A Multi-Modal Combinatory Categorial Grammar Analysis of the -Te Form Complex Predicate in Japanese

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http://www.ling.ohio-state.edu/~kubota/papers/te_slides_cssp.pdf
Outline

- Data and problem
- Analysis in Multi-Modal CCG
- Conclusion
-te form complex predicate in Japanese

(1)  a. **benefactive:**

V-**te morau** (‘have somebody V for the benefit of oneself’),
V-**te kureru** (‘V for the benefit of the speaker’),
V-**te hosii** (‘want somebody to V’), etc.

b. **modal/aspectual:**

V-**te iru** (progressive),
V-**te oku** (perfect),
V-**te simau** (perfect), etc.

(2) Mary-wa John-ni piano-o **hii-te morat-ta.**
Mary-TOP John-DAT piano-ACC play-TE BENEF-PAST
‘Mary had John play the piano for her.’
Syntactic structure of the -te form complex predicate?

(3)  a. complex predicate analysis

```
S
 /   \
XP   XP ... V
    /\      \V1+V2
```

b. VP complementation analysis

```
S
 /   \
XP ... VP V2
     /\    
    XP ... V1
```
The dual nature of the -te form complex predicate

[Shibatani, 1978, McCawley and Momoi, 1986]

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(CP: complex predicate, VPC: VP complementation)

√: V1 and V2 behave like a lexical unit
*: V1 and V2 do not behave like a lexical unit
Cases where the -te form behaves like complex predicates

(2) Mary-wa John-ni piano-o **hii-te morat-ta**.
    Mary-TOP John-DAT piano-ACC play  BENEF-PAST
    ‘Mary had John play the piano for her.’

(4) a. Mary-wa **piano-o** John-ni **hii-te morat-ta**.
b. *Mary-wa piano-o **hii-te John-ni morat-ta**.  (scrambling)

(5) a. Mary-wa piano-o **yukkuri** John-ni **hii-te morat-ta**.
    Mary-TOP piano-ACC slowly  John-DAT play-TE BENEF-PAST
    ‘Mary had John play the piano slowly for her.’
b. *Mary-wa John-ni piano-o **hii-te murini morat-ta**.
    Mary-TOP John-DAT piano-ACC play  forcibly BENEF-PAST
    intended: ‘Mary forcibly had John play the piano for her.’
    (adverb placement)
Cases where the -te form behaves like complex predicates (cont.)

    play-TE BENEF-PAST
    ‘Mary had John play the piano and Bill play the guitar for me.’

        flute-ACC  play  BENEF-PAST intended: ‘Mary had John play the piano and Bill play the flute for her.’

(RNR)
Cases where the -te form behaves like VP complementation

(7) Mary-wa John-ni [[piano-o hii-te] [huruuto-o hui-te]]
Mary-TOP John-DAT piano-ACC play flute-ACC play morat-ta.
BENEF-PAST
‘Mary had John play the piano and play the flute for her.’
(embedded VP coordination)

(8) Mary-wa John-ni piano-o hii-te sae morat-ta.
Mary-TOP John-DAT piano-ACC play even BENEF-PAST
‘Mary asked John even the favor of playing the piano for her.’
(focus particle insertion)

(9) Kimi-ni Tookyoo-ni it-te hosii koto wa hosii ga, ...
you-DAT Tokyo-LOC go  want  want but
‘I certainly do want you to go to Tokyo, but . . . ’
(reduplication)
(3) a. complex predicate analysis

```
S
   /\    
  XP   XP  ...  V
```

b. VP complementation analysis

```
S
   /\    
  XP   ... V  VP V2
```

```
   /\    
  XP   ... V1 V2
```
Basic idea of the proposed analysis

Descriptively, V1 and V2 of the -te form complex predicate are put together in a way that is

- **tighter** than the way in which ordinary arguments are combined with the head, but
- **looser** than the way in which elements are combined in the lexicon.

Multi-Modal Combinatory Categorial Grammar

- recognizes different **modes** of syntactic composition.
  - The dual nature of the -te form can be captured by assigning a distinct mode of composition.
  - Key idea: The mode for -te form complex predicate formation has an **intermediate** degree of flexibility.
- places much less importance on hierarchical structure than in phrase structure-based theories.
  - Avoids the problem for phrase structure-based accounts.
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Multi-Modal Combinatory Categorial Grammar (MMCCG) [Baldridge, 2002]

- Properties inherited from CCG:
  - type-driven lexicalism
  - flexibility of constituency
    - enables accounts of nonconstituent coordination, traceless extraction, etc.
    - without modality, overgenerates grossly

- Innovation: incorporation of ‘modal control’ from Type-Logical Grammar [Moortgat, 1996, Oehrle, 1998]
  - enables systematic control of the flexibility
  - solves the problem of overgeneration of earlier CCG
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Flexible constituency for non-constituent coordination

[Dowty, 1988]

Type-Raising: $A \vdash B/(B\setminus A)$

Function Composition: $A/B \quad B/C \vdash A/C$

(10) [Anna married] and [I detest] Manny. (right-node raising)

(11)

\[
\begin{array}{c}
\frac{\text{Anna}}{NP} \\
\frac{S/(S\setminus NP)}{S/\NP} \quad \frac{\text{married}}{(S\setminus NP)/\NP} \\
\frac{(S\setminus NP)/\NP}{S/\NP} \quad \frac{\text{married}}{(S\setminus NP)/\NP} \\
\frac{S/\NP}{S} \\
\end{array}
\]

\[
\begin{array}{c}
\frac{\text{and}}{(X\setminus X)/X} \\
\frac{S/\NP}{(S/\NP)/(S/\NP)} \quad \frac{\text{I detest}}{S/\NP} \\
\frac{(S/\NP)/(S/\NP)}{S/\NP} \quad \frac{\text{Manny}}{NP} \\
\end{array}
\]
Flexible constituency for non-constituent coordination

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Function Composition:  \( A/B \quad B/C \vdash A/C \)

(10) [Anna married] and [I detest] Manny.  (right-node raising)

(11)

\[
\begin{array}{cccc}
\text{Anna} & \text{married} & \text{and} & \text{I detest} \\
\text{NP} & (S\setminus NP)/NP & (X\setminus X)/X & S/\text{NP} \\
S/(S\setminus NP) > \text{TR} & (S\setminus NP)/\text{NP} < \text{Manny} & (S/\text{NP})/S/\text{NP} > \text{FC} & \text{NP}
\end{array}
\]

\[
\begin{array}{cccc}
\text{married} & \text{and} & \text{I detest} & \text{Manny} \\
(S\setminus NP)/NP & (S/\text{NP})/S/\text{NP} & \text{NP} & \text{NP}
\end{array}
\]

\[
\begin{array}{cccc}
\text{married} & (S\setminus NP)/NP & \text{NP} & \text{NP}
\end{array}
\]

\[
\begin{array}{cccc}
\text{and} & (S/\text{NP})/S/\text{NP} & \text{NP} & \text{NP}
\end{array}
\]
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\[
\begin{align*}
\text{Anna} & \quad \text{married} & \quad \text{I detest} \\
\text{NP} & \quad \text{NP} & \quad \text{NP} \\
\text{S/(S\setminus NP)} & \quad (S\setminus NP)/NP & \quad (X\setminus X)/X \\
\text{S/NP} & \quad (S/\text{NP})(S/\text{NP}) & \quad S/\text{NP} \\
\text{S/\text{NP}} & \quad S/\text{NP} & \quad \text{Manny} \\
\text{S} & \quad \text{S} & \quad \text{NP}
\end{align*}
\]
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(10) [Anna married] and [I detest] Manny. (right-node raising)

(11)

\[
\begin{array}{c}
\text{Anna} \\
NP
\end{array} \quad \begin{array}{c}
\text{married} \\
(S\setminus NP)/NP
\end{array} \quad \begin{array}{c}
\text{and} \\
(X\setminus X)/X
\end{array} \quad \begin{array}{c}
\text{I detest} \\
S/NP
\end{array} \quad \begin{array}{c}
\text{Manny} \\
NP
\end{array}
\]

\[
\begin{array}{c}
S/(S\setminus NP) \quad (S\setminus NP)/NP \quad (S/NP)/(S/NP) \quad S
\end{array}
\]

\[
\quad \quad \quad \quad \quad S/NP
\]
Flexible constituency for non-constituent coordination

[Dowty, 1988]

Type-Raising: \[ A \vdash B / (B \setminus A) \]

Function Composition: \[ A/B \ B/C \vdash A/C \]

(10) [Anna married] and [I detest] Manny. (right-node raising)

(11) \[
\begin{array}{c}
\frac{\text{Anna}}{NP} > \text{TR} \frac{\text{married}}{(S \setminus NP)/NP} > \text{FC} \frac{S/NP}{S/NP} > \text{FC} \frac{\text{and}}{(X \setminus X)/X} \frac{\text{I detest}}{S/NP} > \text{FC} \frac{(S/NP) \setminus (S/NP)}{S/NP} > \text{FC} \frac{\text{Manny}}{NP} > S
\end{array}
\]
Slash modalities for controlling flexibility

(13) *player, that \[ t_1 \text{ shoots} \] and \[ \text{he misses} \]

(coordinate structure constraint) [Baldridge, 2002, 97]

(14)

\[
\begin{array}{c}
\text{that} \\
S \backslash NP \\
(N \backslash N) / (S \backslash NP)
\end{array}
\quad \begin{array}{c}
\text{shoots} \\
(X \backslash X) / \ast X \\
\text{and} \\
S \backslash S
\end{array}
\quad \begin{array}{c}
\text{he} \\
NP \\
S \backslash NP
\end{array}
\quad \begin{array}{c}
\text{misses} \\
\ast X \\
S
\end{array}
\quad <
\quad \begin{array}{c}
\text{and} \\
NP \\
S \backslash NP
\end{array}
\quad >
\quad \begin{array}{c}
\text{S} \\
\ast S
\end{array}
\quad \begin{array}{c}
\text{he} \\
NP \\
S \backslash NP
\end{array}
\quad \begin{array}{c}
\text{misses} \\
\ast X \\
\text{and} \\
S \backslash S
\end{array}
\quad *** < FC ***
(13) *player_i that [t_i shoots] and [he misses]
    (coordinate structure constraint) [Baldridge, 2002, 97]

(14) \[
\frac{\text{that}}{(N \backslash N)/(S \backslash NP)} \quad \frac{\text{shoots}}{S \backslash NP} \quad \frac{(X \backslash *X)/*X}{S \backslash *S} \quad \frac{\text{and}}{***} \quad \frac{\text{he misses}}{NP \quad S \backslash NP} \quad \frac{\text{S \backslash NP}}{***} \quad \frac{<\text{FC}>}{***}
\]
Hierarchy of modes

neither permutative nor associative

left
associative

right
associative

both permutative and associative

permutative
### Combinatory rules with modalities

#### (15) Function Application

- a. \( A/\ast B \ B \vdash A \)
- b. \( B \ A/\ast B \vdash A \)

#### (16) Function Composition

- a. \( A/\Diamond\Diamond B \ B/\Diamond\Diamond C \vdash A/\Diamond\Diamond C \)
- b. \( B/\langle\langle C \ A/\langle\langle B \vdash A/\langle\langle C \)

#### (17) Type-Raising

- a. \( A \vdash B/_{i}(B/_{j}A) \)
- b. \( A \vdash B/_{i}(B/_{i}A) \)

#### (18) Permutation

- a. \( A/\times B/\times C$ $\vdash A/\times C/\times B$ $\)
- b. \( A/\times B/\times C$ $\vdash A/\times C/\times B$ $\)
Lexical entries

(19) a. Mary-ga: $NP_n$
b. John-ni: $NP_d$
c. piano-o: $NP_a$
d. morat-ta: $S\backslash NP_n \backslash NP_d \backslash VP$ (V2 of complex predicate)
e. yon-de: $VP\backslash NP_a$ (V1 of complex predicate)

(/ and \ are the abbreviations for /. and \.)
Lexical entries

(19)  
  a. Mary-ga: \( NP_n \)  
  b. John-ni: \( NP_d \)  
  c. piano-o: \( NP_a \)  
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  e. yon-de: \( VP \backslash NP_a \) (V1 of complex predicate)  

(\( / \) and \( \backslash \) are the abbreviations for \( . / \) and \( . \).)
Lexical entries

(19)  

a. Mary-ga: $NP_n$

b. John-ni: $NP_d$

c. piano-o: $NP_a$

d. morat-ta: $((S\backslash NP_n)\backslash NP_d)\otimes VP$ (V2 of complex predicate)

e. yon-de: $VP\backslash NP_a$ (V1 of complex predicate)

(/ and \ are the abbreviations for /, and \.)
Scrambling (1)

(4a) Mary-wa *piano-o* John-ni **hii-te morat-ta.**
Mary-TOP piano-ACC John-DAT play BENEF-PAST
‘Mary had John play the piano for her.’

(20) 

\[
\begin{array}{c}
\text{hii-te} \\
\text{morat-ta} \\
\text{FC}
\end{array}
\]

\[
\begin{array}{c}
\text{VP} \backslash \text{NP}_a \\
\text{S} \backslash \text{NP}_n \backslash \text{NP}_d \langle \phi \rangle \text{VP}
\end{array}
\]

\[
\begin{array}{c}
\text{John-ni} \\
\text{piano-o} \\
\text{NP}_d
\end{array}
\]

\[
\begin{array}{c}
\text{Mary-ga} \\
\text{NP}_n
\end{array}
\]

\[
\begin{array}{c}
\text{NP}_a \\
\text{Perm}
\end{array}
\]

\[
\begin{array}{c}
\text{S} \backslash \text{NP}_n \backslash \text{NP}_d \\
\text{S} \backslash \text{NP}_n \backslash \text{NP}_a \\
\text{S} \backslash \text{NP}_n
\end{array}
\]

\[
\text{<}
\]

Yusuke Kubota

A MMCCG Analysis of the -*Te* Form Complex Predicate
Scrambling (1)

(4a) Mary-wa piano-o John-ni hii-te morat-ta.
Mary-TOP piano-ACC John-DAT play BENEF-PAST
‘Mary had John play the piano for her.’

(20)
Scrambling (1)

(4a) Mary-wa *piano-o* John-ni *hii-te morat-ta*.

Mary-TOP piano-ACC John-DAT play BENEF-PAST

‘Mary had John play the piano for her.’

(20)

Mary-ga *piano-o* John-ni *hii-te morat-ta*.

Mary-ga piano-o John-ni S

NP_n [NP_d] [NP_a] [S]

NP_n [NP_d] [NP_a] [S]

NP_n [NP_d] [NP_a] [S]

NP_n [NP_d] [NP_a] [S]

NP_n [NP_d] [NP_a] [S]
Scrambling (2)

(4b) *Mary-wa piano-o hii-te John-ni morat-ta.
Mary-TOP piano-ACC play John-DAT BENEF-PAST
intended: ‘Mary had John play the piano for her.’

(21) \[
\begin{array}{c}
\text{John-ni} \\
NP_d
\end{array}
\quad \text{morat-ta}
\begin{array}{c}
S \backslash NP_n \backslash NP_d \backslash \varnothing VP
\end{array}
\quad \text{*** Perm ***}
\quad \begin{array}{c}
\begin{array}{c}
\text{NP}_d
\end{array}
\end{array}
\]

Yusuke Kubota
A MMCCG Analysis of the -Te Form Complex Predicate
Scrambling (2)

(4b) *Mary-wa piano-o hii-te John-ni morat-ta.
\[\text{Mary-TOP piano-ACC play John-DAT BENEF-PAST}\]
intended: ‘Mary had John play the piano for her.’

(21) \[
\frac{\text{John-ni}}{NP_d} \quad \frac{\text{morat-ta}}{*** S \backslash NP_n \backslash NP_d \backslash \diamond \diamond VP} \quad *** \text{Perm} ***
\]
Focus particles

(8) Mary-wa John-ni piano-o hii-te sae morat-ta.
Mary-TOP John-DAT piano-ACC play even BENEF-PAST
‘Mary asked John even the favor of playing the piano for her.’

(22)

\[
\begin{array}{c}
\text{piano-o} \\
\text{NP}_a \\
\text{VP} \\
\text{NP}_a \\
\text{VP} \\
\text{S} \\
\text{NP}_n \\
\text{NP}_d \\
\end{array}
\begin{array}{c}
\text{hii-te} \\
\text{VP} \\
\text{NP}_a \\
\text{VP} \\
\text{S} \\
\text{NP}_n \\
\text{NP}_d \\
\end{array}
<
\begin{array}{c}
\text{morat-ta} \\
\text{VP} \\
\end{array}
\begin{array}{c}
\text{S} \\
\text{NP}_n \\
\text{NP}_d \\
\end{array}
\]
Focus particles

(8) Mary-wa John-ni piano-o hii-te sae morat-ta.
Mary-TOP John-DAT piano-ACC play even BENEF-PAST
‘Mary asked John even the favor of playing the piano for her.’

(22) piano-o
  \[
  \begin{array}{c}
  \text{hii-te} \\
  \text{VP} \backslash NP_a \\
  \text{sae} \\
  \text{VP} \\
  \text{morat-ta} \\
  \text{ VP} \\
  \end{array}
  \]
Coordination

(4) Mary-wa John-ni [[piano-o hii-te] [huruuto-o hui-te]]
Mary-TOP John-DAT piano-ACC play flute-ACC play
morat-ta.
BENEF-PAST
‘Mary had John play the piano and play the flute for her.’

(23)
Coordination

(4) Mary-wa John-ni [piano-o [hii-te] [huruuto-o [hui-te]]] Mary-TOP John-DAT piano-ACC play flute-ACC play morat-ta.

BENEF-PAST

‘Mary had John play the piano and play the flute for her.’

(23) \[
\begin{array}{c}
\text{John-ni} \\
\text{NP}_d
\end{array}
\quad \quad
\begin{array}{c}
\text{piano-o} \\
\text{NP}_a
\end{array}
\quad \begin{array}{c}
\text{hii-te} \\
\text{VP} \setminus \text{NP}_a
\end{array}
\quad \begin{array}{c}
\text{uta-o} \\
\text{NP}_a
\end{array}
\quad \begin{array}{c}
\text{utat-te} \\
\text{VP} \setminus \text{NP}_a
\end{array}
\quad \begin{array}{c}
morat-ta \\
\text{S} \setminus \text{NP}_n \setminus \text{NP}_d \setminus \text{VP}
\end{array}
\quad \text{\&}
\quad \begin{array}{c}
\text{S} \setminus \text{NP}_n \setminus \text{NP}_d \\
\text{VP}
\end{array}
\quad \begin{array}{c}
\text{S} \setminus \text{NP}_n
\end{array}
\]

The duality of the -te form complex predicate can be straightforwardly accounted for in MMCCG.

Features of MMCCG that distinguishes it from other theories:

- relaxation of the notion of phrase structure
- slash modalities for capturing different degrees of combinatoric flexibility
References


References (Cont.)

Categorial type logics.

Multi-modal type-logical grammar.


*Nihongo no Bunseki (Analysis of Japanese)*.
Taishukan, Tokyo.
RNR (1)

(6a) Mary-wa John-ni piano-o, Bill-ni gitaa-o hii-te
Mary-TOP John-DAT piano-ACC Bill-DAT guitar-ACC play
morat-ta.

'B Mary had John play the piano and Bill play the guitar for her.'

(24) \[
\begin{align*}
\text{John-ni} & \quad \text{piano-o} & \quad \text{Bill-ni gitaa-o} \\
\frac{NP_d}{NP_a} & \quad \frac{NP_d}{NP_a} & \quad \frac{NP_d}{NP_a} \\
\frac{VP/(VP\setminus NP_d)}{TR} & \quad \frac{(VP\setminus NP_d)/(VP\setminus NP_a)}{TR} & \quad \frac{Bill-ni gitaa-o}{FC} \\
\frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} & \quad \frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} & \quad \frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} \\
\frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} & \quad \frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} & \quad \frac{VP/(VP\setminus NP_d)}{VP/(VP\setminus NP_a)} < \\
\quad \text{John-ni piano-o Bill-ni gitaa-o} & \quad \text{hii-te} & \quad \text{morat-ta} \\
\quad : & \quad : & \quad : \\
\quad VP/(VP\setminus NP_d) & \quad VP\setminus NP_d & \quad VP\setminus NP_d \\
\quad VP/(VP\setminus NP_d) & \quad VP\setminus NP_d & \quad VP\setminus NP_d \\
\quad VP & \quad FC & \quad < 
\end{align*}
\]
(6b) *Mary-wa John-ni piano-o **hii-te**, Bill-ni huruuto-o
Mary-TOP John-DAT piano-ACC play Bill-DAT flute-ACC
**hui-te morat-ta.**
play BENEF-PAST
intended: ‘Mary had John play the piano and Bill play the flute for her.’

(25) \[
\begin{array}{c}
\text{John-ni} \\
\text{NP}_d \\
\hline
(S \setminus \text{NP}_n) / \left( (S \setminus \text{NP}_n) \setminus \text{NP}_d \right) \\
\end{array}
\]
\[
\text{piano-o hii-te} \\
\vdots \\
\vdots \\
\hline
\text{VP} \\
\hline
\begin{array}{c}
\text{(S \setminus \text{NP}_n) \setminus \text{NP}_d} \\
\vdash (\text{(((S \setminus \text{NP}_n) \setminus \text{NP}_d) \vdash VP}) \\
\end{array}
\]
\[
** FC > **
\]
Adverb placement

(5a) Mary-ga piano-o *yukkuri* John-ni hii-te morat-ta.
Mary-NOM piano-ACC slowly John-DAT play-TE BENEF-PAST
‘Mary had John play the piano slowly for her.’

(26) \[
\begin{array}{c}
\text{yukkuri} \\
\text{VP/VP}
\end{array} \quad \begin{array}{c}
\text{hii-te} \\
\begin{array}{c}
\text{TR} \\
\text{VP/VP}
\end{array}
\end{array} \quad \begin{array}{c}
\text{morat-ta} \\
\begin{array}{c}
\text{FC} \\
\text{VP/VP}
\end{array}
\end{array} \quad \begin{array}{c}
\text{John-ni} \\
\text{NP/} \begin{array}{c}
\text{Perm} \\
\text{NP/} \begin{array}{c}
\text{VP/VP}
\end{array}
\end{array}
\end{array} \quad \begin{array}{c}
\begin{array}{c}
\text{VP/VP}
\end{array} \\
<
\end{array}
\end{array}
\]

(27) Geach: \( A / \times B \vdash (A / \times C) / \times (B / \times C) \)
Adverb placement

(5a) Mary-ga piano-o *yukkuri* John-ni hii-te morat-ta.
Mary-NOM piano-ACC slowly John-DAT play-TE BENEF-PAST
‘Mary had John play the piano slowly for her.’

(26)

\[
\begin{array}{c}
\frac{\text{hii-te}}{\text{VP/NP}_a} \\
\frac{\text{morat-ta}}{\text{VP/NP}_d \sigma_0 \text{VP}}
\end{array}
\]

\[
\begin{array}{c}
\frac{\text{John-ni}}{\text{VP/NP}_d} \\
\frac{\text{yukkuri}}{\text{NP}_d}
\end{array}
\]

\[
\begin{array}{c}
\frac{\text{yukkuri}}{\text{VP}/\text{VP}} \\
\frac{\text{VP/NP}_a \sigma_0 \text{VP}}{\text{Perm}}
\end{array}
\]

\[
\begin{array}{c}
\frac{\text{VP/NP}_a \sigma_0 \text{VP}}{<}
\end{array}
\]

(27) Geach: \[A/\times B \vdash (A/\times C)\times (B/\times C)\]
Adverb placement

(5a) Mary-ga piano-o *yukkuri* John-ni hii-te morat-ta.
Mary-NOM piano-ACC slowly John-DAT play-TE BENEF-PAST
‘Mary had John play the piano slowly for her.’

(26)

\[
\begin{array}{c}
\text{yukkuri} \quad \frac{\text{hii-te}}{VP\backslash NP_a} \\
\text{VP/VP} \\
\text{(VP\backslash NP_a)/(VP\backslash NP_a)} \\
\text{G}
\end{array}
\quad \begin{array}{c}
\text{John-ni} \quad \frac{\text{morat-ta}}{VP\backslash NP_a\backslash (VP\backslash NP_a)/(VP\backslash NP_a)} \\
\text{NP_d} \\
\text{VP\backslash NP_a\backslash (VP\backslash NP_a)/(VP\backslash NP_a)} \\
\text{TR} \\
\text{VP\backslash NP_d\backslash (VP\backslash NP_a)/(VP\backslash NP_a)} \\
\text{FC} \\
\text{VP\backslash NP_a\backslash (VP\backslash NP_a)/(VP\backslash NP_a)} \\
\text{Perm} \\
\text{VP\backslash NP_a} \\
\text{<}
\end{array}
\]

(27) Geach: \( A/\times B \vdash (A\backslash \times C)/\times (B\backslash \times C) \)
Previous approach (1): [Sells, 1990]

(28) co-head analysis

\[ S \]

\[ \cdots \quad B \quad \cdots \quad \uparrow \downarrow \]

\[ \uparrow \downarrow \]

\[ \cdots \quad A \quad \cdots \quad \uparrow \downarrow \]

\[ \Rightarrow \quad \text{monoclausal f-structure} \]

- Can’t distinguish narrow and wide scope readings for adverbs.
- Overgenerates impossible cases of RNR.
(29) verb raising analysis

```
S
  NP
    John-wa
    John-TOP
  VP
    NP
      Mary-ni
      Mary-DAT
    VP
      V1
        NP
          hon-o
          book-ACC
        V
          yon-de
          read-TE
      V2
        morat-ta
        BENEF-PAST
```

- Not clear how adverb scrambling is treated.
- VP coordination would involve a movement of the embedded verb violating CSC.
Comparison with Baldridge’s (2002) system

- Two differences between the present fragment and Baldridge’s:
  - unary rule for scrambling (instead of crossed composition) likely to increase generative power
  - Geach rule not standardly assumed in CCG

- A linguistically motivated fully general analysis seems to have computationally unattractive properties.

- Is it possible to render the present analysis in Baldridge’s system?: Probably yes, with certain restrictions.