. (\diamond A \wedge \diamond B) \wedge (A \vee B) : (X \rightarrow X) \rightarrow X$
- (f) sensei ga kita ka (otherwise) =  $(\diamond \exists y [\text{sensei}(y) \wedge \text{kita}(y)]) \wedge (\diamond \neg (\exists y [\text{sensei}(y) \wedge \text{kita}(y)])) : t$

Here, we can define the truth condition of this sentence as the following: there exists two possible world which are accesible from the real world, that is, a possible world in which 'Sensei ga kita.' is true and a possible world in which 'Sensei ga kita.' is not true and in the real world, at least one of 'Sensei ga kita.' and "otherwise" is true. The condition in the real world is no more than tautology and can be omitted from the formula. Consequently, we get the set of possible worlds, and this constitutes the denotation for the interrogative. The interpretations for the following examples can be considered in the same way as those above, so we omit explanation.

3. Dare ga kita ka.

who NOM came Q

'Who came?'

• syntax

- (a) Dare : Prn = T
- (b) ga : T \ S / IV
- (c) kita : IV = T
- (d) Dare ga kita = S
- (e) ka : X \ X / X
- (f) Dare ga kita ka : S / S
- (g) Dare ga kita ka (otherwise): S

- translation into EL
  - (a)  $Dare = \lambda x[x = dare] : e \rightarrow t$
  - (b)  $ga = \lambda PQ\exists y[P(y) \wedge Q(y)] : (e \rightarrow t) \rightarrow (e \rightarrow t) \rightarrow t$
  - (c)  $kita = \lambda y [kita (y)] : e \rightarrow t$
  - (d)  $Dare\ ga\ kita = \exists y[(dare = y) \wedge kita(y)] : t$
  - (e)  $ka = \lambda AB.(\diamond A \wedge \diamond B) \wedge (A \vee B) : (X \rightarrow X) \rightarrow X$
  - (f)  $Dare\ ga\ kita\ ka = (\diamond \exists y[(y = dare) \wedge kita(y)]) \wedge (\diamond \neg(\exists y[(y = dare) \wedge kita(y)])) : t$

### 3.4 Toward the Second Level of Interpretation

We have presented a formal account of denotational semantics for a sentence of interrogative form in Japanese, within the framework of possible world semantics. Next we explain the relation between the denotational meaning of a sentence and its usage. An interrogative sentence has several possible usages which is variable according to the context. Here, we assume a continuity between the denotation and possible usage of a sentence. In our framework, a denotation for a sentence of interrogative form constitutes the basis for the sentence's several usages. In order to describe these usages in each context, we introduce notions like "attitudes" or "intentions" which work as a choice operator among denotations. For a sentence of the form 'A ka.', the denotation which is defined within our framework is a set of possible worlds; one world in which 'A' is true and the other in which 'not (A)' is true. The usage of this sentence becomes "question" when the intention of the speaker chooses both worlds. It becomes "rhetorical question" when the world 'not (A)' is chosen. The usage "exclamation" is resulted from the choice of the world where 'A' is true. As an example, consider 'Mari ga kita ka (Did Mari come?)'. The denotation of this sentence defined within our theory is a set of two possible worlds; one is the world where 'Mari came' is true and the other the one where 'otherwise (=  $\neg(\text{Mari came})$ )' is true. Let us assume here that this sentence has three usages (question, exclamation, rhetorical question). If both possible worlds are chosen by the intention of the speaker, it will be "a question". If the world which is chosen is the one where "Mari ga kita" is true, it will be "an exclamation" and if it is the one where " $\neg(\text{Mari ga kita})$ " is true, it becomes "a rhetorical question". Thus, our theory of interrogatives defines possible use of a sentence in terms of the denotation which is common and basic for all usages.

## 4 Conclusion

In this paper we explicated the mechanism of an interrogative sentence by positing two levels for the interpretation. In Japanese and possibly in other languages, an interrogative sentence has usages other than questioning. It has been questioned for a long time whether these several usages are "meanings" for a sentence. From a semantic (denotational semantic) point of view, it is very strange to assume a sentence to have several meanings. This is because of its basic principle; one meaning for one form. In this study, we emphasized the need of distinction between meaning (denotational meaning) and usages of a sentence. Questions, exclamations, etc., are "usages" of a sentence of interrogative form. We showed that a unique meaning (denotation) of every interrogative sentence

can be defined independent of these contextual meanings. Although meaning and usage of a sentence is independent of each other, there is a continuity between them. In our framework, a denotation for a sentence is a meaning that every usage of a sentence has in common. Usages of a sentence that vary according to contexts (question, exclamation, rhetorical question, etc.) are explained in terms of a focusing or choice operator on the unique denotation.

This study of Japanese interrogatives made clear the nature of particle "ka", especially, the relation between interrogative end marker "ka" and parallel listing particle "ka". By considering the former as the special case (as syntactically and semantically), we constructed the uniform approach to "ka", a modal particle in Japanese.

The merit of this study as a theory of interrogatives is that it succeeded in showing how nondeclarative sentence can be described within denotational semantics. We made clear the need of two levels for the interpretation of a nondeclarative sentence. From the viewpoint of a theory of Japanese, we think that the explanation we gave for particle "ka" may be applied to analysis of other *modal* particles and may contribute to give more specific description of *modality* in Japanese.

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## Notes

<sup>1</sup>See Okada-Watanabe[10] for Montague theoretic analysis of the case markers and topic markers.

<sup>2</sup>See Hiz[3].

<sup>3</sup>Other particles being considered to have this effect are *zo*, *namu*, *koso*, *wa*, *ya*, and *mo*. Existence of these particles in a sentence requires the change of the form of predicates, which is called "musubi". *Zo*, *namu*, *ya*, and *ka* require a predicate to be a form of *rentai-kei* "attributive form", *koso*, *izen-kei* "realis form", and *wa* and *mo*, *shuusi-kei* "conclusive form".

<sup>4</sup>The introduction of categorial variable into categorial syntax is due to Lambek[5].

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