Polymorphic Quantifier

Sumiyo Nishiguchi

Stony Brook University, Department of Linguistics
Stony Brook, NY 11794, USA
Osaka University, Graduate School of Letters, Department of English Linguistics
1-5 Machikaneyama, Toyonaka, Osaka 560-8532, Japan
snishigu@ic.sunysb.edu
http://homepage3.nifty.com/sumiyo_nishiguchi/

Abstract. The generalized quantifier theory does not apply to Japanese quantifiers since: i) the number of NP argument is unspecified; and, ii) quantities are often expressed by predicative adjectives. The word order changes the interpretation, e.g., non-split quantifiers correspond to definite NPs with uniqueness and maximality conditions while split NPs are wide scope indefinites. This paper shows that adjectival quantifiers are polymorphic, and that continuation-based combinatory categorial grammar (1) accounts for different meanings between (non)split quantifiers.

1 Limit to Generalized Quantifier Theory

The generalized quantifier theory in (2) maps the syntactic constituency between a noun and a determiner into a quantifier. Such view and even relational view on generalized quantifier which considers the relation between two sets (3, 4) cannot handle Japanese quantificational words whose number of argument is not necessarily two. Moreover, being a determiner-less language, quantities are often expressed by predicates naturally. A quantificational phrase and a modified noun show long distance dependency as a split NP or a floating quantifier.

1.1 Predicative Adjectival Quantifiers

In English, quantifiers are normally noun phrases as in *Many people attended*. However, as (5) observes, numbers and quantities are more naturally expressed as a predicate in Japanese. While English-type quantifiers are possible as in (1a), predicative adjectives (1b) are more natural.

(1) a. Oku-no nihonjin-wa A-gata-da.
many-GEN Japanese-TOP A-type-be
'Many Japanese are type A'

b. Nihonjin-wa A-gata-ga oi.
Japanese-TOP A-type-NOM many
'Many Japanese are type A'

While weak determiners such as *many*, *few*, and *five* can appear as predicative adjectives, strong determiners like *every* and *most* cannot in English.[1][2] In Japanese, both weak and strong quantifiers appear as predicative adjectives (2b).

(2) a. The number of attendants was {many/few/forty/*most/*every}.
b. Shussekisha-ga {okat/sukunakat/yonju-nin-dat/hotondo-dat/zen-in-dat}-ta.
attendant-NOM many/few/40-CL/most/every-be-PAST
'The attendants were many/few/40/most/all'

Since adjectives denote a property or a set of entities, the denotations of *many* and *three* would be the sets of entities whose numbers are considered to be many, and three, respectively. (7) proposes the function BE which shifts generalized quantifiers such as *an authority* in type (et, t) into (et) in predicate position (*Mary considers John competent in semantics and an authority on unicorns*).

As far as adjectival quantifiers predicate only one argument and cardinal numbers are concerned, the (et) analysis works. However, Japanese quantificational adjectives predicate more than one argument.

1.2 Unspecified Number of Argument

Since quantifiers in Japanese, which is a language without overt determiners, do not correspond to noun phrases as in English, (5) points out that the NP-quantifier universal in (2) should be rejected.

(3) U1 NP-Quantifier universal:
"Every language has syntactic constituents (called noun-phrases) whose semantic function is to express generalized quantifiers over the domain of discourse." (2,177)

Even though Japanese generalized quantifiers do not correspond to noun phrases, (5) claims that quantification in Japanese is still based on a relation between two predicates. (8) further proposes that Japanese generalized quantifiers are relational.

(4) a. (Tokyo-wa) (gakusei-ga) oi(E)
Tokyo-TOP dog-NOM many
'There are many students in Tokyo'
b. (hitobito-wa) hotondo(E) (kaetteshimatta).
people-TOP most went home-PAST
'Most people have left'

[1] Weak quantifiers are admitted in there-sentences while strong quantifiers are not (6, 2).

[2] (7) says that *every NP* and *most NP* cannot appear in the complement of *consider*.

(i) Mary considers that two islands/*every island/*most islands.

This analysis works as far as quantificational words take exactly two arguments. However, in arguably non-configurational language Japanese, the number of argument is not specified. (9) proposes generating sentences by means of phrase structure rule in (5):

(5) x' → x'* x

At sentential level, subject can be null or of any number as far as there is a predicate in a sentence final position.

(6) S → NP* V
S → NP* AP

1 argument:

(7) Shussekisha$_{NP}$-ga {sukunakat/okat}$_{AP}$-ta.
attendants-NOM few/many-PAST
'There were few/many attendants (Lit. The attendants were few/many'

2 arguments:

(8) Nihonjin$_{NP}$-wa A-gata$_{NP}$-ga oi$_{AP}$.
Japanese-TOP A-type-NOM many
'Many Japanese are type A'

3 arguments:

(9) Gakusei$_{NP}$-wa amerikajin$_{NP}$-ga komochi$_{NP}$-ga oi$_{AP}$.
student-TOP American-NOM with kids-NOM many
'Many students are Americans who have children'

1.3 Uniqueness and Maximality of Non-Split NP and Indefinite Split NP

We further observe that word order marks definiteness of the quantifier noun phrase. While English floating quantifiers are limited to universals such as *all* and *each* (10) as in (10a), Japanese floating quantifiers have more variety (11). While English floating quantifiers do not allow long distance dependencies (10b), a Japanese numeral quantifier and a modified noun can be split by adverbials under certain restrictions (12).

(10) a. The students all came.
b. *The students yesterday all came.

(11) a. Gakusei-ga zen-in/mina/3-nin kita.
student-NOM all-member/all/3 came
'All/three students came'

b. Chichioya-wa {hotondo/taigai/daitai} shiawase-da.
father-TOP most happy-be
'Fathers are mostly happy.'
c. Gakusei-wa rokuwari kuruma-o mot-teiru.
student-TOP 60 percent car-ACC have-PROG
'Sixty percent of the students have a car'

(12) a. NP_{nomi} *Adv* Q_i *V*
Tomodachi-ga kino san-nin kita.
friend-NOM yesterday 3-CL came
'Three friends of mine came yesterday'
b. NP_{nom} NP_{acci} *Adv* Q_i *V*
Tomodachi-ga hon-o kino san-satsu katta.
friend-NOM book-ACC yesterday 3-CL bought
'A friend of mine bought three books yesterday'
c. NP_{acci} NP_{nom} *Adv* Q_i *V*
Hon-o tomodachi-ga kino san-satsu katta.
book-ACC friend-NOM yesterday 3-CL bought
'Three friends of mine came yesterday'
d. *NP_{acc} NP_{nomi} *(Adv)* Q_i *V*
*Hon-o tomodachi-ga (kino) san-nin katta.
book-ACC friend-NOM yesterday 3-CL bought
'A friend of mine bought three books yesterday'
e. *NP_{nomi} NP_{acc} *(Adv)* Q_i *V*
*Tomodachi-ga hon-o (kino) san-nin katta.
friend-NOM book-ACC yesterday 3-CL bought
'Three friends of mine bought a book yesterday'

(11) discusses NP split of the definite superlative in Hungarian. Interestingly, NP split is allowed only with a comparative indefinite reading, but not with absolute definite reading of the superlative.

(13) [$_{Leftdisl}$ zöld ló-val] [$_{FOCUS}$ itt] találkoztam a legzszebb-bel
green horse-with here met-I the prettiest-with
'I met a prettier green horse here than anywhere else'
'*As for green horses, it was here that I met the prettiest of them, i.e., the prettiest green horse that there is'

In Japanese, the use of a non-split quantifier phrase should satisfy the uniqueness presuppositions. A prenominal quantifier is exhaustive while a postnominal quantifier is not.

(14) a. # 2-hiki-no neko-ga hashit-te, hoka-no neko-wa suwat-teiru. [exhaustive]
2-CL-GEN cat-NOM run-and other-GEN cat-TOP sit-PROG
'The two cats are running and other cats are sitting'
b. Neko-ga 2-hiki hashit-te, hoka-no neko-wa suwat-teiru. [non-exhaustive]
cat-NOM 2-CL run-and other-GEN cat-TOP sit-PROG
'Two cats are running and other cats are sitting'

(15) a. # 3-nin-no gakusei-ga kino hataraita. Mo hutari-mo hataraita. [exhaustive]
3-CL-GEN student-NOM yesterday worked more 2-CL-also worked
'The three students worked yesterday. Two others worked, too'
b. Gakusei-ga kino 3-nin hataraita. Mo hutari-mo hataraita. [non-exhaustive]
student-NOM yesterday 3-CL worked more 2-CL-also worked
'Three students worked yesterday. Two others worked, too'

(16) a. # 2-to-no midori-no uma-ni at-te, mata 3-to-ni atta. [exhaustive]
2-CL-GEN green-GEN horse-DAT met-and again 3-CL-DAT met
'I met the two green horses and met three more, too'
b. Midori-no uma 2-to-ni at-te, mata 3-to-ni atta. [non-exhaustive]
green-GEN horse 2-CL-DAT met-and again 3-CL-DAT met
'I met two green horses and met three more, too'

A prenominal quantifier phrase should refer to a unique set which is the maximal collection of things. *2-hiki-no neko* in (14a) corresponds to a definite NP *the two cats* and there should be only two cats in the domain of discourse. On the other hand, a floating (split) quantifier phrase does not have such implication and corresponds to indefinite *two NP*.[3]

(17) a. $\exists X.[\text{cat'}(X) \wedge |X| = 2 \wedge \forall y.[\text{cat'}(y) \rightarrow y \sqsubseteq X] \wedge \text{ran'}(X)]$
b. $\exists X.[\text{cat'}(X) \wedge |X| = 2 \wedge \text{ran'}(X)]$

(18) a. $\exists X.[\text{student'}(X) \wedge [|X| = 3] \wedge \forall y.[\text{student'}(y) \rightarrow y \sqsubseteq X] \wedge \text{worked'}(x)]$
b. $\exists X.[\text{student'}(X) \wedge [|X| = 3] \wedge \text{worked'}(x)]$

Note that split NPs are scope insensitive and always take wider scope over a bare noun phrase. It has been pointed out that split NP allows a distributive reading but not a collective reading (13, 14, among others). In (19a), three students may either make a cake together (a cake > three students) or make three cakes each (three students > a cake). On the other hand, (19b) only allows each student to make separate cakes (three students > a cake).

(19) a. 3-nin-no gakusei-ga keeki-o tsukutta. [$\surd$collective, $\surd$distributive]
3-CL-GEN student-NOM cake-ACC made
'The three students made a cake'
b. Gakusei-ga 3-nin keeki-o tsukutta. [*collective, $\surd$distributive]
student-NOM 3-CL cake-ACC made
'Three students made a cake'

(20) a. {3-biki-no neko-ga/Neko-ga 3-biki} 2-hiki-no nezumi-o tabeta. [$\surd$collective, *distributive]
3-CL-GEN cat-NOM/cat-NOM 3-CL 2-CL-GEN rat-ACC ate
'(The) three cat ate two rats'
b. {3-biki-no neko-ga/Neko-ga 3-biki} nezumi-o 2-hiki tabeta. [$\surd$collective, *distributive]
3-CL-GEN cat-NOM 2-CL-GEN rat-ACC ate
'(The) three cats ate two rats'

[3] See discussions on the uniqueness effects of English definite noun phrases in (12).

In order to force a narrower reading on a split QP, a distributivity marker *zutsu* 'each' is necessary (15, 16).

(21) Neko-ga 3-biki nezumi-o 2-hiki-zutsu tabeta. [*collective, √distributive] [4]
cat-NOM 3-CL rat-ACC 2-CL-each ate
'Three cats ate two rats each'

(22) a. non-split QP: definite with uniqueness presuppositions and maximality condition (exhaustive)
b. split QP: wide scope indefinite
c. zutsu (each) QP: distributive phrase

Even though Japanese lacks determiners, (19) assumes that Japanese noun phrases have D or something equivalent in terms of the function. In harmony with Fukui's analysis, (20) proposes a null determiner of type (et, (et, t)) which combines with a bare noun phrase of type (et). If so, the null determiner corresponds to an indefinite determiner [5]. Alternatively, we might assume a contextually determined choice function f (18) which maps a nominal property into an individual or plural individuals.

(23) a. Gakusei-ga kita.
student-NOM came
'A student came'
b. $[\![student]\!] = \mathrm{f}_{(et,e)}\exists \mathrm{x.f}(\lambda \mathrm{x.student'(x)})$

2 Flexible Type Approach to Adjectival Quantifiers

The unspecified number of arguments suggests a polymorphic type for adjectival quantifiers, (et^n, t), that can be either (et), (et,(et,t)) or ((et,(et,(et))),t). Proportional *many* would have the following lexical entry:

(24) $[\![many]\!]_{((e\to t)^n \to t)}$
$= \lambda \mathrm{P}_1,\mathrm{P}_2,...,\mathrm{P}_n.|\mathrm{P}_1 \cap \mathrm{P}_2 \cap,...,\cap \mathrm{P}_n| \geq |\mathrm{P}_n| \cdot \mathrm{c}$

A quantificational word in such a flexible type can take any number of arguments. We also adopt N-ary Function Application (NFA) (22,40) for interpreting flat structures. Let us add NFA to the basic rules in the Combinatory Categorial Grammar (CCG) (23, 24).

[4] The scope escaping effect of split NPs appears to be limited clause internally, as English wide-scope indefinites show the similar behavior (17, 18). (18) suggests that the bound variables in the embedded clause do not provide neutral environment.

(ii) Do-no kyoju-mo jibun-ga suisenshita hon-o 3-satsu yonda gakusei-o hometa.
any professor-also self-NOM recommended book-ACC 3-CL read student-ACC praised
'Every professor praised a student who read three books that he recommended'

[5] (21) assumes a null determiner for bare NP and shows that Hungarian split NP takes narrower scope than any other kind of scope bearing element.

(25) a. N-ary Function Application:
$[\![[_{X^n} X^o AA'A"...]]\!]^g =$
$[\![X^0]\!]^g([\![A_n]\!]^g)([\![A_{n-1}]\!]^g)...([\![A_1]\!]^g)$
where $A_1, A_2, ..., A_{n-1}, A_n$ is the order of *A, A', A"*...on X^0's argument-list

b. N-ary Function Application:
A_1: a,...,A_n:z A_1,...,$A_n \backslash$ B:f $\Rightarrow$ B: f((a),...,(z)) ($^n <$)

1 argument:

(26) Shussekisha-wa sanju-nin-dat-ta.
attendant-TOP 30-CL-be-PAST
'The number of attendants was thirty'

$$\frac{\dfrac{shussekisha - wa}{N : \lambda x.attendant'(x)}\ \text{Lex} \qquad \dfrac{sanju - nin - dat - ta}{N\backslash S : \lambda P.|P| = 30}\ \text{Lex}}{S : |\lambda x.attendent'(x)| = 30}\ <$$

2 arguments:

(27) Gakusei-wa amerika-jin-ga oi.
student-TOP American-NOM many
'There are many Americans among students'

$$\frac{\dfrac{gakusei - wa}{N : \lambda x.student'(x)}\text{Lex} \quad \dfrac{amerikajin - ga}{N : \lambda y.American'(y)}\text{Lex} \quad \dfrac{oi}{N\backslash(N\backslash S) : \lambda P, Q.|P \cap Q| \geq |Q| \cdot c}\text{Lex}}{S : |\lambda x.student'(x) \wedge American'(x)| \geq |\lambda x.student'(x)| \cdot c}\ ^n <$$

3 arguments:

(28) Gakusei-wa amerikajin-ga komochi-ga oi.
student-TOP American-NOM with kids-NOM many
'Many students are Americans who have children'

$$\frac{\dfrac{gakusei - wa}{N : \lambda x.student'(x)}\text{Lex} \quad \dfrac{amerikajin - ga}{N : \lambda y.American'(y)}\text{Lex} \quad \dfrac{komochi - ga}{N : \lambda z.parent'(z)}\text{Lex} \quad \dfrac{oi}{N\backslash(N\backslash(N\backslash S)) : \lambda P, Q, R.|P \cap Q \cap R| \geq |R| \cdot c}\text{Lex}}{S : |\lambda x.student'(x) \wedge American'(x)| \geq |\lambda x.student'(x)| \cdot c}\ ^n <$$

3 Uniqueness by Word Order

The different meaning between floating and non-floating quantifiers implies that word order contributes to meaning. In other words, the meaning of a (non)floating quantifier is sensitive to word order, and the order of evaluation affects interpretation. The (in)definiteness appears to be the result of the left-to-right evaluation, and definite interpretation is the result of processing a prenominal numeral first. Let us add a raising rule into a continuized type and its reverse, lowering, to basic rules in CCG (25):

(29) a. Functional Application
A/B: f B: a $\Rightarrow$ A: f(a) ($>$)
A: a A\B: f $\Rightarrow$ B: f(a) ($<$)

b. Functional Composition
   A/B: f B/C: g ⇒ A/C : λx. f(g(x)) (B)
   A\B: f B\C: g ⇒ A\C: λx.f(g(x)) (B)
c. Type Raising
   A: a ⇒ S/(A\S): λf.f(a) (T)
d. Type Raising into a Continuatized Type
   A: a ⇒ S/(A\S): λk.k(a) (T)
e. Lowering
   S/(A\S):λk.k(a) ⇒ A: a (LOWER)

The type raising rule into a continuized type (29d) enables any type of syntactic category to become a quantifier. Japanese bare nouns are inherently type (et) which undergo type raising into an existential indefinite noun phrase ((et,t),t). A measure phrase which is also type (et) either as a common noun or an adjective is also raised into the same continuized type as the raised bare noun.

(30)

$$\dfrac{\dfrac{\dfrac{\dfrac{gakusei-ga}{N:\lambda x.student'(x)}\text{Lex}}{S/(N\backslash S):\lambda k.\exists x.k(\lambda x.student'(x))}\text{T} \quad \dfrac{\dfrac{3-nin}{NP\backslash S:\lambda X.|X|=3}\text{Lex}}{S/((NP\backslash S)\backslash S):\lambda k.k(\lambda X.|X|=3)}\text{T}}{S/(N\backslash S):\lambda k.\exists X.k(\lambda X.student'(X)\wedge|X|=3)}\text{B}}{N:\lambda X.\exists X.student'(X)\wedge|X|=3}\text{LOWER} \quad \dfrac{kita}{NP\backslash S:\lambda y.came'(y)}\text{Lex}}{S}>$$

(31)

$$\dfrac{\dfrac{\dfrac{\dfrac{3-nin-no}{NP\backslash S:\lambda X.|X|=3}\text{Lex}}{S/((NP\backslash S)\backslash S):\lambda k.k(\lambda X.|X|=3)}\text{T} \quad \dfrac{\dfrac{gakusei-ga}{N:\lambda x.student'(x)}\text{Lex}}{S/(N\backslash S):\lambda k.\exists x.k(\lambda x.student'(x))}\text{T}}{S/(NP\backslash S):\lambda k.k(\lambda X.|X|=3\wedge student'(X))}\text{B}}{N:\lambda X.|X|=3\wedge student'(X)}\text{LOWER} \quad \dfrac{kita}{NP\backslash S:\lambda y.came'(y)}\text{Lex}}{S}>$$

Since the measure phrase and the bare noun are in the same continuized type, the left category takes wider scope over the one on the right by definition. When an indefinite continuized bare noun composes with a definite measure phrase on the right, the whole quantifier phrase is interpreted to be indefinite in (30). On the other hand, *3-nin-no* is not existential in the continuized type so that the composed quantifier phrase comes to have exhaustive scalar implicature in (31).

4 Conclusion

Quantities are expressed by predicative adjectives and split and non-split quantifiers in Japanese. Since the number of arguments is unspecified, we need a polymorphic type for adjectival quantifiers. The word order differentiates the definiteness of quantifiers, which is explainable by left to right evaluation of a bare noun and a numeral phrase in the continuized type.

Bibliography

[1] Shan, C.C., Barker, C.: Explaining crossover and superiority as left-to-right evaluation. Linguistics and Philosophy (2006) 91–134

[2] Barwise, J., Cooper, R.: Generalized quantifiers and natural language. Linguistics and Philosophy (1981) 159–219

[3] Zwarts, F.: Determiners: a relational perspective. In: Studies in Model-Theoretic Semantics. Foris, Dordrecht (1983) 37–62

[4] van Benthem, J.: Essays in logical semantics. Reidel, Dordrecht (1986)

[5] Imani, M.: On quantificaiton in japanese. English Linguistics **7** (1990) 87–104

[6] Milsark, G.: Toward an explanation of certain peculiarities of the existential construction of english. Linguistic Analysis **3** (1977) 1–29

[7] Partee, B.: Noun phrase interpretation and type-shifting principles. In: Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers. Reidel, Dordrecht (1986) 115–144

[8] Ogata, N.: Japanese particles and generalized quantifiers. In: Proceedings of the 4th Summer Conference 1990 Tokyo Linguistics Forum. (1991) 115–127

[9] Hale, K.L.: Remarks on japanese phrase structure: Comments on the papers on japanese syntax. In: MIT working papers in Linguistics. Volume 2. (1980) 185–203

[10] Sportiche, D.: A theory of floating quantifiers and its corollaries for constituent structure. Linguistic Inquiry (1988) 425–449

[11] Szabolcsi, A.: Comparative superlatives. In: MITWPL. Volume 8. (1986)

[12] Roberts, C.: Uniqueness in definite noun phrases. Linguistics and Philosophy **26** (2003) 287–350

[13] Terada, M.: Incorporation and Argument Structure in Japanese. PhD thesis, University of Massachusetts, Amherst (1990)

[14] Nakanishi, K.: Event quantification and distributivity. In: Event Structures in Linguistic Form and Interpretation. Mouton de Gruyter, Berlin (to appear)

[15] Choe, J.W.: Anti-Quantifiers and a Theory of Distributivity. PhD thesis, University of Massachusetts, Amherst (1987)

[16] Kobuchi-Philip, M.: Semantics of zutsu. In: Formal Approaches to Japanese Linguistics. Volume 4 of MITWPL., Cambridge (to appear)

[17] Abusch, D.: The scope of indefinites. Natural Language Semantics (1993) 83–135

[18] Kratzer, A.: Scope or pseudoscope? are there wide-scope indefinites? http://semanticsarchive.net/ (1997)

[19] Fukui, N.: The principles-and-parameters approach: a comparative syntax of english and japanese. In: Approaches to Language Typology. Clarendon Press, Oxford (1995) 327–372

[20] Nishiguchi, S.: Logical properties of japanese kakari zyosi. In: Osaka University Working Papers in English Linguistics. Volume 7. (2002) 115–133

[21] Szabolcsi, A.: Focussing properties, or the trap of first order. Theoretical Linguistics **10** (1983) 125–146
[22] Büring, D.: Binding Theory. Cambridge University Press, Cambridge (2005)
[23] Steedman, M.: The Syntactic Process. MIT Press, Cambridge, Mass. (2000)
[24] Szabolcsi, A.: Bound variables in syntax (are there any?). In: Proceedings of the 6th Amsterdam Colloquium. (1987) 331–353
[25] Barker, C.: Continuations and the nature of quantification. Natural Language Semantics **10** (2002) 211–242