<table>
<thead>
<tr>
<th><strong>Title</strong></th>
<th>Categorial Grammar and Type Ambiguity of Japanese Particles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author(s)</strong></td>
<td>Nishiguchi, Sumiyo</td>
</tr>
<tr>
<td><strong>Citation</strong></td>
<td>Osaka Literary Review. 42 P.153-P.167</td>
</tr>
<tr>
<td><strong>Issue Date</strong></td>
<td>2003-12-24</td>
</tr>
<tr>
<td><strong>Text Version</strong></td>
<td>publisher</td>
</tr>
<tr>
<td><strong>URL</strong></td>
<td><a href="https://doi.org/10.18910/25221">https://doi.org/10.18910/25221</a></td>
</tr>
<tr>
<td><strong>DOI</strong></td>
<td>10.18910/25221</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
</tr>
</tbody>
</table>
Categorial Grammar and Type Ambiguity of Japanese Particles

Sumiyo Nishiguchi

Abstract
The purpose of this article is to present a new type-shifting rule from \(<a, a>\) to \(<a, <a, b>>\), which I call d-rule. This unknown raising is called for in view of the polymorphism of Japanese particles, kakari zyosi, such as wa, mo, sae, dake and sika, which undergo an extraordinary type-shift between \(<e, e>, <et, et>, <t, t>, <<et, et>, <et, et>>, <e, <et, t>>, as well as the determiner type \(<et, <et, t>>\). None of the present type-shifting rules in the framework of Combinatory Categorial Grammar, or ‘Geach Rule,’ ‘Montague Rule,’ ‘argument lowering’ in Partee and Rooth (1983), or ‘z-rule’ (Jacobson 1999) in Flexible Categorial Grammar is applicable to these natural language phenomena. The fact that kakari particles undergo type-shift to determiner-type, as attested to by Weak Crossover effects, requires such a novel type-raising rule.

1 Introduction
Japanese kakari zyosi, such as wa (topic marker), mo (‘also’), sae (‘even’) and dake (‘only’), are polymorphic in that they can attach to CN, PN, VP, PP or S (Nishiguchi 2003). This indicates that they go through unusual type-shift between \(<e, e>, <et, et>, <t, t>, <<et, et>, <et, et>>, <e, <et, t>>, as well as the determiner type \(<et, <et, t>>\), which is detected by the syntactic Weak Crossover (WCO) effects. In this paper, I suggest a new type-raising rule, because of the insufficiency of the combinatory
rules in Combinatory Categorial Grammar (CCG), and type-shift rules such as Geach Rule (Geach 1972) in the framework of Flexible Categorial Grammar. Although most of the type-shifts of these particles are explainable in the present analyses, another type-raising mechanism, which I call d-rule, should be constructed between \( <e, e> \) type and \( <et, <et, t>> \) type:

\[
(1) \quad d\text{-rule} \\
\text{change type } <a, a> \text{ to } <a, <a, b>>
\]

---

First, I will briefly overview the frameworks of Categorial Grammar (CG), starting from the Ajdukiewicz-Bar-Hillel calculus, Flexible Categorial Grammar and Combinatory Categorial Grammar. Then, the unique types of Japanese particles will be discussed.

2 Categorial Grammar

The original Categorial Grammar proposed by Ajdukiewicz (1935) and Bar-Hillel (1953) was based on fixed categories. Categories could be combined by a rule of functional application.

In the framework of Bar-Hillel (1953), e.g., the English sentence *Poor John sleeps* belongs to category \( s \) (for *sentence*),
John to the category n, poor to $\frac{n}{[n]}$, and sleeps to $\frac{s}{(n)}$, where n is approximately interpreted as the category of name-like strings. $\frac{n}{[n]}$ is the category of those strings with an n to their right forms a string belonging to the category n. $\frac{s}{(n)}$ is the category with n to the left which forms s.

In the current theory of CG, the corresponding notation is as follows:

(2) Poor John sleeps
   NP/NP NP NP/S
   NP
   S

2.1 Flexible Categorial Grammar
2.1.1 Montague Rule

Many attempts have been made to add various operations on the functions and arguments to the basic context-free apparatus. More flexible versions incorporating type-change have been proposed since then. For example, Montague Rule (Montague 1973) raises John (NP) to S/(NP\S), which corresponds to <et, t> in type theory.

(3) Poor John sleeps
   NP/NP NP NP/S
   S/(NP\S)
   S/(NP\S)
   S

(4) Montague Rule
    change type a to $\langle a, b \rangle, b$

Montague rule allows type <e> to be raised to <et, t>, but type <e, e> is not allowed to shift to <et, <et, t>>, which Japanese kakari particles undergo, to be discussed in section 3.
2. 1. 2 Geach Rule

Another prominent rule adopted by flexible categorial grammar is the ‘Geach Rule’ (Geach 1972):

(5) **Geach Rule**
change type \(<a, b>\) to \(<<c, a>, <c, a>>\)

This rule can be used, e.g., to lift cross-categorial connectives *and* or *or*, which can be conjoined with virtually every major category (Montague 1973; Partee and Rooth 1983):

(6)  Bill and Nick are happy.
    \[
    \text{S/(NP/S)} = \left( ((\text{NP}\backslash \text{S})) \left( (\text{S/(NP/S)}) / (\text{S/(NP/S)}) \right) \right) / (\text{S/(NP/S)})
    \]

(7)  Polly dances and sings.
    \[
    \text{NP} = (\text{NP/S}) / (\text{NP/S})
    \]

(8)  Sue swims and Terri eats.
    \[
    \text{NP} = (\text{S/S}) / \text{S}
    \]

By listing ordinary *and* in lexicon as \((\text{S/S}) / \text{S}\), all other categories can be derived by “Geaching.”

In the Japanese language, connective particles *to* (‘and’) and *ka* (‘or’) are also polymorphic, and Geach Rule, likewise, is eligible for generating all categories.

(9)  Taroo-to/ka Hanako-ga odotta.
    Taroo-CON Hanako-NOM dance-PAST
    ‘Taroo and/or Hanako danced.’

(10) Taroo-to/ka
    \[
    \text{S/(NP/S)} = \left( (\text{NP}\backslash \text{S}) \left( (\text{S/(NP/S)}) / (\text{S/(NP/S)}) \right) \right)
    \]

(11) Taroo-ga odotta-ka Hanako-ga odotta.
Sumiyo Nishiguchi

157

Taroo-NOM danced-COM Hanako-NOM danced
‘Taroo danced or Hanako danced.’

(12) Taroo –ga odotta –ka Hanako –ga
   NP  NP\NP   NP\S   S\(S/S)   NP  NP\NP
   odotta.
   NP\S

However, “Geaching” by no means derives <et, <et, t>> out of <e, e>, which is necessary for Japanese particles.

2. 1. 3 Partee and Rooth (1983)
Partee and Rooth (1983) suggests ‘argument lowering’:

(13) Argument Lowering
change type <<<a, b>, b>, c> to <a, c>

This changes, e.g., complex intransitive verbs of type <<<e, t>, t>, t> to simple predicates of type <e, t> (van Benthem 1989: 231). But this rule is irrelevant to the type-shift of kakari particles.

2. 1. 4 z-Rule (Jacobson 1996, 1999)
Jacobson’s z-rule enables variable-free semantics.

(14) z-rule
Let f be a function of type <a, <b, c>>. Then z(f) is a function of type <<<b, a>, <b, c>> such that
\[ z(f) = \lambda g [\lambda x [f(g(x)) \cdot x]] \] (for g of type <b, a> and x of type b). (Jacobson 1996: 109)

For instance, z can raise transitive verb love of type <e, et> to <et, et> type:

(15) z (love’)
love’ → z love’; λf [\lambda x [love’ (f(x)) \cdot x]]

Nevertheless, z-rule does not enable any of the types <e, e>,
<et, et>, <et, et>, <et, et>, <et, et, t> to be raised to the determiner type <et, et, t>.

2.2 Combinatory Categorial Grammar

Combinatory Categorial Grammar (CCG) has been developed by Mark Steedman (Steedman 1987, 1988, 2000). CCG aims to generalize pure Categorial Grammar by Ajdukiewicz and Bar-Hillel. In order to allow coordination of contiguous strings, CCG includes certain further operations on functions related to Curry’s combinators such as B (Curry and Feys 1958):

\[ (16) \quad \text{Forward composition (} > \text{B)} \]
\[ X/Y \quad Y/Z \Rightarrow \_n \quad X/Z \quad \text{(Steedman 2000 : 40)} \]

Although there are a lot of composition rules having been developed (cf. Steedman 2000:169), none of them enables type-raising of kakari particles from <e, e> to <et, et, t>. A new rule is called for in order to account for the linguistic evidence relevant to kakari zyosi.

3 Polymorphic Aspects of Kakari Particles

In the Japanese language, not only coordination, but also kakari particles are polymorphic. In section 3.1., I will introduce the cross-categorial status of Japanese particles, part of which is explainable by present type-raising rules. Section 3.2 discusses syntactic evidence of quantification of noun phrases attached by kakari particles, which attests to the fact that these particles are of determiner type <et, et, t>. No existing theory can account for this extraordinary type-shift between <e, e> and <et, et, t>. I suggest, in section 4, a new type-raising rule, which is necessary to accommodate these natural language phenomena.
3. 1 Type Ambiguity of *Kakari* Particles
Japanese particles such as *wa* (topic marker), *mo* (‘also’), *sae* (‘even’), *dake* (‘only’) and *nomi* (‘only’) are polymorphic, as I argued in Nishiguchi (2002):

(17) Particles Attached to PN

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Taro-<strong>mo</strong> hasitta.</td>
<td>Taro-also ran</td>
</tr>
<tr>
<td>b.</td>
<td>Taro</td>
<td><strong>-mo</strong></td>
</tr>
<tr>
<td></td>
<td>NP</td>
<td>NP/(S/(NP\S))</td>
</tr>
<tr>
<td>c.</td>
<td>Taro-<strong>wa</strong> hasitta.</td>
<td>Taro-TOP ran.</td>
</tr>
<tr>
<td>d.</td>
<td>Taro</td>
<td><strong>-wa</strong></td>
</tr>
<tr>
<td></td>
<td>NP</td>
<td>NP/(S/(NP\S))</td>
</tr>
<tr>
<td>e.</td>
<td>Taro-<strong>dake-ga</strong> hasitta.</td>
<td>Taro-only-NOM ran</td>
</tr>
<tr>
<td>f.</td>
<td>Taro</td>
<td><strong>-dake</strong></td>
</tr>
<tr>
<td></td>
<td>NP</td>
<td>NP/(S/(NP\S))</td>
</tr>
<tr>
<td></td>
<td>hasitta.</td>
<td>NP\S</td>
</tr>
<tr>
<td>g.</td>
<td>Taro-<strong>sae</strong> hasitta.</td>
<td>Taro-even ran</td>
</tr>
<tr>
<td>h.</td>
<td>Taro</td>
<td><strong>-sae</strong></td>
</tr>
<tr>
<td></td>
<td>NP</td>
<td>NP/(S/(NP\S))</td>
</tr>
</tbody>
</table>
(18) Particles Attached to CN
   a. Inu-\textit{wa} hasitta.
      dog-TOP ran
      'The dog ran.'
   b. \textbf{Inu-\textit{wa} hasitta.}
      \hspace{1cm} NP\S \hspace{1cm} (NP\S)\hspace{1cm} \hspace{1cm} (S/(NP\S)) \hspace{1cm} \hspace{1cm} NP\S
   c. Inu-mo hasitta.
      dog-also ran
      'The/a dog ran, too.'
   d. \textbf{Inu-mo hasitta.}
      \hspace{1cm} NP\S \hspace{1cm} (NP\S)\hspace{1cm} (S/(NP\S)) \hspace{1cm} NP\S
   e. Inu-dake-ga hasitta.
      dog-only-NOM ran
      'Only the dog ran.'
   f. \textbf{Inu-dake-ga hasitta.}
      \hspace{1cm} NP\S \hspace{1cm} (NP\S)\hspace{1cm} (S/(NP\S)) \hspace{1cm} (S/(NP\S)) \hspace{1cm} (S/(NP\S)) \hspace{1cm} NP\S
   g. Inu-sae hasitta.
      dog-even ran
      'Even the/a dog ran.'
   h. \textbf{Inu-sae hasitta.}
      \hspace{1cm} NP\S \hspace{1cm} (NP\S)\hspace{1cm} (S/(NP\S)) \hspace{1cm} NP\S

(19) Particles Attached to Infinitive Verb
   a. Taroo-\textit{wa taberu-dake-da.}
      Taroo-TOP eat-only-be
      'Taroo only eats.'
(20) Particles Attached to VP
   ‘Taroo only stumbled.’

(21) Particles Attached to PP
a. Taroo-ga Makudonarudo-de-wa taberu-(koto)
   ‘Taroo eats only at McDonald’s.’

b. Taroo -ga Makudonarudo -de 
   taberu-(koto) 
   ‘Taroo eats even at McDonald’s.’

c. Taroo-ga Makudonarudo-de-sae taberu-(koto)
   ‘Taroo eats even at McDonald’s.’
e. Taroo-ga Makudonarudo-de-sika tabe-nai-(koto)
   Taroo-NOM McDonald's-LOC-only eat-NEG-(fact)
   'Taro° eats only at McDonald's.'

f. \[
\begin{array}{c}
\text{Taroo} \quad -ga \\
\text{NP} \quad \text{NP\NP}
\end{array}
\quad \begin{array}{c}
\text{Makudonarudo} \\
\text{NP}
\end{array}
\quad \begin{array}{c}
\text{-de} \\
\text{NP\((\text{NP\S})/(\text{NP\S})\)}
\end{array}
\quad \begin{array}{c}
\text{-sika} \\
\text{((NP\S)/(NP\S))\((NP\S)/(NP\S))}
\end{array}
\quad \begin{array}{c}
\text{tabe} \\
\text{NP\S}
\end{array}
\quad \begin{array}{c}
\text{-nai} \\
\text{(NP\S)/(NP\S)}
\end{array}
\]

As shown in above examples, Japanese kakari particles go
through type-shifts between \text{<e, e>}, \text{<e, <et, t>}, \text{<et, et>}, and \text{<et, et>}. Geaching raises type \text{<e, e>} to \text{<et, et>} and to \text{<et, et>}, \text{<et, et>}:

\[
\begin{array}{c}
\text{(22) \quad <e, e>}
\end{array}
\quad \begin{array}{c}
\text{Geaching}
\end{array}
\quad \begin{array}{c}
\text{<et, et>}
\end{array}
\quad \begin{array}{c}
\text{Geaching}
\end{array}
\]
If we assume the associative law, we can deduce \(<e, \langle e, t \rangle, t\rangle\) from \(<\langle e, e \rangle, t \rangle, t\rangle:\n
(23) \begin{align*}
\langle e, e \rangle & \quad \text{Montague rule} \\
\langle \langle e, e \rangle, t \rangle, t \rangle & \quad \text{Associative rule} \\
\langle e, \langle e, t \rangle \rangle & \quad \text{Associative rule} \\
\langle e, \langle e, t \rangle \rangle & \quad \text{Associative rule}
\end{align*}

The above type-shifts can be captured by Geach Rule, Montague Rule, plus Association Rule. However, *kakari* particles demonstrate another category which is problematic for present type-raising theories, which will be discussed in the next section.

3. 2 Quasi-Generalized Quantifiers: Unaccountable Type

There exists syntactic evidence that common noun phrases attached by *kakari* particles demonstrate Weak Crossover effects, proving quantification. This entails that the category of particles are \((\text{NP}/\text{S})\backslash(\text{S}/(\text{NP}/\text{S}))\), whose semantic type is of determiner-type, \(<\text{et}, <\text{et}, t\rangle\).

It was Kuroda (1970) that first pointed out the quantifier-like behavior of Japanese *kakari* particles. Since Hoji (1985), Weak Crossover effects have been used to detect quantification by Japanese quantifiers. For example, phrases that contain *mo/nomi/sae* particles cannot be co-indexed with *so-ko* in (24):

that-place-GEN lawyer-NOM Toyota-only-ACC sued
'That place's lawyer sued only Toyota.'
b. *So-ko₁-no bengosi-ga Toyota₁-mo uttaeta.
   that-place-GEN lawer-NOM Toyota-also sued
   ‘That place’s lawyer also sued Toyota.’

c. *So-ko₁-no bengosi-ga Toyota₁-sae-o uttaeta.
   that-place-GEN lawer-NOM Toyota-even-ACC sued
   ‘That place’s lawyer sued even Toyota.’

Removing mo/nomi/sae improves grammaticality drastically:

(25) So-ko₁-no bengosi-ga Toyota₁-o uttaeta.
   that-place-GEN lawer-NOM Toyota-ACC sued
   ‘That place’s lawyer sued only Toyota.’

It is also the case with dake:

(26) *So-itu₁-no titioya-ga₁ gakusei₁-dake-o kawaigatta
   that-guy-GEN father-NOM student-only-ACC loved
   ‘His father loved only students’

So-itu (that-guy) cannot be co-indexed with gakusei (student),
as bound variables. Thus, WCO effects detect quantification
with particles.

4 New Type Shift Rule

As I have argued so far, the type <et, <et, t>> cannot be de-
erived by present type-raising rules. However, the existence of
such cross-categorial words testifies unknown links between
their types. Certain rule should permit the shift between <e, e>
or <et, et> and <et, <et, t>>, which I call the d-rule:

(27) d-rule
    change type <a, a> to <a, <a, b>>
5. Conclusion

I have pointed out unknown phenomena in natural language which call for a new type-raising rule, the \textit{d-rule}. This enables cross-categorial Japanese particles to raise between not only \(<e, e>, <et, et>, <et, et>, <et, et>, \) and \(<e, <et, t>>, \) but also \(<et, <et, t>>\) type. The fact that \textit{kakari} particles, such as \textit{wa}, \textit{mo}, \textit{dake}, and \textit{sika} raise to determiner type was attested to by the syntactic evidence of Weak Crossover effects.

Acknowledgments

I express my heartfelt gratitude to Norihiro Ogata for valuable help and guidance. I also benefited greatly from conversation with Pauline Jacobson and Mark Steedman. Thanks go to Andrea Koike and Alana Miller for stylistic improvement.

References


Notes

1 I add *koto* 'the fact that' at the end of these sentences in order to avoid the unnaturalness resulting from the lack of a topic.

2 See Ueyama (1998), Hoji et al. (2000) and others.