A Parallel Interpretation of Floated Quantifiers and Adverbials

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Abstract

In this paper we propose a method to compositionally interpret the meanings of floated quantifiers on the basis of Categorial Grammar (Carpenter 1997) and Davidsonian semantics (Davidson 1980). In this approach, floated quantifiers are accounted for semantically as a kind of adverbial phrase so that we do not need any special syntactic operations, such as quantifier raising, in order to interpret their meanings. The approach also explains 'pragmatic implication' introduced by floated quantifiers on the basis of the whole-part relationship between sets.

1 Introduction

As a relatively free word order language, Japanese often exhibits quantifier floating phenomena. The most common analyses of these are syntactic ones; for example, that by Miyagawa (1989) has been widely accepted within GB theory. In this paper, however, we point out that the transformational analysis is on the wrong track, and propose a way to interpret the meanings of floated quantifiers and to account for their syntactic behaviour. Our assumption is that quantifier floating should be accounted for not just by syntactic operations but rather by the interaction of syntactic and semantic conditions. Our theory also intends to interpret 'pragmatic implication' and semantic differences caused by quantifier floating.

2 Numeral Expressions and Problems

In Japanese a numeral quantifier is always followed by a classifier which indicates the semantic category the quantified nominal belongs to. For example, *san-nin* means "three people", *san-bon* "three long and cylindrical objects", *san-mai* "three thin and flat objects", *san-satu* "three bound objects", and *san-biki* "three animals (dogs, cats, *etc.*)". Numeral quantifiers can be used as modifiers that are suffixed by the genetive case marker *no* and immediately placed before the NP they modify, as seen in (1a). Quantifier floating is a phenomenon in which the numeral quantifiers are separated rightwards from the NP they modify, as seen in (1b).

(1) a. **Sansatu-no** hon-wo John-ga katta.
three-Gen book-Acc John-Nom bought-Past
"John bought three books."

b. Hon-wo John-ga **san-satu** katta.
book-Acc John-Nom three bought-Past
"John bought three books."

Although quantifiers can be separated from the modified NPs as in (1b), it is not the case that all NPs allow quantifiers to float, as seen in (2).

(2) * Gakusei-tachi-wa **kuruma-de san-dai** ryokoushita.
student-Pl-Top car-By three travel-Past
"The students traveled by three cars."

In addition, the grammatical roles are crucial for the acceptability of the sentence with floated quantifiers as seen in (3).

(3) a. * Gakusei-ga$_i$ hon-wo **go-nin**$_i$ katta.
student-Nom book-Acc five buy-Past
"Five students bought a book."

b. Hon-wo$_i$ gakusei-ga **go-satu**$_i$ katta.
book-Acc student-Nom five buy-Past
"A student bought five books."

In (3a) the object NP is inserted between the floated quantifer and the NP it modifies, so the floated quantifer and the NP are not adjacent. As seen in (3a), if the floated quantifier and the subject NP it modifies are separated, the sentence is ungrammatical. On the other hand (3b) is a scrambled version of (3a) and the object NP comes first and the subject NP is inserted between floated quantifier *go-satu* and the object NP it modifies. This word order is grammatical.

The *no*-marked quantifier and floated quantifier do not necessarily have the same meaning; they often undergo significantly different interpretations, as shown in (4a, b):

(4) a. John-ga **nizyuppēzi-no** ronbun-wo yonda.
John-Nom twenty pages-Gen paper-Acc read-Past
"John read a twenty page paper."

b. John-ga ronbun-wo **nizyuppēzi** yonda.
John-Nom paper-Acc twenty pages read-Past
"John read twenty pages of a paper."

The meaning implied in (4a) is "the number of pages of the paper is exactly twenty, and John read all of them", while we can infer from (4b) that "the number of pages of the paper is larger than twenty and the number of pages John read was exactly twenty." The former part of this meaning may be canceled depending on the context because (4b) can be true even if the fact that the number of pages of the paper is exactly twenty being explicitly mentioned in the context. Moreover, Okutsu (1996b) points out that, while the quantified NP (4a) can be either definite or indefinite, in (4b) the twenty pages John read remains unidentified in the context.

As for a sentence with a floated quantifier, for example in (5a), and a sentence with a non-floated quantifier in (5b), we assume that both (5a) and (5b) truth-conditionally mean (5c).

(5) a. John-ga hon-wo **san-satsu** yonda.
John-Nom book-Acc three read-Past

b. John-ga **san-satsu-no** hon-wo yonda.
John-Nom three-Gen book-Acc read-Past
"John read three books."

c. There are three books such that John read them.

(5a) differs from (5b) in that some set with members more than three is assumed in the context and it is implied that what John read is just its part. We assume that the floated quantifier

provides the conventional implicature, 'there is a set A such that the elements in its subset are three books that John read.'

This paper accounts for this intuitively captured meaning of floated quantifiers and the similarity of adverbials on the basis of the whole-part relation between sets. We also assume that another context-dependent meaning of 'John didn't read more than four books' is a conversational implicature deriving from Grice's maxim of quantity (Grice 1975).

3 Previous Studies

3.1 Miyagawa (1989) and Shibatani (1977)

Miyagawa (1989) and Shibatani (1977) try to explain quantifier floating from a syntactic point of view. Shibatani (1977) proposes a generalization that numeral quantifiers can be floated from *ga*-marked NPs, which are typically subject NPs, and *wo*-marked NPs, which are object NPs. According to Shibatani, the ungrammaticality of (2) derives from the case marking by *de* in the NP from which the quantifier floats. Such an explanation, however, leaves other cases of floating unexplained by neglecting the existence of floated *ni*-marked object NPs. For example, (6) is completely grammatical even though the quantifier is floated from a *ni*-marked NP.

(6) Tom-ga yūmeina **kyouzyu-ni sannin** atta.
Tom-Nom famous professor-Dat three see-Past
"Tom met three famous professors."

The account by Miyagawa (1989) is based on a condition imposed between an NP and a numeral quantifier requiring only mutual c-command. His analysis, however, predicts unfavorable consequence that the ill-formed NP in (7) is expected to be grammatical.

(7) * $[_{NP}$ $[_{NP}$ gakusei-no] san-nin seikō]
student-Gen three success
"A success of three students."

In addition, according to his theory only *ga*-marked and *wo*-marked NPs allow the quantifier to float, so it is impossible to account for the floating out of *ni*-marked NPs mentioned in (6). This shows that a purely syntactic approach to the problem does not work and that some semantic information, specifically that of θ-roles, must be refered to by the rule.

3.2 Okutsu (1996a, 1996b)

Some previous studies, on the other hand, have tried to shed light on the semantic aspects of numeral quantifiers. For example, Okutsu (1996a, 1996b) describes the semantic differences between floated quantifiers and non-floated ones, and Yazawa (1985) also points out the adverbial property of floated quantifiers. These, however, are descriptive studies and the question still remains as to how to formulate them by a formal apparatus.

3.3 Yatabe (1993) and Fukushima (1991)

As a theoretical study, Yatabe (1993) mentions quantifier floatings briefly. His HPSG-based approach is syntactic, that is, mainly concerned with whether Japanese syntactic structure is symmetric or asymmetric and there is little concern for semantics. On the other hand, Fukushima (1991) proposes a semantic analysis which is the extension of the analysis of floated quantifiers in English by Dowty and Belinda (1984). In Fukushima's account, scrambling is assumed to induce filler-gap dependencies, so the structure [$Subj$ [Obj_i [$SubjOrientedFQ$ [t_i V]]]], which is the same word order as (3a), is overgenerated and he does not present any argument for it.

4 The Interpretation by the Model

4.1 Syntactic Framework

We adopt Categorial Grammar (Carpenter 1997) as a syntactic frame work because we believe the syntactic combinations of natural language accurately reflect how meanings are put together. Categorial Grammar is a logic-based grammar which combines words by functional application.

For example, Figure 1 below shows the syntactic derivation of (8), which is an example of a non-floated numeral quantifier.

(8) John-ga **sansatu-no** hon-wo katta.
John-Nom three-Gen book-Acc bought-Past
"John bought three books."

We assume here that the canonical word order of Japanese is SVO. As seen in Figure 1 a type of non-floated quantifier is assigned a category np/np, which is the same category as an adjective, while the category of floated quantifer is X/X, which means that the category it returns is the same category it takes as an argument. An example of floated quantifier is (9) and the derivation of (9) is Figure 2.

(9) John-ga hon-wo **sansatu** katta.
John-Nom book-Acc three buy-Past
"John bought three books."

The word order in Japanese is relatively free and object NPs can be scrambled as seen in (10). Here, hypothetical resource x is used as a trace of the object NP in the derivation of (10) illustrated in Figure 3.

(10) hon-wo$_i$ John-ga t_i **san-satu** katta.
book-Acc John-Nom three bought-Past
"John bought three books."

4.2 Semantic Framework

There are two types of numeral quantifiers: one expresses the number of NPs and the other expresses the quantity of the NPs they modify. In order to interpret the former type of quantifier, a set of NPs is stipulated and the meaning of the quantifier is interpreted by means of the *cardinality* of the set. For the latter type, on the other hand, functions which output the quantity are defined: for example, the function f_l which returns the length of an NP and the function f_w returns the weight of an NP.

(11) John-ga hon-wo san-satsu yonda.
John-Nom book-Acc three read-Past
"John read three books."

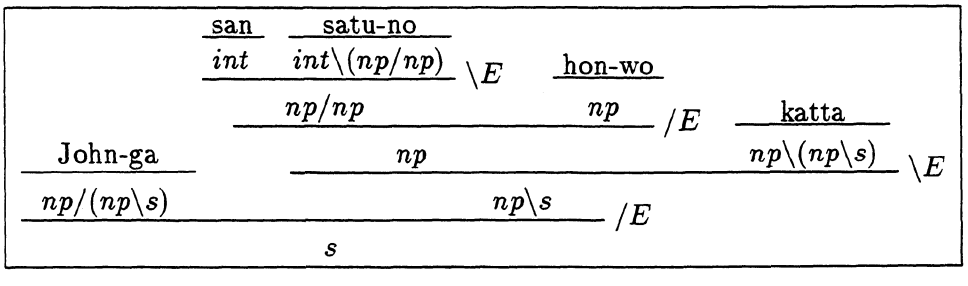

Figure 1: Syntactic derivation of (8)

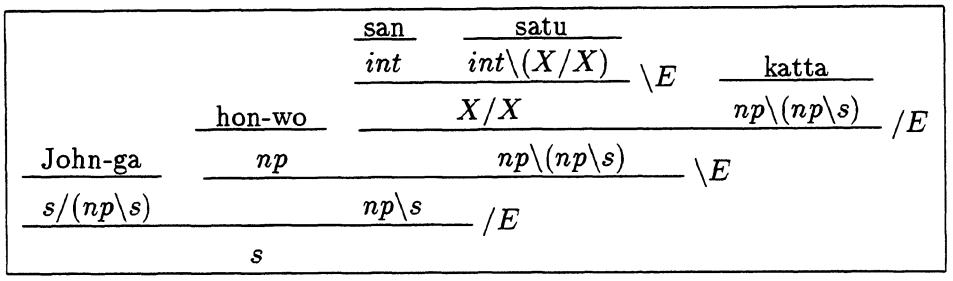

Figure 2: Syntactic derivation of (9)

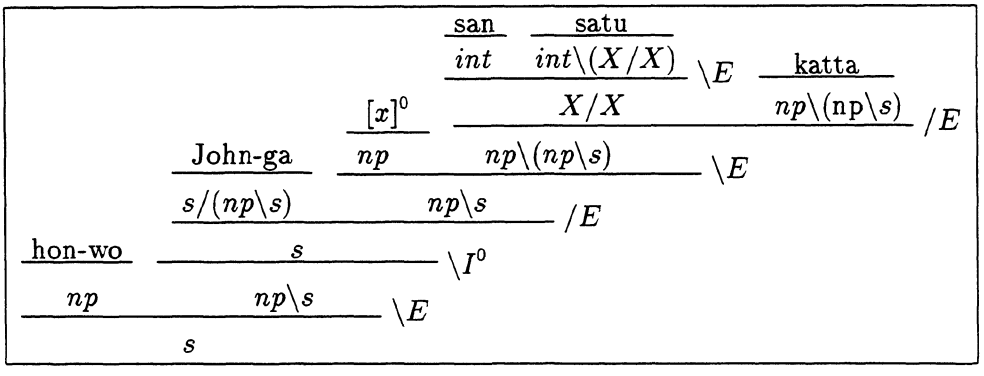

Figure 3: Syntactic derivation of (10)

Now let us illustrate the semantic derivation of the sentence with a floated quantifier. Figure 4 shows the lexical items in (5a), which is repeated as (11) for convenience. The illustration of the derivation is shown in Figure 5. The lexical items are represented as composed of the triple <*syntax*; *semantics*; *implicature*>, and the pair <*syntax*; *semantics*> is used as an abridged notation when there is no relevant pragmatic implicature. The category of floated quantifiers is the same as adverb, X/X, i.e., it returns the same category that it takes as an argument.

Figure 4 is the lexical items of (11), which is an example of a floated quantifier and we show the derivation of (11) in Figure 5. The whole representation for *semantics* in Figure 5 says that there is a set Z, and the number of the element of Z is three. For some z, z is a member of the set Z and z is a book, and there is an event e, of which is *Reading* is predicated, and *John* is an Agent of the event e and z is a Patient of the event.

On the other hand, the meaning implied by floated quantifier is represented immediately next to the semantics. According to the representation there is a set X which includes the set Z as subset and X can be further bound by the context. If the set X is canceled by the context, then the implied meaning is the same as the truth-conditonal meaning.

Adverbials of degree are also numeral quantifiers. As we mentioned, the truth-conditional meaning of the sentence with non-floated quantifiers and floated quantifiers is the same, but it

yonda $\mapsto \langle np\backslash(np\backslash s);\ \lambda v.\lambda w.\exists e[\mathrm{Reading}(e) \wedge \mathrm{Agent}(e, w) \wedge \mathrm{Patient}(e, v)]\rangle$
satsu $\mapsto \langle int\backslash X/X;\ \lambda y.\lambda Q.\lambda P.\lambda m.\exists Z[f_s(Z) = y \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]];$
$\lambda y.\lambda Q.\lambda P.\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_s = y \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]]\rangle$
san $\mapsto \langle int;\ 3\rangle$
hon-wo $\mapsto \langle np;\ \lambda y.book(y)\rangle$
John-ga $\mapsto \langle s/(np\backslash s);\ \lambda P.P(John)\rangle$

Figure 4: Lexical Items of (11)

san-satsu;
$\langle X/X;\ \lambda Q.\lambda P.\lambda m.\exists Z[f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]];$
$\lambda Q.\lambda P.\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]]\rangle$
san-satsu yonda;
$\langle np\backslash(np\backslash s);$
$\lambda P.\lambda m.\exists Z[f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge \lambda w.\exists e[\text{Reading}(e) \wedge \text{Agent}(e, w)$
$\wedge \text{Patient}(e, z)](\text{m})]]$
$= \lambda P.\lambda m.\exists Z[f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge \exists e[\text{Reading}(e) \wedge \text{Agent}(e, m) \wedge \text{Patient}(e, z)]]];$
$\lambda P.\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge \lambda w.\exists e[\text{Reading}(e)$
$\wedge \text{Agent}(e, w) \wedge \text{Patient}(e, z)](\text{m})]]$
$= \lambda P.\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_s(Z) = 3 \wedge \exists z[z \in Z \wedge P(z) \wedge \exists e[\text{Reading}(e)$
$\wedge \text{Agent}(e, m) \wedge \text{Patient}(e, z)]]]\rangle$
hon-wo san-satsu yonda;
$\langle np\backslash s;$
$\lambda m.\exists Z[f_s(Z) = 3 \wedge \exists z[z \in Z \wedge \text{book}(z) \wedge \exists e[\text{Reading}(e) \wedge \text{Agent}(e, m) \wedge \text{Patient}(e, z)]]];$
$\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_s(Z) = 3 \wedge \exists z[z \in Z \wedge \text{book}(z) \wedge \exists e[\text{Reading}(e)$
$\wedge \text{Agent}(e, m) \wedge \text{Patient}(e, z)]]]\rangle$
John-ga hon-wo san-satsu yonda;
$\langle s;\ \exists Z[f_s(Z) = 3 \wedge \exists z[z \in Z \wedge \text{book}(z) \wedge \exists e[\text{Reading}(e) \wedge \text{Agent}(e, John) \wedge \text{Patient}(e, z)]]];$
$\exists X \exists Z[X \supseteq Z \wedge f_s(Z) = 3 \wedge \exists z[z \in Z \wedge \text{book}(z) \wedge \exists e[\text{Reading}(e)$
$\wedge \text{Agent}(e, John) \wedge \text{Patient}(e, z)]]]\rangle$

Figure 5: Derivation of (11)

does not hold for adverbials of degree. In (12a), the truth-conditional meaning is that the length of Central street is 100m and John did not necessarily run the full length. This meaning is not the same as that of (12b); in a typical case, the street is longer than 100m and John ran along only part of it.

(12) a. John-ga **hyaku-mētoru-no** Chūōdōri-wo hasitta.
John-Nom 100-m-Gen Central street-Acc run-Past
"John ran 100m Central street."

b. John-ga Chūōdōri-wo **hyaku-mētoru** hasitta.
John-Nom Central street-Acc 100-m run-Past
"John ran 100m along Central street."

Therefore, we treat adverbials of degree as non-floated numeral quantifiers and differentiate them from floated quantifiers, but the properties of syntax and semantics of both floated quantifiers and adverbials of degree are similar in terms of the point we discuss here.

hashitta $\mapsto \langle np\backslash(np\backslash s);\ \lambda v.\lambda w.\exists e[\text{Running}(e) \wedge \text{Agent}(e, w) \wedge \text{Path}(e, v)]\rangle$
mētoru $\mapsto \langle int\backslash(X/X);\ \lambda y.\lambda Q.\lambda P.\lambda m.\exists Z[f_{l_m}(Z) = y \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]];$
$\lambda y.\lambda Q.\lambda P.\lambda m.\exists X \exists Z[X \supseteq Z \wedge f_{l_m}(Z) = y \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]]\rangle$
hyaku $\mapsto \langle int;\ 100\rangle$
Chūōdōri-wo $\mapsto \langle np;\ \lambda y.\text{Central-st}(y)\rangle$
John-ga $\mapsto \langle s/(np\backslash s);\ \lambda P.P(John)\rangle$

Figure 6: Lexical item of (12)

hyaku mētoru;
$\langle X/X;\ \lambda Q.\lambda P.\lambda m.\exists X\exists Z[f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]]];$
$\lambda Q.\lambda P.\lambda m.\exists X\exists Z[X \supseteq Z \wedge f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge Q(m)(z)]]]\rangle$
hyaku mētoru hashitta;
$\langle np\backslash(np\backslash s);$
$\lambda P.\lambda m.\exists Z[f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge \lambda w.\exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, w) \wedge \text{Path}(e, z)](\text{m})]]$
$= \lambda P.\lambda m.\exists Z[f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge \exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, m) \wedge \text{Path}(e, z)]]];$
$\lambda P.\lambda m.\exists X\exists Z[X \supseteq Z \wedge f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge \lambda w.\exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, w) \wedge \text{Path}(e, z)](\text{m})]]$
$= \lambda P.\lambda m.\exists X\exists Z[X \supseteq Z \wedge f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge P(z) \wedge \exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, m) \wedge \text{Path}(e, z)]]]\rangle$
Chūōdōri-wo hyaku mētoru hashitta;
$\langle np\backslash s;$
$\lambda m.\exists Z[f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge \text{Chūōdōri}(z) \wedge \exists e[\text{Running}(e) \wedge \text{Agent}(e, m) \wedge \text{Path}(e, z)]]];$
$\lambda m.\exists X\exists Z[X \supseteq Z \wedge f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge \text{Chūōdōri}(z) \wedge \exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, m) \wedge \text{Path}(e, z)]]]\rangle$
John-ga Chūōdōri-wo hyaku mētoru hashitta;
$\langle s;$
$\exists Z[f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge \text{Chūōdōri}(z) \wedge \exists e[\text{Running}(e) \wedge \text{Agent}(e, \textit{John}) \wedge \text{Path}(e, z)]]];$
$\exists X\exists Z[X \supseteq Z \wedge f_{l_m}(Z) = 100 \wedge \exists z[z \in Z \wedge \text{Chūōdōri}(z) \wedge \exists e[\text{Running}(e)$
$\wedge\ \text{Agent}(e, \textit{John}) \wedge \text{Path}(e, z)]]]\rangle$

Figure 7: Derivation of (12)

An adverbial creates a new set which is a subset of the set denoted by *Chūōdōri-wo*, which is morphologically marked by the accusative *wo*, as a floated quantifier does. In order to show a unified treatment of floated quantifiers and adverbials by this model, I show the lexical items of (12) in Figures 6 and the derivation of (12b) in Figure 7. In Figure 6 and 7, the function f_{l_m} is a sort of the function f_l and outputs how many meters the length is. The truth-conditional meaning of the last step of Figure 7 is such that there is a set Z and the length denoted by the set Z is 100m, and there are elements z, of which Central street can be predicated, of the set Z; furthermore, there is the event e which is *Running*, and John is the Agent of the event and z is the Patient. The implied meaning says that there is a set X whose subset is the set Z, and X is bound by the context in which the sentence is used. Note that this implicature can be canceled depending on the context. Assume that Central street is only 50m long and John went up and down the street; even in such a situation (12b) holds.

In our proposal, the floated quantifier semantically combines with the predicate only if the NP that the quantifier 'quantifies' bears a θ-role within the verb's lexical definition. Thus floating is limited to Agent, Patient, Theme, and Path. The *de*-marked NP in (2), bearing Instrument, is an adjunct and cannot be combined with the quantifier into a well-formed formula.

Indefiniteness observed in the objects of the actions in (11) and (12) is explained straightforwardly. The *wo*-marked accusative NPs may be prefixed by the iota operator for indicating definiteness or may be left as in Figures 5 and 7 in the case of being indefinite; the set introduced by the floated quantifier or the adverbial, Z, is a subset of the set denoted by the accusative NP, X, and as such remains indefinite.

4.3 Some Consequences of the Proposed Analysis

In this section let us consider some consequences of our approach to the quantifier floating phenomena and discuss how the problems mentioned in §2 are solved.

Firstly, according to the approach proposed here a floated quantifier modifies the NP whose position is immediately precedent to it, so sentences like (3a) can be ruled out. While as seen in (3b), the object NP occurs in the position preceding to the subject NP by scrambling and the floated quantifier and the object NP is separated, we can put a hypothetical variable x instead of the object NP and semantically bind it by a slash introduction rule, so our proposal predicts (3b) as grammatical.

Secondly, unlike Shibatani (1977), our proposal is able to cope with one part of *ni*-marked NPs, which can be both an argument of the verb and adjunct, because our formalization is based on not the classification of case of the NP but the θ-role, i.e., we can say that the quantifiers can float from only the NPs which have θ-roles, especially Agent, Patient, Theme and Patient, which are the arguments of a verb, irrespective of the morphological case information. The framework, therefore, proposed in this paper is a semantically oriented framework, and the problems caused by syntactic approaches such as c-command in Miyagawa (1989) can be avoided.

5 Conclusion

In this paper we have proposed a method to compositionally interpret the meaning and conventional implicature of floated quantifiers on the basis of Categorial Grammar and Davidsonian semantics. This model also shows that adverbials and quantifiers can be uniformly treated by the whole-part relation, a relation between a set Z expressed by the accusative NP and a set X which is restricted by the context in which the sentence is used.

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