Empirical Issues in Syntax and Semantics 7
O. Bonami & P. Cabredo Hofherr (eds.) 2008, pp. 283–306
http://www.cssp.cnrs.fr/eiss7

Solving the Morpho-Syntactic Puzzle of the Japanese -*Te* Form Complex Predicate: A Multi-Modal Combinatory Categorial Grammar Analysis

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1 Introduction

Japanese has a class of verbs that subcategorize for predicates marked by the morpheme *-te*, such as the matrix verb *morat-ta* in (1).[1]

(1) Mary-ga John-ni piano-o hii-**te** morat-ta.
Mary-NOM John-DAT piano-ACC play-TE BENEF-PAST
'Mary had John play the piano for her.'

The syntactic structure of this construction, which I hereafter call the *-te* form complex predicate, has long been a puzzle in Japanese generative grammar (Shibatani, 1978; McCawley and Momoi, 1986; Sells, 1990). In a nutshell, it has properties of both sentential complementation and lexical complex predicates and exhibits what at first sight seems to be a contradictory set of distributional properties with respect to the morphological wordhood of the sequence of the embedded verb (V1) and the embedding verb (V2). In terms of a certain set of criteria, it appears as if the V1 and V2 form a tight lexical unit like lexical complex predicates (such as the causative construction and compound verbs), whereas in terms of another set of criteria, it lines up with typical sentential complementation, suggesting the existence of an embedded VP constituent headed by the V1.[2]

*I would like to thank Olivier Bonami, who reviewed this paper for this volume, for his helpful comments. Also, special thanks go to E. Allyn Smith for last-minute proofreading.

[1]The set of verbs that take *-te* marked complements can be roughly classified into two types: benefactive predicates (such as *-te morau* 'have somebody V for the benefit of oneself', *-te kureru* 'V for the benefit of the speaker' and *-te yaru/ageru* 'V for the benefit of somebody else', and modal/aspectual predicates (such as *-te iru* (progressive), *-te oku* (perfect) and *-te simau* (perfect)).

[2]There is a slight oversimplification in this pre-theoretical characterization of the problem. In the literature of complex predicates (especially in HPSG), some constructions have been analyzed as forming *syntactic* complex predicates (see, for example, the analysis of German verbal complexes by Hinrichs and Nakazawa (1994) and the analysis of a certain kind of complex predicate in Korean by Chung (1998)). The *-te* form complex predicate exhibits properties similar to these syntactic complex predicates. I discuss possibilities and limitations of analyzing the *-te* form in terms of *argument composition*—the typical mechanism employed in the analysis of syntactic complex predicates in HPSG—in section 3.

Previous authors such as Sells (1990) and Matsumoto (1996) have generally treated this construction as a special kind of syntactic complementation, but it turns out that such analyses run into problems accounting for the phenomena for which the *-te* form behaves in tandem with lexical complex predicates. An alternative approach that treats the sequence of the V1 and V2 as a lexical unit would obviously suffer from the exact opposite problem, falling short of accounting for cases in which the *-te* form behaves like sentential complementation.

This paper presents a new analysis of this construction in Multi-Modal Combinatory Categorial Grammar (MMCCG) (Baldridge, 2002), in which the duality of the *-te* form complex predicate is captured by a mechanism that constitutes a central feature of the theory. The following two aspects most sharply distinguish the proposed analysis from previous approaches:

(i) In the MMCCG analysis, the distributional properties of the *-te* form complex predicate are *not* accounted for in terms of syntactic structures (thereby obviating the need to assign mutually inconsistent syntactic structures that different sets of phenomena call for, which is essentially the source of the problem for analyses in other frameworks).

(ii) Instead, the apparently contradictory set of behaviors of this construction are accounted for in terms of the lexically specified combinatoric properties of the *-te* form complex predicate, whereby the V1 and V2 are put together in a way that is 'tighter' (in a sense to be made precise) than the way in which ordinary arguments are combined with the head verb.

The proposed analysis can be seen as taking full advantage of the theoretical architecture of MMCCG since (i) the notion of phrase structure plays no role in categorial grammar in general, where the grammar is viewed as a logical deductive system and not as a structure building system and (ii) a fine-grained control over lexically specified combinatoric properties of linguistic expressions is the major advantage of MMCCG as compared to earlier versions of CCG. As we will see below, this latter property is crucial in giving a precise analysis of this construction in the lexicalist setup of CCG.

2 Syntactic patterns

The following table summarizes the behaviors of the *-te* form complex predicate and contrasts them with those of lexical complex predicates and typical sentential/VP complementation.[3,4]

[3]To my knowledge, McCawley and Momoi (1986) were the first to systematically investigate the puzzling nature of the *-te* form complex predicate, including many of the observations that I present below.

[4]CP and SC/VPC stand for 'complex predicate' and 'sentential complementation/VP complementation', respectively. '✓' in a column means that the pattern in question is possible. '$*$' means that the pattern results in ungrammaticality.

(2)

	-te form	CP	SC/VPC
interclausal scrambling	✓	✓	*
adverb between V1 and V2	*	*	✓
argument cluster coordination involving V1	*	*	✓
postposing of 'VP' headed by V1	*	*	✓
clefting of 'VP' headed by V1	*	*	✓
coordination of 'VP' headed by V1	✓	*	✓
focus particle between V1 and V2	✓	*	✓
reduplication of V2 alone	✓	*	✓

This section presents relevant data of the *-te* form complex predicate for each of these tests. Due to space limitations, I omit corresponding data for lexical complex predicates and sentential/VP complementation constructions.[5]

2.1 Cases in which the *-te* form behaves like a complex predicate

Japanese allows for scrambling of arguments fairly freely within a single clause. In the *-te* form complex predicate, in spite of the fact that the V1 is semantically an argument of the V2, arguments of the V1 can be freely scrambled with arguments of the V2. (3b) is an example in which the accusative object *piano-o* of the V1 is scrambled over a matrix dative argument *John-ni*.

(3) a. Mary-ga John-ni piano-o hii-te morat-ta.
Mary-NOM John-DAT piano-ACC play-TE BENEF-PAST
'Mary had John play the piano for her.'

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

Word orders that are different from the canonical one (in this case, the NOM ≺ DAT ≺ ACC order) are associated with marked information structure (in terms of what is and is not given), but given appropriate contexts, all permutations of the three NPs are possible for sentences like (3a). However, a word order in which an argument of either the V1 or the V2 splits the sequence of the sentence-final verb cluster (i.e. the sequence of the V1 and V2) is strictly ungrammatical, as shown in (4).

(4) *Mary-ga piano-o **hii-te** *John-ni* **morat-ta**.
Mary-NOM piano-ACC play-TE John-DAT BENEF-PAST
intended: 'Mary had John play the piano for her.'

The distribution of adverbs exhibits essentially the same pattern. That is, in terms of adverb placement, the cluster of the V1 and V2 behaves like a single lexical element. As shown in (5a), an adverb that semantically modifies the V2 can appear closer to the V1 than an embedded argument does, which would be unexpected if there were an embedded VP constituent headed by the V1. But sentences like (5b), in which an adverb splits the sequence of the V1 and V2, are ungrammatical, just like sentences like (4) in which an argument splits the verb cluster are ungrammatical.

[5] I hope to discuss these in a longer version of this paper.

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

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

The generalization that can be drawn from the above patterns of argument scrambling and adverb placement is that dependents (arguments and adjuncts) of the V1 and those of the V2 can scramble freely with one another but they cannot split the sentence-final verb cluster.

The pattern of argument cluster coordination (ACC) also provides evidence for the inseparability of the cluster of the V1 and V2. As shown by the following contrast, ACC involving nominal arguments of the V1 and V2 is possible but ACC involving the V1 together with nominal arguments of the V1 and V2 is not:

(6) a. [John-ni piano-o], [Bill-ni gitaa-o] **hii-te** **morat-ta**.
John-DAT piano-ACC Bill-DAT guitar-ACC play-TE BENEF-PAST
'I had John play the piano and Bill play the guitar for me.'

b. *[John-ni piano-o **hii-te**], [Bill-ni gitaa-o **hii-te**] **morat-ta**.

(6b) is bad since the cluster of the V1 and V2 is split up for the first conjunct.

Postposing and clefting are the final pieces of evidence for the tight connection between the V1 and V2. Postposing is a construction in which an element of the sentence is segregated to a position following the main verb, with the pragmatic function of making the postposed element an afterthought (Simon, 1989). In clefting, an element is displaced from the rest of the sentence (which gets topicalized) and placed in the focus position immediately preceding the copula. The data in (7) and (8) show that in neither of these constructions can the sequence of the V1 and V2 be split apart.

(7) a. **Yon-de** **morat-ta** yo, John-ni sono-hon-o.
read-TE BENEF-PAST John-DAT that-book-ACC
'I had John read that book for me.'

b. *John-ni **morat-ta** yo, sono-hon-o **yon-de**.

c. *John-ni sono-hon-o **morat-ta** yo, **yon-de**.

(8) a. [John-ga Mary-ni **yon-de** **morat-ta**] no wa sono-hon-o da.
John-NOM Mary-DAT read-TE BENEF-PAST NMLZ TOP that-book-ACC COP
'What John had Mary read for him was that book.'

b. *[John-ga Mary-ni **morat-ta**] no wa sono-hon-o **yon-de** da.
John-NOM Mary-DAT BENEF-PAST NMLZ TOP that-book-ACC read-TE COP
intended: lit. 'What John had Mary do for him was read that book.'

c. *[John-ga Mary-ni sono-hon-o **morat-ta**] no wa **yon-de** da.
John-NOM Mary-DAT that-book-ACC BENEF-PAST NMLZ TOP read-TE COP
intended: lit. 'What John had Mary do for him with that book was read it.'

2.2 Cases in which the *-te* form behaves like sentential/VP complementation

In apparent contradiction to the data reviewed in the previous subsection, the patterns of VP coordination, focus particle insertion and reduplication suggest that the V1 and

V2 do not form a lexical unit but rather are combined in the syntax.

(9) is a case of VP coordination. In this sentence, two VPs (each composed of an embedded verb and its argument) are coordinated.

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

Coordination of this form is not allowed with lexical complex predicates as shown by the ungrammaticality of the following example involving the compound verb construction:

(10) *Dono gakusei-mo [piano-o hiki], [uta-o utai]-sugi-ta.
every.student piano-ACC play song-ACC sing-overdo-PAST
intended: 'Every student played the piano and sang a song, both excessively.'

It would be very difficult to account for the contrast between the *-te* form complex predicate and lexical complex predicates exemplified in (9) vs. (10) if the V1 and V2 were analyzed as forming one lexical item in both constructions.

Facts about focus particle insertion and reduplication also indicate that the V1 and V2 in the *-te* form complex predicate constitute separate words in the syntax. It is known that focus particles cannot appear inside a word boundary (for example, they cannot appear between the two component verbs in the compound verb construction). As shown in (11), however, the *-te* form complex predicate allows a focus particle to split the sequence of the V1 and V2. (12) shows that the V2 can be independently reduplicated, which would also be impossible if the V1 and V2 formed a morphological word as is the case with the lexical complex predicate constructions.

(11) John-ni piano-o **hii-te** *sae* **morat-ta**.
John-DAT piano-ACC play-TE even BENEF-PAST
'I asked John even the favor of playing the piano for me.'

(12) Kimi-ni Tookyoo-ni **it-te** **hosii** koto-wa **hosii** ga, ...
you-DAT Tokyo-LOC go-TE want want though
'Though I do want you to go to Tokyo, ...'

3 Previous analyses

In this section, I discuss three kinds of existing and conceivable analyses of the *-te* form complex predicate in three major syntactic frameworks: Sells' (1990) 'co-head' analysis in LFG, Kageyama's (1993) verb-raising analysis in the GB theory and an analysis in HPSG based on the argument composition mechanism (Hinrichs and Nakazawa, 1994). For each of these analyses, I point out empirical and theoretical problems. Though these analyses appear to be quite different, they fail for essentially the same reason: because of the 'contradictory' nature of the distributional properties of the *-te* form complex predicate, analyses that crucially rely on the notion of phrase structure run into problems that are difficult to reconcile.

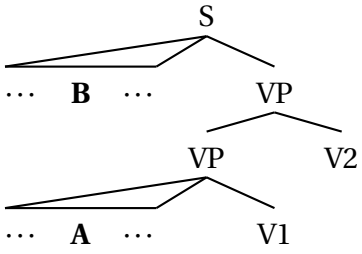
3.1 Sells' (1990) co-head analysis

Sells' (1990) analysis of the *-te* form complex predicate can be seen as an attempt to capture the duality of this construction by making use of the multi-dimensional architecture of LFG and treating it as monoclausal and biclausal at different levels of syntactic representation at the same time. That is, in his analysis, the V1 and V2 in the *-te* form complex predicate (he treats the latter as an 'auxiliary' verb) share a single f-structure, although, at the level of c-structure, the V1 is embedded under the V2. The sharing of the f-structure by the V1 and V2 is tantamount to the assumption that (as far as predicate-argument structure is concerned) they are co-heads of the construction and for this reason I will henceforth call this assumption the 'co-head assumption'. Sells further introduces a VP rule like the following for combining a projection of the V1 with a lexical V2, in addition to the ordinary S rule and VP rule:

(13) $\begin{array}{lcll} \text{VP} & \rightarrow & \text{VP} & \text{AUX} \\ & & \uparrow{=}\downarrow & \uparrow{=}\downarrow \end{array}$

These two assumptions in effect make it possible to optionally 'liberate' arguments of the V1 to the structurally higher position headed by the V2. That is, because of the co-head assumption, in terms of the f-structural predicate-argument relationship, any argument of the V1 is automatically an argument of the V2, meaning that it can establish a sisterhood relation to the V2 at c-structure. At the same time, rule (13) still allows for a possibility in which an argument of the V1 is directly realized as a sister of its 'original' head V1 at c-structure. This is because (13) says that the V2 combines with a partially saturated projection of the V1 (in Sells' system VP is a verbal projection in which any number of non-subject arguments are saturated, including zero). Thus, schematically in the picture in (14), for any given argument of the V1, there are potentially two syntactic positions at which it can surface: the hierarchically lower position **A** governed by the V1 or the hierarchically higher position **B** governed by the V2.

(14)



The availability of two positions for arguments of the V1 accounts for the patterns of scrambling and VP coordination. Furthermore, since the sequence of the V1 and V2 is not analyzed as a lexical unit, the data of focus particle insertion and reduplication are also unproblematic.

The co-head assumption is the crux of Sells' analysis. This assumption not only drives the optional raising of an embedded argument as described above, but also is crucially made use of in accounting for the distribution of adverbs observed in (5). That is, in Sells' analysis, an independently motivated linear order constraint formulated as in (15) interacts with the co-head assumption to exclude a possibility for the adverb to be linearly positioned between the V1 and V2, accounting for the ungrammaticality of sentences like (5b).

(15) $\neg$ HEAD $\prec$ HEAD (where HEAD is any category annotated $\uparrow=\downarrow$)

Given this linear order constraint, the adverb cannot linearly appear after the V1 when the two get syntactically realized as co-sisters of the V2, since the V1 is annotated as the head ($\uparrow=\downarrow$), being licensed by rule (13).

However, there are some problems for Sells' co-head assumption. First, for at least some of the predicates that take the *-te* marked complements such as *morau* (benefactive) and *hosii* ('want'), the V1 is arguably a semantic argument of the V2 and the co-head assumption seems inappropriate.[6] For example, under Sells' analysis, it is not clear how the ambiguity of adverb interpretation can be distinguished for such predicates (like many other complex predicate constructions, these predicates exhibit scope ambiguity of adverbs between a reading in which the adverb modifies the higher verb and one in which it modifies the lower verb). Second, for a verb such as *morau*, which takes a nominal argument (in the case of *morau*, a dative argument bearing the benefactor semantic role) in addition to the *-te* marked embedded VP, sentences like (6b) would be incorrectly licensed as a case of coordination of embedded VPs where the dative argument of the matrix verb is syntactically realized within the projection of the embedded verb. Given that the f-structures of the V1 and V2 are completely identified in Sells' analysis, it is not clear how such a misanalysis would be ruled out.[7]

Given the above observations, I conclude that Sells' (1990) analysis, while neatly capturing many of the patterns of the *-te* form complex predicate with a relatively simple set of assumptions, does not cover all of the cases adequately.

3.2 Head movement analysis in the GB theory

Kageyama (1993) sketches an analysis of the *-te* form complex predicate in the GB theory in terms of head movement. In his suggested analysis (which is not worked out in full detail), the duality of the *-te* form is in effect captured by means of rule ordering. That is, he assumes a biclausal deep structure for the *-te* form complex predicate and further introduces a head movement operation that raises the embedded verb from its base position to a position where it adjoins to the V2 to form a cluster as in (16):

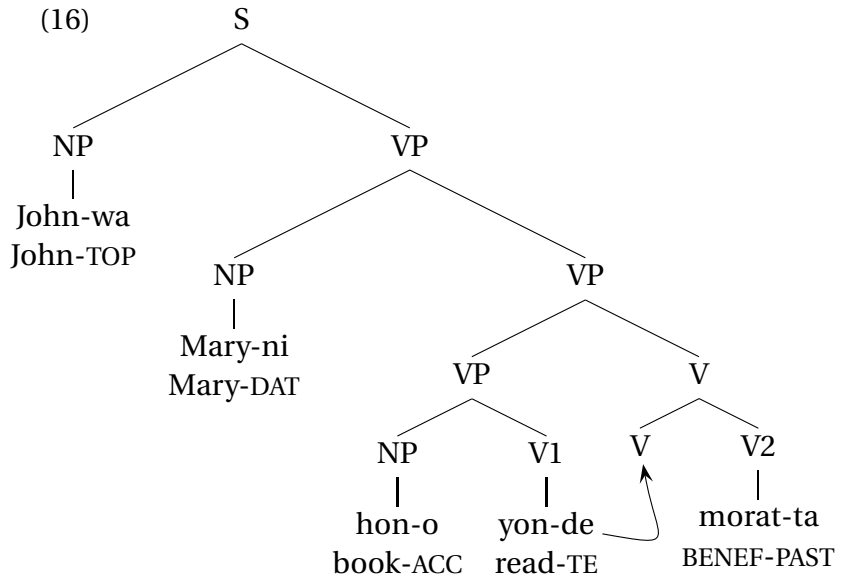
[6] In LFG, semantics is represented at a component called 'semantic structure', which is distinct from f-structure. Thus, in principle, it is conceivable that an f-structurally monoclausal predicate is mapped onto a biclausal semantic structure. However, phenomena like adverb scope that fall within the domain of the syntax-semantics interface have standardly been treated at the level of f-structure in LFG (see, for example, the analysis of complex predicates in Japanese by Matsumoto (1996)). Also, an analysis that assumes a mismatch between a monoclausal f-structure and a biclausal semantic structure would involve a significant complication in the mapping between different levels of syntactic and semantic representation. For a discussion of the technical difficulties of such an approach within LFG, see Andrews and Manning (1999, 11).

[7] One might alternatively assume a flat constituent structure in which both the V1 and the nominal arguments of the V1 and V2 are licensed as sisters of the V2 by a phrase structure rule like the following:

(i) S $\rightarrow$ XP* V AUX
$\uparrow$ GF $=\downarrow$ $\uparrow=\downarrow$ $\uparrow=\downarrow$

This analysis, together with the assumption that ACC cannot involve part of a complex predicate, will correctly account for the contrast in (6). However, it is not clear how embedded VP coordination as in (9) is licensed in this kind of analysis with the absence of an embedded VP node in the syntax.

(16)



In this analysis, phenomena for which the *-te* form behaves as if it had a complex embedded structure are sensitive to the structure before the head movement takes place and phenomena for which the V1 and V2 behave like a lexical unit are sensitive to the structure after the head movement.

There are two major problems for this type of approach. The first problem is that it cannot account for the pattern of adverb placement straightforwardly. Recall from the discussion in section 2 that arguments and adjuncts of both the V1 and V2 can be freely scrambled with one another. Thus, sentences like (17), in which an adverb that semantically modifies the V1 linearly precedes an argument of the V2 (in this case, the dative argument *Mary-ni*), are perfectly acceptable.

(17) John-wa *yukkuri* Mary-ni son-hon-o yon-de morat-ta.
John-TOP slowly Mary-DAT that-book-ACC read-TE BENEF-PAST
'John had Mary read the book for him slowly.'

This kind of sentence is difficult to account for in Kageyama's approach. Assuming that the structure of the *-te* form complex predicate is something like (16), and assuming that adverbs are base-generated at positions corresponding to their semantic scope (which is a fairly standard assumption in the theoretical setup adopted by Kageyama (1993)), in the underlying structure the matrix dative argument has to linearly precede the embedded VP which contains the adverb. From the analysis in (16), it should be clear that the head movement does not change the relative linear order between the matrix dative argument and the embedded adverb. Thus, unless some syntactic operation is introduced for scrambling an adverb across a clause boundary, sentences like (17) cannot be licensed in Kageyama's analysis.[8]

[8]Long-distance scrambling of adverbs (except possibly for cases in which the landing site is the sentence-initial position) is impossible in full sentential/VP complementation, suggesting that positing such a scrambling operation would lead to an unwanted overgeneration in Kageyama's (1993) approach.

(i) a. ?? John-wa *yukkuri*$_i$ Mary-ni [t_i son-hon-o yomu koto]-o meizi-ta.
John-TOP slowly Mary-DAT that-book-ACC read NMLZ-ACC order-PAST
intended: 'John ordered Mary to read the book slowly.'

Second, this analysis runs into problems accounting for the possibility of VP coordination. In Kageyama's analysis, head movement has to be an obligatory operation in order to account for the fact that arguments and adverbs cannot split the sequence of the V1 and V2. Given this, the V1 of the final conjunct alone has to move to adjoin to the V2 in a structure involving coordination in order to satisfy the requirement of obligatory head movement. That is, (9) would be analyzed along the following lines:

(18) Mary-wa John-ni [$_{VP}$ [$_{VP}$ piano-o **hii-te**] [$_{VP}$ huruuto-o t_i]] [$_{V}$ **hui-te**$_i$ **morat-ta**].

This movement operation, however, is dubious since it violates the Coordinate Structure Constraint (CSC). Given that scrambling of arguments out of coordinate structures obeys the CSC (and the ATB exception to it),[9] it is not clear how this exceptional property of head movement is reconciled with the rest of the grammar.

3.3 Argument composition approach in HPSG

Quite a lot of analyses of complex predicates have been proposed in the literature of HPSG, building on the idea of argument composition (Hinrichs and Nakazawa, 1994). Thus, it is worthwhile to consider whether a plausible analysis of the *-te* form complex predicate can be formulated along these lines.

In analyses of complex predicates in HPSG in terms of argument composition, two kinds of head-complement rules are distinguished: the ordinary head-complement rule and the head-governee rule (in Chung's (1998) and Kathol's (1998) terminology). The former is used to discharge nominal arguments of the head verb and the latter is used for combining the head verb with a verbal argument, where all the unsaturated arguments of the governee daughter are passed on to the head (i.e. this rule is specifically tailored for complex predicate formation). It is usually assumed[10] that the governee daughter of the head-governee rule is non-phrasal (in the sense that it has not yet combined with the nominal arguments that it subcategorizes for). That is, the verbs that form a complex predicate first combine with one another to form a cluster and then discharge the nominal arguments by the ordinary head-complement rule.

However, it is possible to relax this assumption and allow the governee daughter of the head-governee rule to be phrasal, in which case the governee daughter can have some of its arguments discharged by itself before combining with the governing verb. This analysis will resemble Sells' LFG analysis in that arguments of the V1 can be either discharged within the syntactic projection of the V1 or inherited to the V2 and discharged in the higher projection, allowing for multiple possible structures in many cases. An analysis of the *-te* form complex predicate along these lines can account for scrambling, VP coordination and focus particle insertion facts in much the same way as in Sells' analysis. However, this analysis shares some problems with Sells' (1990)

b. ?? John-wa *yukkuri*$_i$ [Mary-ga t_i son-hon-o yon-da] to it-ta.
John-TOP slowly Mary-NOM that-book-ACC read-PAST COMP say-PAST
intended: 'John said that Mary read the book slowly.'

[9] For relevant examples, see the contrast between (20) vs. (18b) in Sells (1990, 326).

[10] For example, see Hinrichs and Nakazawa (1994), Kathol (1998) and Chung (1998).

and Kageyama's (1993) approaches. The same problem of adverb placement as in Kageyama's analysis arises if adverbs are analyzed as taking scope at their surface positions.[11] The pattern of ACC, which poses problems for Sells' analysis, does not seem to be readily accounted for in this approach either, given that the *-te* form complex predicate is treated as a case of syntactic complementation just like in Sells' (1990) analysis. Furthermore, given the availability of VP constituents headed by the V1 in the syntactic structure, it is not clear how these constituents escape from the application of syntactic operations like clefting and postposing unlike other ordinary arguments of the V2.

4 A new analysis of the *-te* form complex predicate in Multi-Modal Combinatory Categorial Grammar

In this section, I formulate an analysis of the *-te* form complex predicate in Japanese in Multi-Modal Combinatory Categorial Grammar (MMCCG).[12] MMCCG (see Baldridge (2002) and Steedman and Baldridge (2007) for a more complete and general introduction to the theory) is a recent extension of Combinatory Categorial Grammar (CCG) that is designed to capture cross-linguistic generalizations more adequately and precisely than earlier versions of CCG (Steedman, 1996, 2000).

What distinguishes categorial grammar from other kinds of syntactic theories, most of which recognize the notion of phrase-structure as a theoretical primitive in some way or other, is the identification of the grammar of natural language as a logical deductive system (or an analogy drawn between them). However, in natural language (unlike in ordinary logical systems such as propositional logic), the way in which elements drawn from the lexicon are put together (which is manifested in the linear order and hierarchical structure of linguistic resources) often makes a difference in whether or not a particular proof (of the sentencehood of a string of words) succeeds. In order to accommodate this extra-logical aspect of natural language, Type-Logical Grammar (TLG) (Moortgat, 1997; Oehrle, 1998) recognizes different 'modes' of linguistic composition, each of which is susceptible to a different set of structure-changing operations.[13] MMCCG incorporates this idea from TLG into the setup of CCG by distinguishing different kinds of slashes decorated with modality specifications. The combinatory

[11] It should, however, be noted that if one adopts the adjunct-as-argument approach (Manning et al., 1999) or the nondeterministic scope resolution mechanism for adverbs (first proposed by Cipollone (2001) and applied to a wider range of complex predicate constructions in Japanese by Kubota (2007)), this problem goes away.

[12] Roughly speaking, research of categorial grammar as a linguistic theory is currently split into two camps: Combinatory Categorial Grammar (CCG), a variant that is more concerned with linguistic and computational application, and Type-Logical Grammar (TLG) (Moortgat, 1997; Oehrle, 1998), a variant that is more concerned with studying logical and mathematical properties of the formal systems used for modelling natural language.

As discussed by Steedman and Baldridge (2007), with the introduction of the notion of modality from TLG into CCG, the two variants have come to resemble each other very closely as far as actual linguistic application is concerned. My choice of MMCCG in this paper is purely for expository convenience and should not be taken as a commitment to any of the theoretical assumptions that sets CCG apart from TLG.

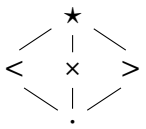
[13] The idea of treating surface morpho-syntactic realization and the functor-argument relationships of linguistic resources separately dates back at least to Dowty (1982). A somewhat informal but a quite insightful demonstration of the utility of the idea of recognizing different kinds of linguistic composition

rule schemata are then redefined accordingly in such a way that the effect of modal control in the logical deductive system of TLG is replicated in the rule-based system of CCG.[14]

4.1 A MMCCG fragment of Japanese

In MMCCG, different modes of linguistic composition are organized in an inheritance hierarchy. For a grammar of Japanese that handles the behaviors of the *-te* form complex predicate, I assume the following inheritance hierarchy of modes:

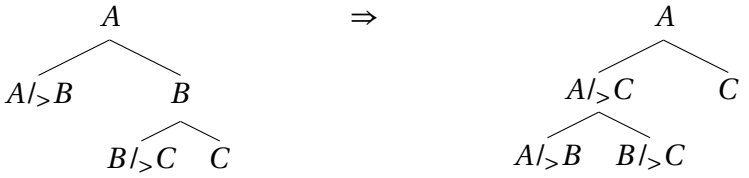
(19)



The modes are arranged from top to bottom by their permissibility; the ⋆ mode at the top node is the least permissive and is neither permutative nor associative in either direction, while the · mode at the bottom node is the most permissive and is both permutative and associative in both directions. The three modes bearing intermediate permissibility each have a single property: < is left associative, > is right associative, and × is permutative.

The distinction between right and left associative modes (which is not present in Baldridge's system) is introduced here in order to distinguish two 'restructuring' operations illustrated by the following diagrams:[15]

(20) a.



b.

That is, in the right associative mode, if combining the relevant linguistic expressions by function application (the most basic operation for combining two linguistic expressions) to produce a larger expression results in a right-branching derivation, there is an alternative left-branching derivation involving the same linguistic resources where the two functors are combined first into a single functor that takes the argument of the

in syntactic theory can be found in Dowty (1996), where the advantages of such a theoretical architecture is discussed based on an analysis of a wide range of word order-related phenomena in English.

[14]This constitutes a significant improvement of the theoretical architecture of CCG; in earlier versions of CCG, there was no way of distinguishing 'logical' and 'extra logical' aspects of the grammar of natural language and therefore it was often necessary to introduce language-specific stipulations in the component of combinatory rules. However, such stipulations were dubious given that the component of combinatory rules was supposed to capture linguistic universals.

[15]Following the practice of the CCG literature, I adopt the 'result leftmost' notation of slashes. That is, $A\backslash B$ is a category that combines with a B to its left to become an A.

original innermost functor (i.e. C) and produces the output of the original outermost functor (i.e. A).

Since function composition (FC) is the combinatory rule that makes possible the alternative derivations, Harmonic FC rules are modally constrained as follows to ensure the above effect:[16,17]

(21) a. $A/_{>}B \quad B/_{>}C \quad \vdash \quad A/_{>}C$ b. $A\backslash_{<}B \quad C\backslash_{<}A \quad \vdash \quad C\backslash_{<}B$

The distinction of left and right associative modes is motivated by empirical evidence: as we will see below, by assigning the left associative mode as the combinatoric mode for complex predicate formation, the syntactic properties of the *-te* form complex predicate can be neatly captured.

Two remarks are in order regarding the applicability conditions of combinatory rules with modality specifications like the ones in (21). First, following Baldridge (2002), I assume that combinatory rules can apply only when the modality specification on the input is at least as permissive as what is specified in the rule. For example, (21a) is applicable when the mode of the slash of the righthand element of the input (i.e. what instantiates $B/_{>}C$) is the most permissive mode $(\cdot)$. Second, the slash of the output category inherits the mode of the slash originally associated with the argument that it is still looking for. That is, in (21), if the righthand side input category instantiates the slash to the most permissive mode, then that mode, and not the mode of the slash of the lefthand side category, is inherited as the mode of the output category (since that's the mode by means of which the category C is to be looked for throughout). This is due to the Principle of Inheritance as defined in Steedman and Baldridge (2007, 14).

As for the other combinatory rules, function application (FA) is defined in the same way as in non-modalized CCG except that it is specified for the least permissive $\star$ mode (which ensures that it is applicable to any mode, as guaranteed by the convention of rule schema application described above):

(22) a. $A/_{\star}B \quad B \quad \vdash \quad A$ b. $B \quad A\backslash_{\star}B \quad \vdash \quad A$

Type-raising (TR) is defined in the following way:

(23) a. $A \quad \vdash \quad B/_i(B\backslash_i A)$ b. $A \quad \vdash \quad B\backslash_i(B/_i A)$

The index i is a variable for slash modalities. The purpose of this variable index here is to guarantee that the original combinatoric property is preserved after the application of TR. That is, TR reverses the functor-argument relationship between the categories

[16] In this paper, I omit the semantics. However, it should be noted that giving the standard model-theoretic semantics for the proposed syntactic fragment is straightforward. See Kubota and Smith (2006) for an illustration of how that can be done for a CCG fragment of Japanese similar to the present one.

[17] From these definitions of FC, it should be clear that the left and right associative modes introduced in the current system (and notated by the subscripts < and > on slashes) are for regulating the flexibility of the order of linguistic composition, that is, the order in which lexical resources having functor-argument relationships to one another are combined in a derivation. This should not be confused with the linear order of functors and arguments manifested in the surface string of words, which is represented by the slanting of slashes—right (/) and left (\)—as is traditionally done in categorial grammar.

involved, but the combinatory mode by means of which the two expressions are combined (which roughly corresponds to the morpho-syntactic cohesion between them) remains unchanged.

In addition to the above rules, I introduce the following unary rules to handle scrambling:[18,19]

(24) a. $A/_{\times}B/_{\times}C/_{\times}\$_1 \vdash A/_{\times}C/_{\times}B/_{\times}\$_1$ b. $A\backslash_{\times}B\backslash_{\times}C\backslash_{\times}\$_1 \vdash A\backslash_{\times}C\backslash_{\times}B\backslash_{\times}\$_1$

This enables a functor looking for two categories successively in the same direction to flip the order of these arguments. With this, each verb can be listed only once in the lexicon in its basic word order, with all other orders being obtained from that basic entry by successive applications of (24).[20]

Note the modality restriction on the permutative rules in (24). These rules can apply only when the modalities of the slashes for both arguments are permutative. This makes it possible to lexically specify elements that can be scrambled with one another without introducing too much flexibility for word order possibilities.

Finally, I assume the following lexical entries for the present fragment of Japanese. Note that the verb *morat-ta*, one of the predicates that appear as the higher verb in the *-te* form complex predicate construction, is specified to subcategorize for the embedded verb in the left-associative < mode. Since this mode is crucial in the analysis of this construction, I call it the 'complex predicate mode'.

(25)

Mary-ga:	NP_n	piano-o:	NP_a	gitaa-o:	NP_a
uta-o:	NP_a	John-ni:	NP_d	Bill-ni:	NP_d
hii-te:	$VP\backslash NP_a$	utat-te:	$VP\backslash NP_a$	muri-ni:	VP/VP
morat-ta:	$S\backslash NP_n\backslash NP_d\backslash_< VP$			sae:	$(VP\backslash NP_a)\backslash_\star(VP\backslash NP_a)$

Some remarks are in order regarding the abbreviations of notation adopted in (25) and throughout the paper. First, any slash without a specified modality is an abbreviation of /. or \., the most permissive mode. Second, the subscripts *n*, *a* and *d* on the category

[18]The semantics for these permutative rules can be defined as follows:

(i) a. $A/_{\times}B/_{\times}C/_{\times}\$_1 : \lambda x_0...x_n yz.\boldsymbol{\varphi} \vdash A/_{\times}C/_{\times}B/_{\times}\$_1 : \lambda x_0...x_n zy.\boldsymbol{\varphi}$
b. $A\backslash_{\times}B\backslash_{\times}C\backslash_{\times}\$_1 : \lambda x_0...x_n yz.\boldsymbol{\varphi} \vdash A\backslash_{\times}C\backslash_{\times}B\backslash_{\times}\$_1 : \lambda x_0...x_n zy.\boldsymbol{\varphi}$

With these definitions, the straightforward syntax-semantics interface of CCG is maintained.

[19]Here I adopt the $-convention as is standardly employed in CCG to define schematized categories. This is needed since the arguments of a verb that are to be scrambled with one another are not necessarily the two outermost ones.

$\backslash_{\times}\$_1$ in (24b) is to be understood as a metavariable used for category notation that can be instantiated to an arbitrary number (including zero) of iteration of the string '$\backslash_{\times}X$' (where X is a variable over categories and multiple tokens of X does not need to instantiate the same category). The subscript 1 on $ on the input and output ensures the identity of the string that the metavariable is instantiated to in the input and output category specifications. Thus, given the definition in (24b) and given a ditransitive verb category $S\backslash.NP_n\backslash.NP_d\backslash.NP_a$, there are two ways in which the rule can be applied to the input category: (i) instantiating B and C as NP_d and NP_a, respectively and instantiating $\backslash_{\times}\$_1$ as an empty string or (ii) instantiating B and C as NP_n and NP_d, respectively and instantiating $\backslash_{\times}\$_1$ as $\backslash.NP_a$. (i) yields the output $S\backslash.NP_n\backslash.NP_a\backslash.NP_d$ (where the dative and accusative arguments are scrambled) and (ii) yields the output $S\backslash.NP_d\backslash.NP_n\backslash.NP_a$ (where the nominative and dative arguments are scrambled).

[20]An important alternative to this account of scrambling is set-based CCG (Hoffman, 1995). Due to space limitations, I do not discuss this alternative in this paper.

NP are abbreviations for case features (nominative, accusative and dative) for nominal categories. For example, NP_n stands for a nominative NP. Third, *VP* is an abbreviation for the complex category $S\backslash NP_n$. Finally, regarding the associativity of slashes, where parentheses are omitted, the slashes should be taken to associate to the left. That is, $S\backslash NP_n\backslash NP_d\backslash_< VP$ is an abbreviation for $((S\backslash NP_n)\backslash NP_d)\backslash_< VP$. Other aspects of the lexicon will be explained as they become relevant in the next subsection.

4.2 Accounting for the patterns of *-te* form complex predicate

With the combinatory rules and the lexicon introduced in the previous subsection, an analysis of the *-te* form complex predicate that captures its intermediate nature is straightforward.

The analysis for sentence (3b), where an embedded accusative argument scrambles over a matrix dative argument, is given in (26):

(26)

			hii-te: $VP\backslash NP_a$	morat-ta: $S\backslash NP_n\backslash NP_d\backslash_< VP$
				FC: $S\backslash NP_n\backslash NP_d\backslash NP_a$
		John-ni: NP_d		Perm: $S\backslash NP_n\backslash NP_a\backslash NP_d$
	piano-o: NP_a			FA: $S\backslash NP_n\backslash NP_a$
Mary-ga: NP_n				FA: $S\backslash NP_n$
				FA: S

The crucial step is the application of the FC rule (21b), which effectively assigns the subcategorization frame of a ditransitive verb to the cluster of the V1 and V2.[21] FC is applicable here since the relevant slashes in the input categories are both left associative, satisfying the requirement on rule application in (21b).

Note also that the slash modality for the embedded accusative NP remains unchanged from the default mode, that is, the mode in which the V1 was originally looking for it. Technically, this is guaranteed by the Principle of Inheritance as discussed above. This yields the empirically desired result: the property associated with this NP with respect to a verbal category that looks for it, namely, that it can scramble with other dependents, is preserved after the application of this FC rule. That is, after the 'verb cluster formation' by means of FC, the permutative rule (24b) is applicable to the 'derived' ditransitive frame of the verb cluster and can scramble the embedded accusative argument over the matrix dative argument, producing the surface word order of (3b).

Example (4), that is, the example in which a matrix argument splits the sequence of the V1 and V2 is correctly blocked in the present analysis. In order for this sentence to be derived, the dative argument and the V2 would have to combine with one another first. However, that possibility is blocked due to the fact that the complex predicate mode is not permutative. (27) shows a blocked derivation in which an attempt to apply the permutative rule on the V2 fails due to the conflict between the lexical specification of the V2 and the modality restriction imposed on the permutative rule (24b):

[21] The use of FC for forming verb clusters is a standard technique for analyzing complex predicates in CCG (see, for example, the analysis of the Dutch cross-serial dependency construction by Steedman (2000)).

(27)
$$\frac{\text{John-ni}}{NP_d}\quad\frac{\dfrac{\text{morat-ta}}{S\backslash NP_n\backslash NP_d\backslash_< VP}}{S\backslash NP_n\backslash_< VP\backslash NP_d}\textbf{*Perm}$$

Furthermore, an attempt to derive the relevant order by means of type-raising the dative argument does not succeed either. As shown in (28), since the directionalities of the slashes of the two categories do not match after type-raising the dative argument, they cannot be composed by harmonic FC.[22]

(28)
$$\frac{\dfrac{\text{John-ni}}{NP_d}}{(S\backslash NP_n)/(S\backslash NP_n\backslash NP_d)}\text{TR}\quad\frac{\text{morat-ta}}{S\backslash NP_n\backslash NP_d\backslash_< VP}$$

The case of focus particle insertion is accounted for as follows. In the present analysis, the V1 and the V2 are combined in the syntax. Thus, nothing precludes the possibility of there being a still tighter mode of combination by which a focus particle attaches to the V1.[23] Thus, a focus particle is assigned the lexical category $(VP\backslash NP_a)\backslash_\star(VP\backslash NP_a)$ and the derivation for sentence (11) goes as in (29):

(29)
$$\dfrac{\dfrac{\dfrac{\text{piano-o}}{NP_a}\quad\dfrac{\text{hii-te}}{VP\backslash NP_a}\quad\dfrac{\text{sae}}{(VP\backslash NP_a)\backslash_\star(VP\backslash NP_a)}}{VP\backslash NP_a}\text{FA}\quad\dfrac{\text{morat-ta}}{S\backslash NP_n\backslash NP_d\backslash_< VP}}{VP}\text{FA}}{S\backslash NP_n\backslash NP_d}\text{FA}$$

$\star$ is the least flexible mode of linguistic composition, which admits only FA. This treatment of focus particles is motivated by the fact that focus particles attach to the head tightly and are not susceptible to any kind of structure-changing operations such as scrambling. The linguistic use of the $\star$ mode is not limited to focus particles; other particle-like elements such as case markers attaching to nominal expressions can arguably be treated by means of the $\star$ mode given that they are similarly not susceptible to structure-changing operations.[24]

Phenomena involving coordination are also straightforwardly accounted for. In fact, one of the main advantages of the present analysis is that, when coupled with independently motivated and standardly accepted assumptions about coordination in categorial grammar, it automatically predicts the possibility of VP coordination and the patterns of ACC without any further stipulation. Recall from the discussions in previous sections that the patterns exhibited by ACC and VP coordination apparently

[22]The only remaining possibility is crossed composition of the type-raised dative argument and the verb, but that is also impossible. Even if we assumed the existence of crossed composition rules in the current fragment (see footnote 28 for how crossed composition can be formulated if it turns out that it is needed in the current fragment), there is no danger of overgeneration. Crossed composition, being a kind of rule that affects word order, would require the relevant slash modalities to be permutative. However, one of the slashes, that is, the one by which the V2 is looking for the V1, does not carry a permutative mode. Thus, the rule would not be applicable in cases like (28).

[23]Semantically, the focus particle associates with elements in the 'embedded VP', but not with elements in the 'higher clause', which justifies the present treatment where it syntactically attaches to the V1 rather than the V2. Also, the focus particle forms a phonological unit with the V1 and not with the V2.

[24]However, for simplicity, I do not treat case markers as independent lexical items. In the present fragment, nominal expressions are listed in the lexicon with case markers already attached to them. This treatment is purely for expository ease and should not be taken seriously.

contradict one another in that the former but not the latter suggests a tight connection between the V1 and V2 and that these phenomena were the ones that posed problems for the alternative approaches considered above. Given this, the success of the MM-CCG analysis in this respect is a noteworthy aspect of the present proposal.

I posit the following coordination schema in order to treat cases of coordination that do not involve overt conjunctions without introducing phonologically null elements:[25]

(30) $\dfrac{X \quad X}{X}\,\&$

With this coordination schema, examples involving VP coordination such as (9) are licensed as in (31). Since the V1 and V2 do not form a lexical unit in the present analysis, two embedded VPs headed by the V1 can be coordinated and then given as argument to the V2.

(31)
$$\dfrac{\text{John-ni}}{NP_d} \quad \dfrac{\dfrac{\dfrac{\text{piano-o}}{NP_a} \quad \dfrac{\text{hii-te}}{VP\backslash NP_a}\,\text{FA} \quad \dfrac{\text{uta-o}}{NP_a} \quad \dfrac{\text{utat-te}}{VP\backslash NP_a}\,\text{FA}}{VP} \quad \dfrac{}{VP}\,\& \quad \dfrac{\text{morat-ta}}{S\backslash NP_n\backslash NP_d\backslash_< VP}}{S\backslash NP_n\backslash NP_d}\,\text{FA}}{S\backslash NP_n}\,\text{FA}$$

Cases of ACC involving arguments of the V1 and V2 such as (6a) are licensed by employing the analysis of nonconstituent coordination proposed by Dowty (1988). First, by successive applications of TR and FC, the embedded accusative argument and the matrix dative argument are combined into a category that is looking for a ditransitive predicate to its right to form a VP. Then, two such categories are coordinated and the resultant category combines with the 'ditransitive' predicate that is obtained by function composing the V1 and V2 in the same way as in the case of argument scrambling seen above. The derivation is shown in (32).

(32)
$$\dfrac{\dfrac{\dfrac{\text{John-ni}}{NP_d}\,\text{TR} \quad \dfrac{\dfrac{\text{piano-o}}{NP_a}\,\text{TR}}{(VP\backslash NP_d)/((VP\backslash NP_d)\backslash NP_a)}}{VP/((VP\backslash NP_d)\backslash NP_a)}\,\text{FC} \quad \dfrac{\text{Bill-ni gitaa-o}}{VP/((VP\backslash NP_d)\backslash NP_a)}}{VP/((VP\backslash NP_d)\backslash NP_a)}\,\&$$

$$\dfrac{\dfrac{\text{John-ni piano-o Bill-ni gitaa-o}}{VP/((VP\backslash NP_d)\backslash NP_a)} \quad \dfrac{\dfrac{\text{hii-te}}{VP\backslash NP_a} \quad \dfrac{\text{morat-ta}}{VP\backslash NP_d\backslash_< VP}}{(VP\backslash NP_d)\backslash NP_a}\,\text{FC}}{VP}\,\text{FA}$$

The ungrammaticality of ACC involving the V1 together with NP arguments of the V1 and V2 is also correctly predicted in the present analysis. In order to see the crucial aspect of the present analysis that rules out such ungrammatical sentences, it is useful to see how such sentences would be overgenerated in a system that does not make use of modality distinctions. In a non-modalized system where the operations of FC and

[25] The variable X ranges over categories. In order to prevent overgeneration, the actual categories that X can instantiate need to be appropriately constrained, but for the sake of simplicity I gloss over that aspect here.

TR would be freely available for any category, (6b) would be derived much along the same lines as the above analysis of argument cluster coordination for (6a). That is, the string composed of the matrix dative argument and the embedded VP (both of which are arguments of the V2) would be analyzed as a functor that would combine with the V2, which is looking for these two categories, and saturate the argument slots of the V2 corresponding to themselves in one swoop. (33) illustrates the crucial step at which such an argument cluster would be formed by TR and FC:

(33)

$$\dfrac{\dfrac{\dfrac{\text{John-ni}}{NP_d}}{(S\backslash NP_n)/((S\backslash NP_n)\backslash NP_d)}\text{TR} \quad \dfrac{\dfrac{\text{piano-o hii-te}}{VP}}{((S\backslash NP_n)\backslash NP_d)/(((S\backslash NP_n)\backslash NP_d)\backslash VP)}\text{TR}}{(S\backslash NP_n)/(((S\backslash NP_n)\backslash NP_d)\backslash VP)}\text{FC}$$

Now, in the current analysis formulated in MMCCG, such a derivation is ruled out. Specifically, when the embedded VP is type-raised over the category $S\backslash NP\backslash NP$, it has to be type-raised with the $<$ modality so that the resultant functor can ultimately combine with the matrix verb that has the $<$ modality specification imposed on the slash for the embedded VP. Thus, instead of (33), we have:

(34)

$$\dfrac{\dfrac{\dfrac{\text{John-ni}}{NP_d}}{(S\backslash NP_n)/((S\backslash NP_n)\backslash NP_d)}\text{TR} \quad \dfrac{\dfrac{\text{piano-o hii-te}}{VP}}{((S\backslash NP_n)\backslash NP_d)/_<(((S\backslash NP_n)\backslash NP_d)\backslash_< VP)}\text{TR}}{}\textbf{*FC}$$

Being in this category, the embedded VP cannot function compose by (21a) with the type-raised matrix dative argument since $<$ isn't right associative. In other words, the ungrammaticality of sentences like (6b) is predicted as a direct consequence of the intermediate degree of flexibility of the complex predicate mode.

Finally, the phenomenon of adverb scrambling poses an interesting challenge to the proposed MMCCG analysis. Up to this point, except for the unary permutative rules, I have assumed only two types of combinatory rules, namely, FC and TR. These two types of rules are among the set of combinatory rules that Baldridge (2002) assumes to be available in the grammar of natural language, following Steedman (1988; 2000).[26] Furthermore, among the two types of FC rules, the present fragment only made use of harmonic composition, dispensing with crossed composition rules for licensing any of the grammatical sentences seen above. This was possible since a distinct permutative rule was responsible for argument scrambling. However, it seems that these two types of rules, even in conjunction with the permutative rule in the present fragment, are not sufficient for deriving the full range of word order possibilities of adverbs. There are two approaches that one can pursue to deal with the problem of adverb word order: (i) admit crossed composition rules and (ii) extend the set of combinatory rules by introducing Geach rules. The latter solution turns out to be more general and there are cases that can be dealt with only in the latter approach (see footnote 28 for some discussion on this point). Thus, I adopt the latter approach in this paper.

[26]The other ones are FA and substitution; substitution is used for licensing parasitic gaps in languages that allow for them.

Example (5a), an example in which an embedded argument scrambles over an adverb that modifies the matrix predicate, can be derived by introducing the following Geach rule:

(35) $A/_{\times}B \;\vdash\; (A\backslash_{\times}C)/_{\times}(B\backslash_{\times}C)$

The derivation goes as follows:

(36)
$$\dfrac{\dfrac{\dfrac{\dfrac{\text{muri-ni}}{VP/VP}}{(VP\backslash NP_d)/(VP\backslash NP_d)}\mathbf{G}}{((VP\backslash NP_d)\backslash NP_a)/((VP\backslash NP_d)\backslash NP_a)}\mathbf{G} \quad \dfrac{\text{hii-te morat-ta}}{VP\backslash NP_d\backslash NP_a}}{VP\backslash NP_d\backslash NP_a}\text{FA}$$

Note that the Geach rule has the effect of associating the adverb with multiple categories, each modifying different 'levels of verbal projection'. Thus, applying this rule twice to a VP modifier yields a ditransitive verb modifier.

The fact that (5b) is ungrammatical is also correctly predicted. (37) shows a failed derivation for this sentence.

(37)
$$\dfrac{\dfrac{\dfrac{\dfrac{\text{muri-ni}}{VP/VP}}{(VP\backslash NP_d)/(VP\backslash NP_d)}\mathbf{G}}{((VP\backslash NP_d)\backslash VP)/((VP\backslash NP_d)\backslash VP)}\mathbf{G} \quad \dfrac{\text{morat-ta}}{VP\backslash NP_d\backslash_{<}VP}}{}\text{*FA}$$

The derivation in (37) fails at the point where the adverb is supposed to combine with the V2 by FA; the category specification of the V2 does not exactly match the category specification of the argument that the adverb is looking for. Note that the Geach rule, being an order changing rule, requires the relevant slashes to be permutative. Thus, applying the Geach rule (35) with the non-permutative < modality (which would eliminate the category mismatch problem in (37)) is not possible. In other words, here again, the lexical specification regulating the combinatoric flexibility of the *-te* form complex predicate correctly accounts for the possible word order variation in this construction.

The present fragment also correctly licenses sentences in which an adverb that modifies the embedded predicate scrambles over matrix arguments. Thus, (38) can be derived as in (39):

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

(39)
$$\dfrac{\dfrac{\text{yukkuri}}{(VP/VP)} \quad \dfrac{\dfrac{\text{John-ni}}{NP_d} \quad \dfrac{\dfrac{\dfrac{\dfrac{\text{piano-o}}{NP_a} \quad \dfrac{\text{hii-te}}{(VP\backslash NP_a)}}{VP}\text{FA}}{VP\backslash(VP/VP)}\mathbf{TR} \quad \dfrac{\text{morat-ta}}{VP\backslash NP_d\backslash_{<}VP}}{(VP\backslash NP_d)\backslash(VP/VP)}\text{FC}}{VP\backslash(VP/VP)\backslash NP_d}\text{Perm}}{VP\backslash(VP/VP)}\text{FA}}{VP}\text{FA}$$

The crucial step is the type-raising of the embedded VP to the category $VP\backslash(VP/VP)$, which makes the V1 subcategorize for an adverb that modifies it, as it were. The adverb that is 'reanalyzed' as an argument is then raised to the clausal domain of the V2 via the usual process of function composition of the V1 and V2 and is further scrambled over the matrix dative argument by means of the permutative rule, resulting in the word order in (38).[27]

Finally, examples like the following can also be derived in the present analysis:

(40) 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.'

The difference between (38) and (40) is that in (40) an embedded argument scrambles over a matrix argument together with an adverb that modifies the embedded verb. The derivation goes as follows:[28]

(41)

$$\dfrac{\dfrac{\text{piano-o}}{NP_a} \quad \dfrac{\dfrac{\text{yukkuri}}{VP/VP}}{(VP\backslash NP_a)/(VP\backslash NP_a)}\,\mathbf{G} \quad \dfrac{\text{John-ni}}{NP_d} \quad \dfrac{\dfrac{\dfrac{\text{hii-te}}{(VP\backslash NP_a)}}{(VP\backslash NP_a)\backslash((VP\backslash NP_a)/(VP\backslash NP_a))}\,\text{TR} \quad \dfrac{\text{morat-ta}}{VP\backslash NP_d\backslash_< VP}}{((VP\backslash NP_d)\backslash NP_a)\backslash((VP\backslash NP_a)/(VP\backslash NP_a))}\,\text{FC}}{(VP\backslash NP_a)\backslash((VP\backslash NP_a)/(VP\backslash NP_a))\backslash NP_d}\,\text{Perm}}{(VP\backslash NP_a)\backslash((VP\backslash NP_a)/(VP\backslash NP_a))}\,\text{FA}}{VP\backslash NP_a}\,\text{FA}$$

$$VP$$

In this derivation, the V1 is reanalyzed as a verb that subcategorizes for a modifier of a transitive verb and that transitive verb modifier is raised to the 'domain' of the V2 and gets scrambled over the matrix dative argument. Then, the Geached adverb in the matrix clause matches the transitive verb modifier category that the complex predicate is looking for and the two are combined to make the derivation go through.

In this section, we have seen that the present analysis of the *-te* form complex predicate accounts for the apparently contradictory set of patterns exhibited by this construction straightforwardly and naturally.[29] The key insight of the proposed analysis is

[27] This analysis of scrambling of embedded adverbs with matrix arguments is somewhat reminiscent of the treatment of the sublexical scope of adverbs by means of the so-called adjunct-as-argument approach in Manning et al.'s (1999) HPSG analysis of the Japanese causative construction. (But note that the present analysis gets the effect by a fully general interaction of TR and FC, whereas Manning et al.'s (1999) HPSG analysis involves a specific lexical rule that introduces an adjunct into the argument structure list of a predicate.)

[28] Examples like (40) cannot be derived with crossed composition and thus seems to motivate the introduction of Geach. By introducing the following crossed composition rule:

(i) $A/_\times B \quad B\backslash_\times \$_1 \quad \vdash \quad A\backslash_\times \$_1$

some cases of adverb word order (such as (5a)) can be derived. However, (40) is still underivable; the derivation would proceed in the same way as in (41), but fails at the step where the complex predicate discharges the raised adverb. Without the Geach rule, there is no way to resolve the mismatch between the category specification of the adverb (a VP modifier) and what the complex verb is looking for (a transitive verb modifier).

[29] I have not discussed the cases of clefts, postposing or reduplication. These phenomena are not inconsistent with the proposed analysis, and once specific assumptions about the respective phenomena are spelled out in the current fragment, the patterns of the *-te* form complex predicate with respect to these phenomena will fall out straightforwardly. The analysis of the cleft construction that interacts

that the V1 and V2 in the *-te* form complex predicate are put together in a way that is tighter than the way ordinary arguments and adjuncts are combined with the head but looser than the way in which elements like particles are attached to the head. This idea is formally implemented in the framework of MMCCG by assigning a distinct mode of linguistic composition to the *-te* form complex predicate for which the set of combinatory rules applicable is restricted.

5 Conclusion

In this paper, I proposed an analysis of the *-te* form complex predicate in Japanese in Multi-Modal Combinatory Categorial Grammar. The proposed analysis crucially makes use of the multiple modes of syntactic composition of lexical elements available in MMCCG in capturing the intermediate nature of the construction with respect to the tightness of bond between the embedded and embedding verbs. Unlike alternative approaches in other frameworks, since the lexical property of the verbs that take *-te* marked complements fully accounts for the range of seemingly contradictory patterns, the present analysis does not suffer from the dilemma of having to assign conflicting syntactic structures to one and the same string of words. More specifically, in the proposed analysis, the contrast between the complex predicate mode and the default mode (i.e. the mode that allows for scrambling) accounts for the word order patterns found in the scrambling and adverb placement data, where the V1 and V2 cluster together, letting all of their arguments and adjuncts freely scramble with one another. Crucially, this effect is achieved without assuming that the V1 and V2 form a lexical unit. Thus, the phenomena of VP coordination and focus particle insertion do not pose any problems for the present analysis. Finally, we saw that the contrast between VP coordination and ACC, the hardest problem for previous approaches, is given a straightforward solution in the proposed analysis. It was shown that independently motivated assumptions regarding coordination interact with the property of the *-te* form complex predicate to precisely predict the patterns without any additional assumptions.

In closing, I would like to discuss briefly wider implications of the present proposal both theoretically and empirically. First, on the theoretical side, although the present proposal is formulated in MMCCG and is in line with the general assumptions regarding the theoretical architecture outlined in Baldridge (2002), it differs in a nontrivial way from the specific system proposed by Baldridge in the following details:

properly with the present analysis of the *-te* form complex predicate is presented in Kubota and Smith (2007). The right way to analyze the syntax of postposing is rather unclear and is underinvestigated in the current syntactic literature (with a notable exception of Sells (1999)). However, it seems that at least one of the syntactic restrictions on the postposing construction is that neither the element that appears at the main clause position nor the element that appears at the postposition site can be smaller than full-fledged phrases. Given this, it is expected that the pattern of postposing will be accounted for along similar lines as the cases of ACC and the cleft construction, once the details of the syntax of postposing are worked out. Finally, the case of reduplication can be seen as a case similar to VP coordination. In the reduplication construction, the element that appears twice is the V2 rather than a projection of the V1. Because the V1 and V2 are combined in the syntax rather than in the lexicon in the present proposal, the patterns of reduplication do not pose a problem regardless of whether reduplication is treated as a lexical or a syntactic process.

(i) The present system assumes a different hierarchy of modes that distinguishes two associative modes but does not distinguish different permutative modes.

(ii) The present system posits unary permutative rules for handling scrambling unlike Baldridge's system that employs multiset categories originally proposed by Hoffman (1995) for the same purpose.

(iii) The present system posits a Geach rule that is not recognized as a combinatory rule in standard versions of CCG including Baldridge's.[30]

As far as I can tell, the particular choices made by Baldridge (2002) regarding these aspects mostly come from considerations of the generative capacity of the formalism and not from any theoretical or empirical considerations of MMCCG as a linguistic theory per se. While I do not intend to question these features of Baldridge (2002) solely based on the data from Japanese that I have discussed in this paper, these points of comparison are still interesting in that they highlight some issues that need to be ultimately answered in a theory that does justice to both empirical/theoretical adequacy and computational tractability. I hope that the detailed analysis of a relatively complicated set of data that I have conducted in this paper will serve as a starting point for investigating this issue (i.e. the tension between different kinds of requirements imposed on grammar architecture) in greater depth.[31]

Second, on the empirical side, the analysis that I have proposed in this paper resembles (in some respects) the kind of analysis of complex predicates in terms of argument composition in HPSG. A brief comparison of the present approach and an argument composition-based alternative is in order here. The resemblance between the two approaches is most striking in the way in which function composition is made use of in capturing the complex-predicatehood of the *-te* form complex predicate in the present analysis. Essentially, function composition is used to pass unsaturated arguments of the lower verb to the higher verb. Argument composition in HPSG is basically a mechanism that achieves the same effect within the phrase structure-based setup of HPSG.

However, there are important differences between the two approaches. First, function composition in categorial grammar is a general mechanism that ultimately reflects a property of the underlying logical system, whereas argument composition only indirectly models that effect, as it were, by means of a specifically tailored phrase structure rule. Second, while the present analysis directly captures the intermediate degree of morpho-syntactic combinatoric flexibility of the *-te* form complex predicate by means of a lexically assigned modality specification, there does not seem to be any comparable mechanism within the phrase structure-based setup of HPSG.[32] Thus, in the latter approach, the relevant morpho-syntactic properties (such as the restriction on the

[30] It should, however, be noted that Jacobson (1999) assumes Geach rules in a CCG-like system for an entirely different reason (quantificational binding) than the present one.

[31] In this connection, it is interesting to note that these specific issues will not arise if one recasts the present analysis in TLG, which has a more general and less constrained overall theoretical architecture than CCG. (For example, note that both FC and Geach are theorems that are derived from more basic principles in TLG and thus having the former without the latter is not even an option.) Thus, the problems considered in this paper can also be seen as providing an empirical basis for a comparison of different variants of categorial grammar.

[32] This is not quite true with linearization-based HPSG. However, the linearization-based analysis of

kinds of elements that can split the sequence of the V1 and V2) can only be indirectly regulated by adjusting phrase structure rules, lexical specifications of relevant items and LP principles to interact properly with one another. Third, as I have pointed out in section 3.3, even with these elaborations in place, empirical problems still seem to remain in the argument composition-based approach, such as the contrast between embedded VP coordination and ACC. Given these considerations, it seems fair to say that the setup of MMCCG allows for a more general and straightforward solution to the problem in question than the phrase structure-based setup of HPSG does, although an analysis in terms of argument composition will share many important analytical insights with the present proposal due to the similarity between the two approaches.

Finally, there is a somewhat more general point pertaining to linguistic theorizing. The proposed analysis of the *-te* form complex predicate crucially makes use of the notion of different 'modes' of syntactic composition, which (in some sense) replaces the notion of constituency in more standard syntactic theories. Obviously, in order to see whether such a (radical) reconceptualization of theoretical primitives is justified, the theoretical architecture of the kind embodied by MMCCG needs to be compared thoroughly with alternative theories in terms of a wide range of empirical phenomena. What I have done in this paper should be understood as nothing more or less than a first step in such an investigation.

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complex predicates in HPSG such as is proposed by Reape (1994) misses some important generalizations that the argument composition-based analysis captures, as discussed by Kathol (1998). I think that both the linearization-based analysis and the argument composition-based analysis are right in some respects and that the present analysis in MMCCG can be seen as integrating the insights of these different approaches within a single framework. I hope to discuss this point more thoroughly in a longer version of this paper.

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